BME Design-Spring 2026 - NICOLAS MALDONADO
Complete Notebook

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NAVYA JAIN

on

Apr 29, 2026 @11:20 PM CDT

Table of Contents

Team contact Information

Shreya Venkatesh - Jan 30, 2026, 8:02 AM CST

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Project description

Shreya Venkatesh - Feb 20, 2026, 11:14 AM CST

Course Number: BME 301 - Lab 302

Project Name: Smart Walker

Short Name: Smart Walker

Project description/problem statement: The client, a physical therapist working in neuro-rehabilitation, has several patients who use walkers as transition devices. He needs a smart walker for his patients that can objectively measure gait speed, distance walked, and the weight/force applied through the walker. Data is required by Medicare to demonstrate progress and efficacy, but can also help improve clinical assessment and motivate patients as they work to reduce device dependence. Currently, quantitative measurements are taken manually, which is time-consuming and incomplete, as there is no way to measure weight-bearing. Two prototypes have been made by modifying an existing walker, but this compromises structural integrity and is not viable for patient testing. The main goal is to develop a safe, attachable assessment device that provides real-time, clinically relevant gait and weight-bearing data for use with standard walkers by clinicians and patients.

About the client: Mr. Daniel Kutschera is a physical therapist specializing in neuro-rehabilitation at the Encompass Hospital in Fitchburg.

2026/02/02 - Client Meeting 1

Shreya Venkatesh - Feb 02, 2026, 10:14 AM CST

Title: Client Meeting 1

Date: 02/02/2026

Content by: Shreya Venkatesh

Present: Kim Waldman, Nic, Shreya, Navya

Goals: Learn about the project, let the client know about improvements, and make introductions

Content:

- Client requirements
    - Having the ability to measure independently (weight vs distance)
    - Display (patients want to see what their doing, real time display, cell phone clip)
    - Integration with the display and website together
    - Making the design more sleek
    - Portable
- Patients are only with the client for 2 weeks, and progress away from the walker
    - gait speed
    - how far they walke
- Visiting the Rebah Hospital (view high-tech equipment)
- Expenses
    - Save expenses along the way or at the end through Venmo
    - Budget: ~$500

Conclusions/action items: I think we need to come up with some ideas for the display on the walker and find a way to separate the weight/distance data collection, as those are requirements the client has added this semester.

2026/03/04 - Client Meeting 2

Shreya Venkatesh - Mar 04, 2026, 5:26 PM CST

Title: Client Meeting 2

Date: 04/03/26

Content by: Shreya Venkatesh

Present: All team, Client

Goals: Update the client with what we have been up to and purchasing plans

Content:

- Client thoughts:
  - What are the plans for the projection screen?
    - Mount has a phone on the walker, create an app on the phone interface
  - How will patients see real-time data?
    - A mount is required so that real-time data can be seen by the client and/or user
  - The mmwave radar needs to be linear range, track a longer range (the corridor is up to 500ft), so sometimes they might be testing walking as much as possible
  - Calculations of gait speed have to be non-linear as well
  - Long distance: 150ft ~ 50m (looking for a larger range mmwave radar)
  - He loves the schematic!

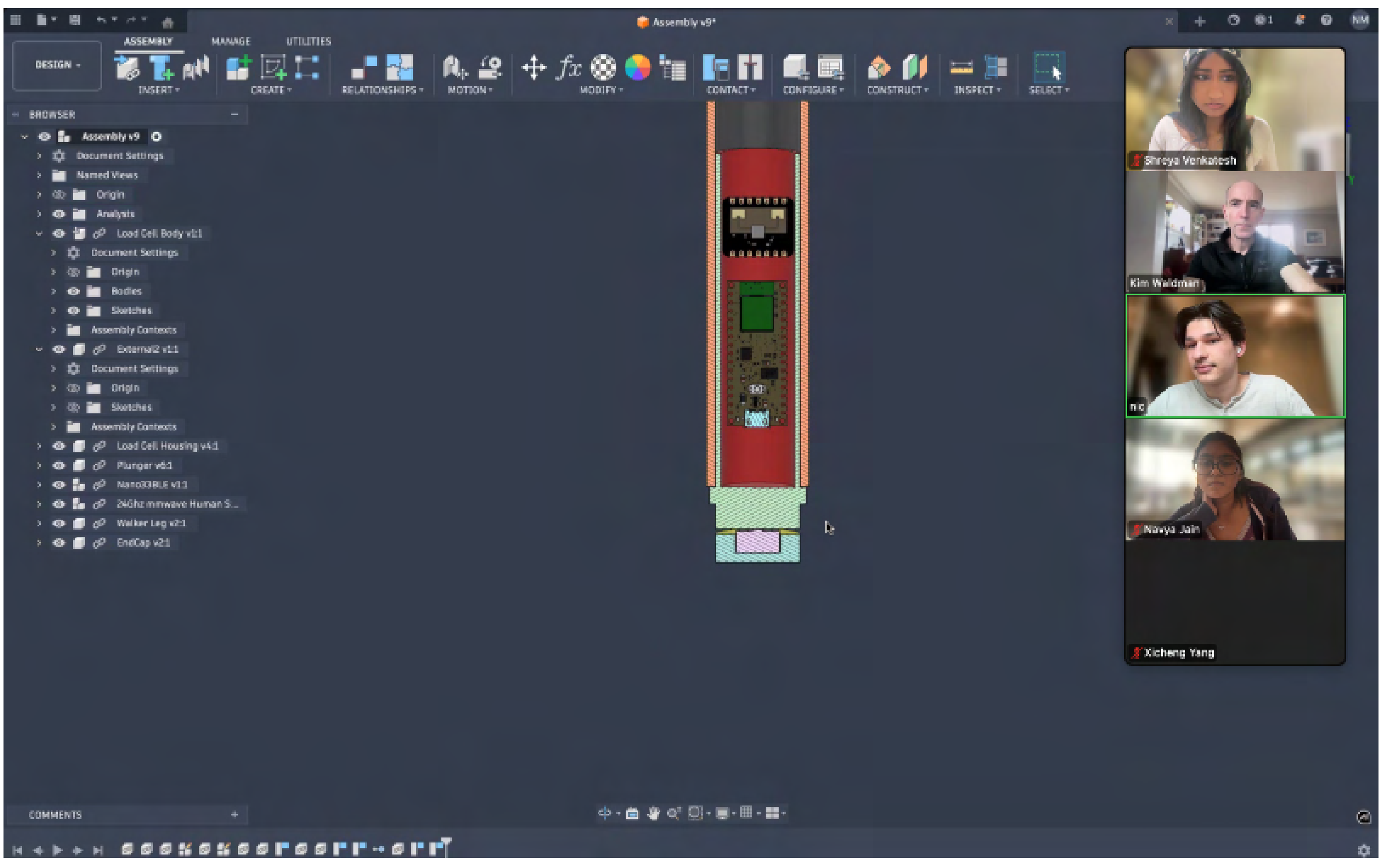


Figure 1: Showing the client the hardware plans

Conclusions/action items: We could look at mmwave radar sensors that are looking at a wider distance (>12m) and high frequency mapping, research non-linear distance calculations (how accurate is the protocol)

We were looking at this mmWave radar: IWR6843

2026/04/27 - Client Meeting 3

Shreya Venkatesh - Apr 29, 2026, 2:13 AM CDT

Title: Client Meeting 3

Date: 27/04/2026

Content by: Shreya Venkatesh

Present: All team, client

Goals: Show client final prototype, testing results, and patent opportunities

Content:

- Next semester, we could go to the clinic and test with the patient
- Patent process is a good next step, he doesn't know many details though

Conclusions/action items: We should discuss with our advisor about the patent process and how feasible it would be to get started.

2026/01/30 - Advisor Meeting 1

Shreya Venkatesh - Feb 02, 2026, 10:14 AM CST

Title: Advisor Meeting 1

Date: 30/01/2026

Content by: Shreya Venkatesh

Present: All Team, Advisor, TA

Goals: Figure out semester expectations and goals

Content:

- Thursday - client availability
- Meet with TA for next Friday
- Look at past group work and evaluate from the beginning (new plans)
- PDS (Thursday due date)
- Thursday, 10 pm advisor reviews Canvas/notebook tasks
- LIDAR - prone to false data -> ultra Y-band boards (very accurate)
- Change the 3D print
- Replace the load cells
- Look at the accelerometer (compare to the ones on Arduino)
- Changing WIFI based website to Bluetooth -> standardization
- Gpath - velocity-based training - hooks onto training equipment
- Notebook should show progress of the design process (>1 weekly entries, structured, complete as soon as possible)

Conclusions/action items: For this weekend, the newer members should become more familiar with the project, do some research, and look at the old PDS make all the required changes. We would like to get a first draft of the PDS by Tuesday, so we have time to make appropriate changes.

2026/02/06 - Advisor Meeting 2

Shreya Venkatesh - Feb 06, 2026, 12:21 PM CST

Title: Advisor Meeting 2

Date: 06/02/2026

Content by: Shreya Venkatesh

Present: All group, TA

Goals: Learn about next step goals for designing, prototyping

Content:

- Instead of replacing the end cap, create a 3d printed insert (Nic is creating a prototype)
- Look into creating a routine schedule for client meetings
    - Maybe meeting with the client to review the PDS
- PDS feedback
    - Nothing to report, just keep updating everything and have reasoning for specific numbers
- General next steps
    - Start prototyping, ordering materials, and design matrix (earlier the better to get feedback)
    - 2 design matrices by next week would be good

Conclusions/action items: I think it would be good to create a design matrix, and maybe include a CAD model.

2026/02/13 - Advisor Meeting 3

Shreya Venkatesh - Feb 13, 2026, 12:25 PM CST

Title: Advisor Meeting 3

Date: 13/02/2026

Content by: Shreya Venkatesh

Present: All team, Advisor, Mentor

Goals: Progress report updates, next step

Content:

- We filled in what happened during the first client meeting and the communication patterns with him
- For sensors, it should be easy to solder and integrate with platforms that we already have experience with
- Make sure that the load cell has a realistic range, and even if between the two covers 250, it should anticipate that patients might now be putting the weight on both at the same time at all times
- For ordering, look at the modality of data, and plan to implement it
    - Sensor matches up with the analog input on the Arduino
    - Output of the load cells (piezoelectric, preamplifier)
        - The dynamic range of the load cell, from the input of the amplifier to the output range of the amplifier, should match the analog
    - What is the plan for power, power transmission
    - Don't confine to Arduino Uno, what about Nucleo as a smaller option?
- Practice all the slides together

Conclusions/action items: We can reach out if we need any targetted feedback for the presentation.

2026/02/27 - Advisor Meeting 4

Shreya Venkatesh - Mar 06, 2026, 3:22 PM CST

Title: Advisor Meeting 4

Date: 27/02/2026

Content by: Nicolas Maldonado

Present: All team, Advisor, Mentor

Goals: Initial Design

Content:

- We discussed the next steps in design
- Found out components would fit inside one housing
- Discussed component selection

Conclusions/action items: Have a complete initial design by next meeting

2025/03/06 - Advisor Meeting 5

Shreya Venkatesh - Mar 06, 2026, 3:22 PM CST

Title: Advisor Meeting 5

Date: 06/03/26

Content by: Shreya Venkatesh

Goals: Review progress with TA and ask for next step feedback

Content:

- Start mmWave radar housing design
- Do some market research and receive design feedback
- Purchase materials by the weekend/early next week
- Continue updating the client on progress and offer opportunities to show your work

Conclusions/action items: I think we need to finish ordering materials soon and start designing the sensor housing as our next key steps.

2026/03/13 - Advisor Meeting 6

NICOLAS MALDONADO - Mar 17, 2026, 12:52 PM CDT

Title: Advisor Meeting 6

Date: 13/03/26

Content by: Nicolas Maldonado

Goals:

Content:

- Show and tell next week in ECB
- Design a clamp that will allow attatchment to the walker body
- Try and finish the prototype by this week

Conclusions/action items:

2026/04/10 - Advisor Meeting 8

Shreya Venkatesh - Apr 10, 2026, 12:20 PM CDT

Title: Advisor Meeting 8

Date: 10/04/2026

Content by: Shreya Venkatesh

Present: All team members

Goals: Figure out next steps for the design process and testing

Content:

- Executive Summary Feedback
  - Next Friday submission
- Find a different time to meet next Friday or throughout the week (engineering expo)
  - Thursday 12:00 - 12:30
- mmWave radar testing: Kinovia
  - distance
  - velocity
- Load cell testing
  - uniform weight applied
  - how long does it take for the load cell to get started when in use?
  - range of weight values - according to user
- Focus on the client interpretation.

Conclusions/action items: We need to start testing soon and getting some quantitative feedback from the design.

2026/04/16 - Advisor Meeting 9

Shreya Venkatesh - Apr 27, 2026, 8:54 AM CDT

Title: Advisor Meeting 9

Date: 16/04/2026

Content by: Shreya Venkatesh

Present: All team, advisor, TA

Goals: Share progress and next steps

Content:

- We shared the updates on testing, and he mentioned that we should have a test with the load cell that considers different weight increments on a standard scale
- Other than that, think about the judging pitch (focus on quantitative values, focus on load cell holder design)

Conclusions/action items: We will need to perform load cell testing in a location where incremental weights are available (gym?), also do some research for the judging pitch

2026/02/25 - Lecture 5 - Diversity and Inclusion Assignment

Shreya Venkatesh - Feb 25, 2026, 2:01 PM CST

Title: Diversity and Inclusion Assignment

Date: 25/02/2026

Content by: All team

Present: All team members

Goals: Think about solutions for expanding diversity and inclusion

Content:

- What components of your design can be improved?
  - The user cannot hold the walker with their hands
  - Visually appealing for kids to encourage usage
- Which of the 7 principles are you addressing?
  - Equitable use because we are looking for avenues to include users who don't have the ability to use their hands (hand disabilities) and possibly encourage more usage among children (younger audiences).
  - Flexibility because we are able to separate components of the smart walker to track specific quantitative measurements, such as just the load cell/end cap to measure force, or just the mmWave radar for speed and distance.
- How can you make these improvements? (What is your action plan?)
  - For users who cannot use their hands, we could add an attachment on the handrails that allows the individual to be strapped in and provides a secure anchor point.
  - For children, we could try adding stickers or different colors to 3D prints (end caps, containers).

Conclusions/action items: We should make the attachements and future works would include brainstorming visually appealing designs, so that more individuals can use our design.

2025/03/20 - Show and Tell Notes

Shreya Venkatesh - Mar 20, 2026, 2:43 PM CDT

Title: Show and Tell Notes

Date: 20/03/2026

Content by: Shreya Venkatesh

Goals: Learn about ways to connect arudino to mmwave radar (bluetooth), design ideas for load cell compartment and wiring, general notes

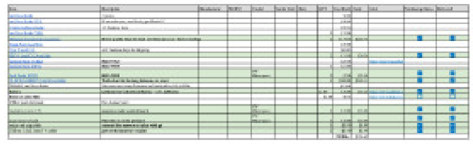
Content:

1. end cap (creating a wider slit that's slanted, creating a thicker height for the load cell compartment)
2. data collection (graph for weight over time)
3. connect Arduino to MmWave radar (connect SPI, I2C, serial connection, puttey app - serial monitor, FBGA, pre built recommend connect both to battery or powering Arduino 5V to wave radar, Dr.N, Uart)
4. electrical housing printing (abs, petg)

Conclusions/action items: Yang said he will explore the recommended options to connect the Arduino to the mmwave radar, and Nic said he will reprint the electrical housing and incorporate the design changes for the load cell wiring to fit better. Navya and I will be working on the testing protocols and soldering some items.

Expense Sheet

NAVYA JAIN - Apr 28, 2026, 10:44 PM CDT



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BME_301_-_Smart_Walker_-_Expense_Spreadsheet_-_Finalisd_Expenditures.pdf (84 kB)

13/4/2026: Soldering and mmWave Radar Calibration

NAVYA JAIN - Apr 28, 2026, 10:20 PM CDT

Title: Soldering and mmWave Radar Calibration

Date: 13/4/2026

Content by: Navya

Present: Navya, Nic, Yang, Shreya

Goals: To solder a load cell amplifier for testing purposes.

Content:

During this team, our team spent 3 hours at the makerspace soldering some of the electrical components together while Yang worked on the mmWave Radar calibration. There was an issue with the mmWave Radar in which it wouldn't connect to the app via bluetooth so he was attempting to work on that. Nic, Shreya and Navya worked on the soldering aspect and performed continuity tests on the soldered parts to make sure they were soldered properly.

Conclusions/action items:

Yang got the mmWave radar calibration working so now we will solder the rest of the electrical system and attempt to begin testing soon.

15/4/2025: App Connectivity

NAVYA JAIN - Apr 28, 2026, 10:24 PM CDT

Title: App Connectivity

Date: 15/4/2026

Content by: Navya

Present: Navya, Nic, Shreya, Yang

Goals: To make sure all of the electrical components are working

Content:

We could not meet for long today but we got the mmWave radar hooked up to a battery source and talked about how to make the design more compact, as well as discussed adjusting the measurements of the load cell housing.

Conclusions/action items:

The next step will be testing.

22/4/2026: Soldering

NAVYA JAIN - Apr 28, 2026, 10:44 PM CDT

Title: Soldering

Date: 22/4/2026

Content by: Navya

Present: Yang, Nic

Goals: To solder everything to solder boards and but them all in their respective housing units.

Content:

Nic and Yang soldered the entirety of the electric system as needed and placed them in their housing compartments to be ready for the poster presentation on Friday.

Conclusions/action items:

None

28/4/2026: mmWave Radar Testing Protocol

NAVYA JAIN - Apr 28, 2026, 10:26 PM CDT

Title: mmWave Radar Testing Protocol

Date: 28/4/2026

Content by: Navya

Present: N/A

Goals: To write a testing protocol for the mmWave Radar testing procedure

Content:

Aim: To evaluate the accuracy and reliability of the mmWave radar system for distance measurement, the radar measurements were compared to position data obtained from Tracker motion analysis software using a calibrated video reference setup. This comparison allowed verification of radar performance under controlled motion conditions representative of expected walker operation.

Materials:

- mmWave radar sensor system (mounted in walker housing)
- Arduino data acquisition system
- Computer with serial monitor and Tracker motion analysis software installed
- Meter stick (for spatial calibration reference)
- Camera (fixed-position recording setup)
- Walker prototype
- Flat indoor testing area

Protocols:

Data Collection from Load Cells

1. Position the walker at the starting location within the camera's field of view.
2. Place a meter stick along the motion path so that a known 1-meter reference distance is clearly visible for Tracker calibration.
3. Begin recording video using the fixed-position camera before initiating walker movement.
4. Start the Arduino serial monitor to record mmWave radar distance measurements.
5. Push the walker forward along a straight path at a natural walking speed while the mmWave radar continuously records distance data.
6. Stop recording once the walker reaches the end of the motion path.
7. Repeat the walking trial three times to evaluate measurement repeatability.
8. Upload the recorded video into Tracker motion analysis software.
9. Calibrate Tracker using the visible 1-meter reference length from the meter stick.
10. Track the walker position frame-by-frame within Tracker to obtain ground-truth displacement data.
11. Export displacement measurements from Tracker for comparison with mmWave radar measurements.

Data Analysis for Data Collected from Load Cells

1. Align mmWave radar distance measurements with corresponding Tracker displacement values using timestamps or frame matching.
2. Compute absolute error between radar-measured displacement and Tracker-measured displacement for each data point.
3. Calculate percent error across all trials
4. Compute the mean percent error across all trials to determine overall radar accuracy.
5. Calculate the standard deviation of measurements across repeated trials to evaluate repeatability.
6. Generate a plot comparing mmWave radar displacement measurements to Tracker displacement measurements.
7. Generate an additional error-versus-distance plot to evaluate how measurement accuracy changes across the operating range.

Conclusions/action items:

Adjust the protocol as needed for future testing.

28/4/2026: Load Cell Testing Protocol

NAVYA JAIN - Apr 28, 2026, 10:28 PM CDT

Title: Load Cell Testing Protocl

Date: 28/4/2026

Content by: Navya

Present: N/A

Goals: To write a testing protocol for the load cell testing

Content:

Aim: Test the weight capacity of our load cells (individually). To verify the accuracy of our calibrated load-cell system, we will compare its measurements with those from a digital reference scale with known accuracy. Both the walker and the reference scale will be placed on the same flat, level surface to minimize variation due to uneven loading. Each load cell will be tested, and data will be collected individually, as each has its own amplifier and Arduino system.

Materials:

- Load cell system (Load cell, amplifier, Arduino)
- Computer?
- Walker
- Rigid board - uniform loading platform
- Weights: 0lb, 25lb, 50lb, 75lb, 100lb, 125lb, 150lb, 175lb, 200lb

Protocols:

Data Collection from Load Cells

1. Lay the rigid board across the walker's handle grips to create a uniform loading platform; the board's weight will be measured on the reference scale beforehand and included in all load calculations.
2. Accuracy will be assessed using linear weight increments of 25 pounds, starting from 0lb up to 300lb. The load must be placed carefully and centrally on the board so that the applied force is evenly distributed across both handle grips.
3. Allow 10 seconds for the load-cell reading to stabilize, then record the walker's measurement.
4. Transfer the same weight setup, including the board, to the reference scale to obtain the true load value.
    1. Repeat this process for three full trials at each load increment to evaluate both accuracy and repeatability.
    2. Additional repeated measurements at a single mid-range load (such as 150 lb) will be collected to assess consistency over time.
5. The walker and reference readings from each trial will be used to calculate absolute error, percent error, and variability across the full operating range, allowing us to determine how well the load-cell system performs under controlled loading conditions.

Data Analysis for Data Collected from Load Cells

Once all measurements have been collected, we will analyze the load-cell system's accuracy by directly comparing the walker's recorded values to the corresponding readings from the reference scale at each 25-lb increment.

1. For each load level, the absolute error (walker reading minus reference reading) must be calculated, and the percent error relative to the true load must be reported. These calculations will be performed for each of the three repeated trials to determine the extent of variation in the readings under the same loading conditions.
2. Compute the mean error and standard deviation across trials for each load to evaluate the sensors' accuracy and repeatability.
3. To visualize performance across the full range, generate a plot comparing the walker's measured load to the reference scale values, as well as an error-versus-load plot to illustrate how measurement error changes with increasing weight.
4. The board's weight will be included in every data point so that the analysis reflects the true load applied to the system. If the mean percent error remains low and consistent across the 0–300 lb range and the variation between repeated trials is small, we will conclude that the load-cell system maintains reliable accuracy throughout its operating range.

Conclusions/action items:

Adjust this protocol as needed for future testing

20/4/2026: Load Cell Testing

NAVYA JAIN - Apr 28, 2026, 10:31 PM CDT

Title: Load Cell Testing

Date: 20/4/2026

Content by: Navya

Present: Navya, Nic, Shreya, Yang

Goals: To calibrate the load cells and test them

Content:

Unfortunately we were unable to complete the load cell testing as we realised that we did not have access to the weighing machine necessary to calibrate the load cells properly. In the calibration of the load cell in the code, a calibration factor is required but this is obtained by weighing various objects on the load cell and seeing the value that is recorded on the app and seeing how the values vary from the literature value. We did end up working on other components such as getting the electrical system together though.

Conclusions/action items:

To complete the load cell calibration and testing.

21/4/2026: mmWave Radar Testing

NAVYA JAIN - Apr 28, 2026, 10:37 PM CDT

Title: mmWave Radar Testing

Date: 21/4/2026

Content by: Navya

Present: Navya, Nic, Shreya, Yang

Goals: To complete the mmWave Radar Testing

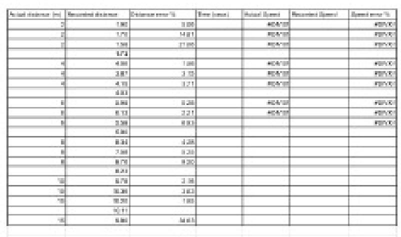
Content:

We used the mmWave Radar to walk from 2-10meters in increments of 2m and compared the values that were obtained via the app with the literature value. We only started with going up to 10m because typically a 10m walk test is utilised to measure the progress of the patient. If we would like to record distances greater than 10m it would require the calibration code for the mmWave Radar to change so that could be something that we do in future works.

Conclusions/action items:

Analyse the data and create the graphs necessary for the poster. Change the calibration code to record distances about 10m.

NAVYA JAIN - Apr 28, 2026, 10:37 PM CDT



Actual distance (m)	Recorded distance	Distance error %	Time (secs)	Actual Speed	Recorded Speed	Speed error %
2	1.90	5.05		#DIV/0!		#DIV/0!
2	1.70	14.81		#DIV/0!		#DIV/0!
2	1.58	21.05		#DIV/0!		#DIV/0!
	1.73					
4	4.00	1.00		#DIV/0!		#DIV/0!
4	3.87	3.35		#DIV/0!		#DIV/0!
4	4.13	3.21		#DIV/0!		#DIV/0!
	4.03					
6	5.98	0.28		#DIV/0!		#DIV/0!
6	6.13	2.21		#DIV/0!		#DIV/0!
6	[illegible]	[illegible]				#DIV/0!
	[illegible]					
8	8.34	4.28				
8	7.98	[illegible]				
8	8.70	[illegible]				
	8.24					
10	9.78	[illegible]				
10	10.38	[illegible]				
10	10.20	[illegible]				
	10.11					
10	[illegible]	[illegible]				
		[illegible]				

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mmWave_Radar_Testing_-_Sheet1.pdf (39 kB)

21/4/2026: mmWave Radar Testing Results

NAVYA JAIN - Apr 28, 2026, 10:36 PM CDT

Title: mmWave Radar Testing Results

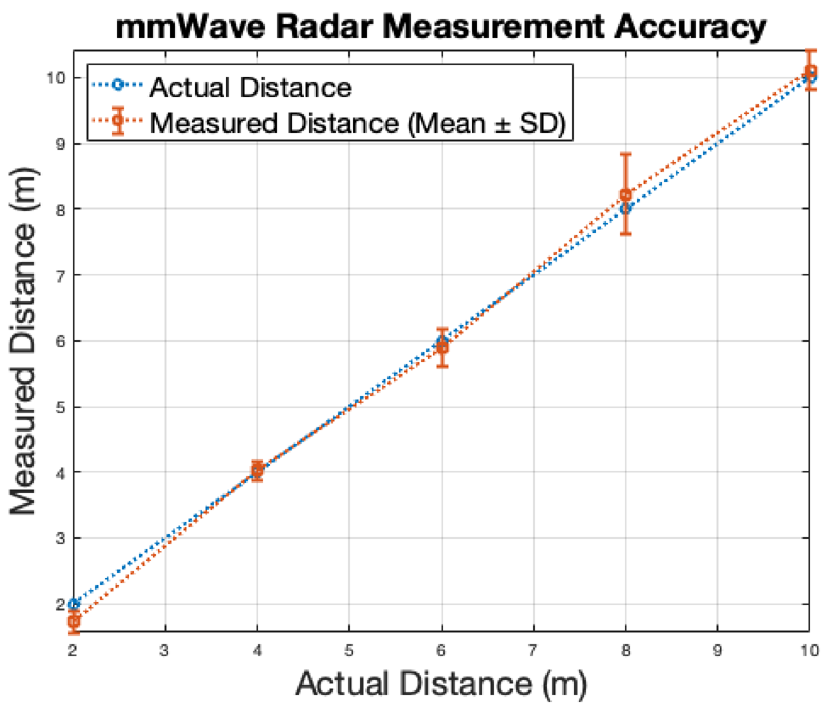
Date: 21/4/2026

Content by: Navya

Present: Shreya

Goals: To produce the graphs of the mmWave Radar Testing

Content:



This graph was produced from the data and the average distance error was 5.7% which was within the range of error that we wanted.

Conclusions/action items:

To change the calibration code to measure greater distances.

22/4/2026: Load Cell Testing

NAVYA JAIN - Apr 28, 2026, 10:40 PM CDT

Title: Load Cell Testing

Date: 22/4/2026

Content by: Navya

Present: Nic, Yang

Goals: To complete the load cell testing

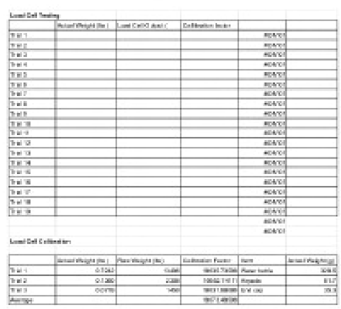
Content:

Nic and Yang worked together to complete the load cell testing by getting the calibration factor for the load cells and using incremental weights to record the outputted weight on the load cell and compare the literature value to that that was outputted on the app. One of the load cells died during the middle of testing so could be why the results we obtained were a little off.

Conclusions/action items:

To analyse the data and produce a graph from the data collected for the poster.

NAVYA JAIN - Apr 28, 2026, 10:41 PM CDT



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Load_Cell_Testing_-_Sheet1.pdf (45.7 kB)

22/4/2026: Load Cell Data Analysis

NAVYA JAIN - Apr 28, 2026, 10:42 PM CDT

Title: Load Cell Data Analysis

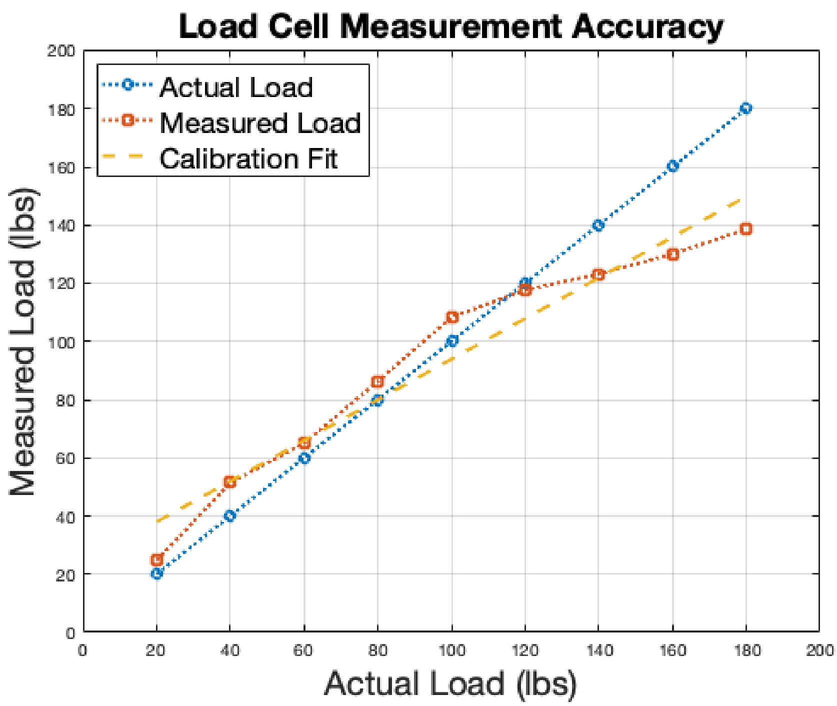
Date: 22/4/2026

Content by: Navya

Present: Shreya

Goals: To analyse the data collected from the load cell testing and produce a graph from the data

Content:



The error obtained was 14.7% which was a little higher than we would like.

Conclusions/action items:

Testing should be repeated to make sure the load cells are accurate and it not something to do with the calibration factor.

2026/02/05 - First Draft - Product Design Specification

Shreya Venkatesh - Feb 06, 2026, 11:58 AM CST

Smart Walker - BME 301

Product Design Specifications

February 5, 2026

Updated: February 5, 2026

Section 302

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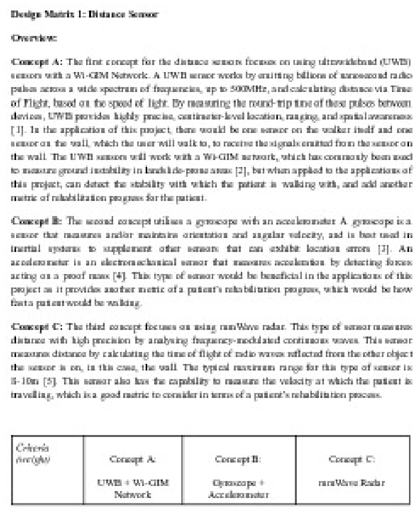
Product_Design_Specification_-_Smart_Walker.pdf (266 kB)

2026/02/12 - Design Matrix

Shreya Venkatesh - Feb 12, 2026, 10:35 PM CST



Design Matrix 1: Distance Sensor

Overview:

Concept A: The first concept for the distance sensors focuses on using ultrawideband (UWB) sensors with a Wi-GIM Network. A UWB sensor works by emitting billions of nanosecond radio pulses across a wide spectrum of frequencies, up to 500MHz, and calculating distance via Time of Flight, based on the speed of light. By measuring the round-trip time of these pulses between devices, UWB provides highly precise, centimeter-level location, ranging, and spatial awareness [1]. In the application of this project, there would be one sensor on the walker itself and one sensor on the wall, which the user will walk to, to receive the signals emitted from the sensor on the wall. The UWB sensors will work with a Wi-GIM network, which has commonly been used to measure ground instability in landslide-prone areas [2], but when applied to the applications of this project, can detect the stability with which the patient is walking with, and add another metric of rehabilitation progress for the patient.

Concept B: The second concept utilises a gyroscope with an accelerometer. A gyroscope is a sensor that measures and/or maintains orientation and angular velocity, and is best used in inertial systems to supplement other sensors that can exhibit location errors [3]. An accelerometer is an electromechanical sensor that measures acceleration by detecting forces acting on a proof mass [4]. This type of sensor would be beneficial in the applications of this project as it provides another metric of a patient's rehabilitation progress, which would be how fast a patient would be walking.

Concept C: The third concept focuses on using mmWave radar. This type of sensor measures distance with high precision by analysing frequency-modulated continuous waves. This sensor measures distance by calculating the time of flight of radio waves reflected from the other object the sensor is on, in this case, the wall. The typical maximum range for this type of sensor is 8-10m [5]. This sensor also has the capability to measure the velocity at which the patient is travelling, which is a good metric to consider in terms of a patient's rehabilitation process.

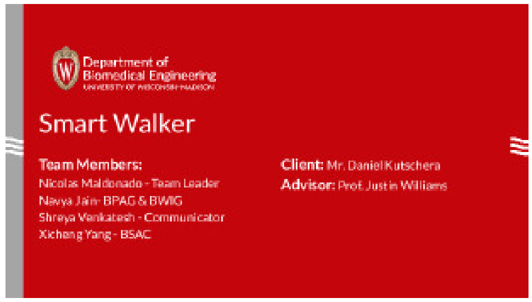
Criteria (weight)	Concept A: UWB + Wi-GIM Network	Concept B: Gyroscope + Accelerometer	Concept C: mmWave Radar

[Download](#)

Design_Matrix_1_.pdf (3.34 MB)

2026/02/20 - Preliminary Presentation

Shreya Venkatesh - Feb 20, 2026, 11:15 AM CST



Download

Smart_Walker_-_Preliminary_Presentation_1_.pdf (1.19 MB)

2026/4/21: Executive Summary Pitch

NAVYA JAIN - Apr 28, 2026, 10:47 PM CDT

301 - Tong - 45 - Smart Walker - Executive Summary

According to the National Institute of Neurological Disorders and Stroke in 2025, Traumatic brain injury (TBI) affects approximately 50 million people worldwide each year and contributes to over 500,000 permanent disabilities annually. TBI most commonly occurs amongst individuals above 65 years, and they frequently rely on walkers. Clinicians commonly use standardized tests, such as the 10-Meter Walk Test, to evaluate progress. However, current assessment methods are predominantly manual and subjective, relying on visual estimation of weight distribution, manual timing of walking trials, and approximation of distance traveled. This introduces challenges, including a lack of quantifiable evidence of rehabilitation progress, difficulty in demonstrating medical necessity to insurance providers, and reduced capacity to monitor subtle changes in gait stability.

Existing mobility aids are expensive, complex, or primarily designed for independent living and fall detection rather than clinical rehabilitation tracking. Most commercial mobility aids prioritize walking assistance and user safety over quantitative data for rehabilitation tracking. For example, the Bure Rise & Go Walker is designed for powered standing and transfer assistance but lacks gait measurement capability. Research prototypes incorporating FlexiForce™ sensors translate applied force and measurement units (IMUs) to estimate gait metrics, but aren't widely available for clinical use. Approximately 6.8 million adults in the United States use walking aids, highlighting a market for a system that tracks rehabilitation progress by integrating sensing and quantitative metrics.

The key innovation of the Smart Walker is its integration with any clinical walker while providing real-time data for all patients. Our design embeds dual load cells within custom end caps, a widely applicable and mass-producible design, and works in tandem with a mmWave radar to quantify weight-bearing and ambulation metrics, such as distance and speed. The mmWave radar overcomes the limitations of prior LiDAR-based approaches by providing higher occlusion tolerance and an extended sensing range of up to 45m. The modular, tool-free attachment of the system allows for easy fixation and removal, and is suitable for all walker models. This represents a novel approach to clinical-grade sensing not present in any current product. The combination of these sensing modalities within a compact, affordable, and universal platform constitutes a commercially viable and patentable system for rehabilitation monitoring.

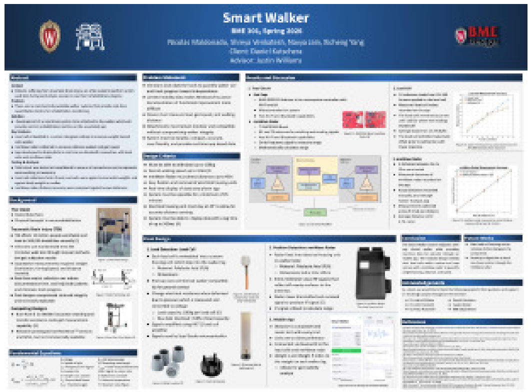
Validation of the Smart Walker was conducted through a structured testing protocol that targets the three performance metric requirements: weight-bearing accuracy, distance and speed measurement, and wireless data transmission. Load cell accuracy evaluation compares measurements against a calibrated digital reference scale across incremental loads from 0 to 108kg (for each load cell) in 12-kg steps, with three trials per load cell. The system is designed to achieve a mean percent error within ±2% of the applied load, satisfying the client's accuracy requirements. The mmWave radar distance and speed measurements are validated against a tape-measured path using Tracker motion analysis software, targeting sub-5% error over a 45m distance. Wireless connectivity is tested across areas without EM noise and in a campus Wi-Fi environment to ensure data integrity. The design meets all primary client requirements: real-time display of weight-beard (0-100 kg), speed (0-10 km/h), and distance, and easy fastening. The device aligns with relevant standards, including: FDA 21 CFR Part 820, ISO 11199-1:2021 for walking frames, IEC 60601 series for electrical safety, and HIPAA for patient data confidentiality, demonstrating the Smart Walker as a clinically validated, commercially viable, and unique rehabilitation monitoring solution.

Download

301_-_Tong_-_45_-_Smart_Walker_FINAL_Executive_Summary.docx (9.33 kB)

2026/4/28: Final Poster

NAVYA JAIN - Apr 28, 2026, 10:46 PM CDT



Download

Final_Poster_Presentation_-_Smart_Walker_1_.pdf (1.76 MB)

2026/01/26 - Team Meeting 1

Shreya Venkatesh - Jan 28, 2026, 1:45 PM CST

Title: Team meeting 1

Date: 26/01/2026

Content by:

Present: Navya, Shreya, Nic, Yang

Goals: Figure out team roles, review past year progress, next steps (meetings with client/advisor)

Content:

- Team Roles
  - Yang Xicheng - BSAC
  - Shreya Venkatesh - Communicator
  - Navya Jain - BWIG, BPAG
  - Nic - Leader
- Team photo
- Client Meeting - Monday, during lab time
- Advisor Meeting - preferably at 12:00 (earlier timing)
- Things to review
  - New members - look over old report, posters, new sensors
  - Nic - research about the boards

Conclusions/action items: Navya has updated the website, Shreya needs to send out some emails, and everyone needs to do some research to be prepared for client meeting and writing the PDS which is required for next week

2026/02/11 - Design Matrix Decisions

Title: Design Matrix for Distance Sensor and End Cap Designs

Date: 11/02/2026

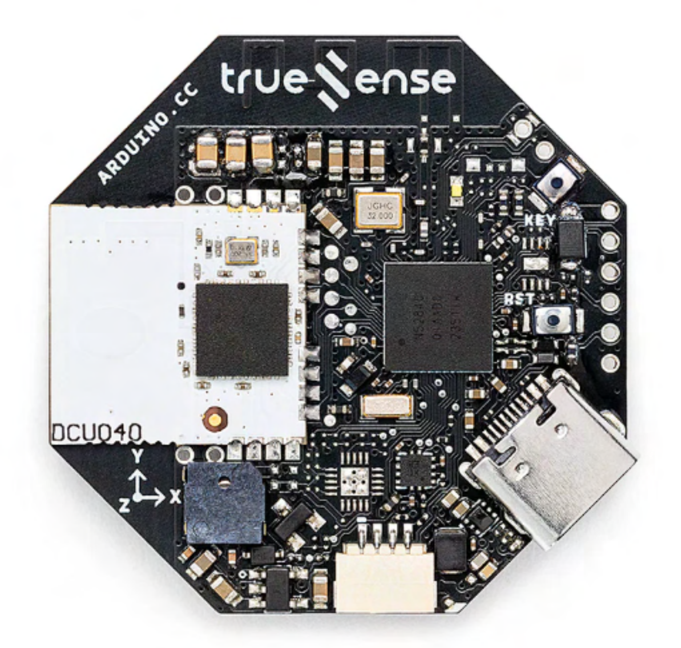
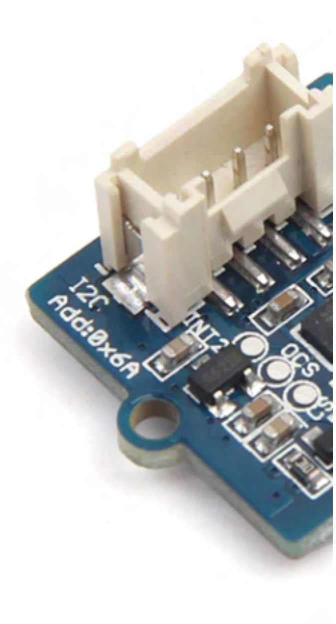
Content by: Shreya Venkatesh

Present: All team members

Goals: Select the products and designs we plan to use for the distance sensor and new end cap, evaluate the criteria, and score the matrices.

Content:

- As a team, we compared our ideas for the distance sensor matrix and decided to select UWB + Wi-GIM Network, Gyroscope + Accelerometer, and mmWave Radar. From the table 1 belc

Criteria (weight)	Concept A: UWB + Wi-GIM Network		Concept E Gyroscope + Acce
			
Accuracy (30)	5	30	3
Consistency (25)	4	20	3
Occlusion Sensing (20)	4	16	3
Size (10)	3	6	5
Power Consumption (10)	2	4	5
Cost (5)	1	1	5
Total (100)	**77**		**70**

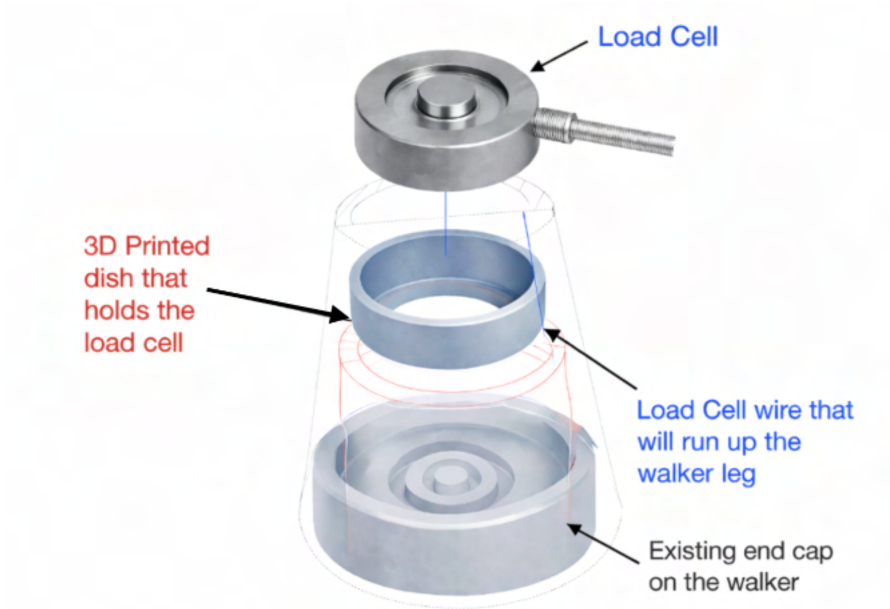
- For the second matrix, we decided to compare end-cap designs, as the current version may have a better fit. The three designs we came up with are the integrated endcap, custom endca

Criteria

(weight)

Concept A:

Integrated Endcap



Durability (25)	*5*	**25**
Cost (25)	*4*	**20**
Reproducibility (25)	*5*	**25**
Ease-of-Use (15)	*3*	**9**
Safety (10)	*4*	**8**
Total (100)	**87**	

Conclusions/action items: Since we have the designs voted on, I think we can proceed to create a CAD file and a fabrication plan for the new end cap. We should also consider the brands we have split up the work.

2026/02/25 - Deciding Sensor Purchasing

Shreya Venkatesh - Apr 29, 2026, 2:15 AM CDT

Title: Deciding Sensor Purchasing

Date: 23/02/2026

Content by: Shreya Venkatesh

Present: All team

Goals: Research sensor brand options and prices in order to purchase

Content:

- Arduino rev 2: $55

Conclusions/action items: We decided to buy arduino from the official website, then the other two sensors we decided to get from other sources

27/1/2026: Guidelines for Adult Stroke Rehabilitation and Recovery

NAVYA JAIN - Jan 29, 2026, 12:36 PM CST

Title: Guidelines for Adult Stroke Rehabilitation and Recovery

Date: 27/1/2026

Content by: Navya

Present: N/A

Goals: To understand current guidelines to terms of recovery process for stroke patients and to see how we can ensure the smart walker ties in with this.

Content:

The primary goals of rehabilitation are to prevent complications, minimize impairments, and maximize function.

- Secondary prevention is fundamental to preventing stroke recurrence, as well as coronary vascular events and coronary heart disease–mediated death.
- Early assessment and intervention are critical to optimize rehabilitation.
- Standardized evaluations and valid assessment tools are essential to development of a comprehensive treatment plan.
- Evidence-based interventions should be based on functional goals.
- Every patient should have access to an experienced multidisciplinary rehabilitation team to ensure optimal outcome.
- The patient and the patient's family members and/or caregivers are essential members of the rehabilitation team.
- Patient and family education improves informed decision-making, social adjustment, and maintenance of rehabilitation gains.
- The multidisciplinary team should utilize community resources for community reintegration.
- Ongoing medical management of risk factors and comorbidities is essential to ensure survival.

Conclusions/action items:

It is very important to look at the entire context of the situation and ensure that the patient is at that stage in their recovery where it is safe for them to use the smart walker.

NAVYA JAIN - Jan 29, 2026, 12:37 PM CST

AHA/ASA-Endorsed Practice Guidelines

Management of Adult Stroke Rehabilitation Care

A Clinical Practice Guideline*

Pamela W. Duncan, PhD, FAPTA, Co-Chair; Richard Zorowitz, MD, Co-Chair; Barbara Bates, MD; John Y. Choi, MD; Jonathan J. Glasberg, MA, PT; Glenn D. Graham, MD, PhD; Richard C. Katz, PhD; Kerri Lamberty, PhD; Dean Reker, PhD

1. Introduction

Download

duncan-et-al-2005-management-of-adult-stroke-rehabilitation-care.pdf (666 kB)

27/1/2026: Traumatic Brain Injury

NAVYA JAIN - Apr 26, 2026, 4:21 PM CDT

Title: Slight Changes in Walking and Balance After Traumatic Brain Injury

Date: 27/1/26

Content by: Navya

Present: N/A

Goals: To understand how TBI affects the walking patterns of people who suffer from TBI

Content:

Different underlying brain regions control different aspects of gait and therefore with TBI of different regions and severity there is a need for comprehensive gait outcome measure assessment and reporting. Gait is underpinned by a complex system of neural cortical and sub-cortical networks and impairment of any of the specific elements of the networks involved can result in impairment. Comprehensive reporting of gait in TBI literature is limited by the cohort sizes that have been examined, as there are many outcome measures that can be assessed and reported, but small samples sizes limit reporting capabilities and may lead to statistical errors.

Gait was shown to be impaired in TBI within the reviewed studies regardless of the severity or stage of the injury, but the specific impairments and the outcomes of clinical relevance are yet to be fully established across the spectrum of the condition. Further research is required to establish standardized methods for gait assessment in TBI, which will help to determine the gait deficits at each severity level of injury (mTBI, modTBI, sevTBI) in larger well-defined cohorts to establish findings.

Conclusions/action items:

This paper illustrated how no matter the severity of the injury, all traumatic brain injury patients suffered from some sort of gait instability.

NAVYA JAIN - Apr 26, 2026, 4:22 PM CDT

sensors

Review

Gait Impairment in Traumatic Brain Injury: A Systematic Review

Anthony Dever [1], Dylan Powell [2], Lisa Graham [1], Rachel Mason [1], Julia Das [1], Steven J. Marshall [3], Rodrigo Vitorio [1], Alan Godfrey [2] and Samuel Stuart [1,4,*]

Abstract: Introduction: Gait impairment occurs across the spectrum of traumatic brain injury (TBI); from mild (mTBI) to moderate (modTBI), to severe (sevTBI). Recent evidence suggests that objective gait assessment may be a surrogate marker for neurological impairment such as TBI. However, the most optimal method of objective gait assessment is still not well understood due to previous reliance on subjective assessment approaches. The purpose of this review was to examine objective assessment of gait impairments across the spectrum of TBI. Methods: PubMed, AMED, OVID and CINAHL databases were searched with a search strategy containing key search terms for TBI and gait. Original research articles reporting gait outcomes in adults with TBI (mTBI, modTBI, sevTBI) were included. Results: 156 citations were identified from the search, of these, 13 studies met the initial criteria and were included into the review. The findings from the reviewed studies suggest that gait is impaired in mTBI, modTBI and sevTBI (in acute and chronic stages), but methodological limitations were evident within all studies. Inertial measurement units were most used to assess gait, with single-task, dual-task and obstacle crossing conditions used. No studies examined gait across the full spectrum of TBI and all studies differed in their gait assessment protocols. Recommendations for future studies are provided. Conclusion: Gait was found to be impaired in TBI within the reviewed studies regardless of severity level (mTBI, modTBI, sevTBI), but methodological limitations of studies (transparency and reproducibility) limit clinical application. Further research is required to establish a standardised gait assessment procedure to fully determine gait impairment across the spectrum of TBI with comprehensive outcomes and consistent protocols.

Keywords: gait; TBI; concussion; inertial-measurement-unit; wearables; biomechanics

1. Introduction

Download

traumaticbraininjury.pdf (1.55 MB)

29/1/2026: Load Cells

NAVYA JAIN - Jan 30, 2026, 11:25 AM CST

Title: Load Cells in Force Sensing Analysis

Date: 29/1/2026

Content by: Navya

Present: N/A

Goals: To understand the theory of load cells in force sensing analysis.

Content:

Load cells have long been used to sense and measure force and torque. When properly designed and used, they are very accurate and reliable sensors. Lift units can also have a load's total weight measured to prevent overload.

A load cell is a device which contains other components. A load cell is a device which contains many components. The most widely used is the strain gauge which is a thin foil resistor, the primary sensing element. They are bonded on elastic materials, such as metals, and have a specific geometry designed for a specific application. The strain gauge resistance changes according to the deformation of the spring element.

The basic signal conditioning of the data from the strain gauge includes amplification and excitation of the analog signal from the load cell data, filtering, AD modulation, demodulation, and dynamic compensation.

Analog signal conditioning is being gradually reduced and substituted with digital conditioning, especially at the linearization process. In the digital world, there is no drift, component tolerance or aging. But the signals will always be analog, and thus, the front end (amplification and filtering) will be also. Ideally, all the ADC dynamic range should be used to take advantage of its full resolution. To do this, a low noise instrumentation amplifying and filtering are needed.

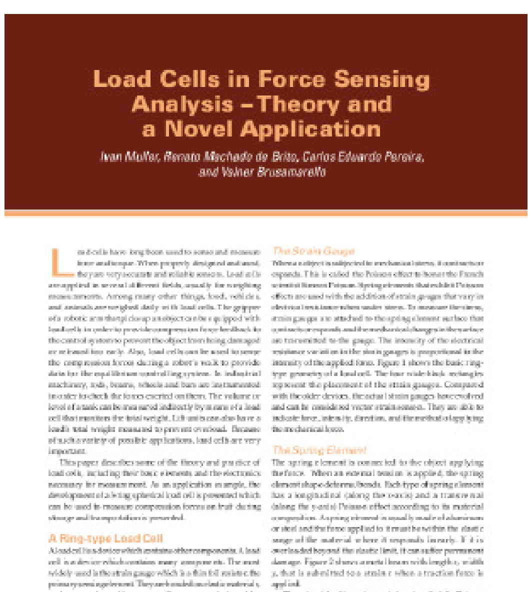
There are several different types and shapes of strain gauge based load cells, including shear beams, bending beams, buttons, rings and canisters. They are capable of sensing compression and traction forces and can be used directly or indirectly in several different applications. For multidimensional, there are some commercial load cells able to capture forces along one axis by means of a central rod.

Citation: I. Muller, R. de Brito, C. Pereira, and V. Brusamarello, “Load cells in force sensing analysis -- theory and a novel application,” *IEEE Instrumentation & Measurement Magazine*, vol. 13, no. 1, pp. 15–19, Feb. 2010, doi: https://doi.org/10.1109/mim.2010.5399212.

Conclusions/action items:

Amplification of the voltage signal from the Wheatstone bridge is necessary. Usually, a strain gauge Wheatstone bridge has 2 mV /Vof sensitivity. With the typical 3V of cell excitation, only 6mV will be available at full scale, and it requires high amplification.

NAVYA JAIN - Jan 30, 2026, 11:25 AM CST

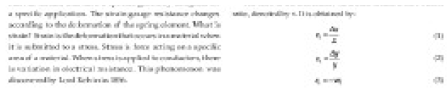

Load Cells in Force Sensing Analysis – Theory and a Novel Application

Ivan Muller, Renato Machado de Brito, Carlos Eduardo Pereira, and Valner Brusamarello

A Ring-type Load Cell

The Strain Gauge

The Spring Element


a specific application. The strain gauge resistance changes according to the deformation of the spring element. What is [illegible] It is submitted to a stress. Stress is force acting on a specific area of a material. [illegible] in electrical resistance. This phenomenon was [illegible]

Download

Load_cells_in_force_sensing_analysis_--_theory_and_a_novel_application.pdf (788 kB)

1/2/2026: Distance Measurement Using Ultrasonic and LIDAR Sensors

NAVYA JAIN - Apr 23, 2026, 9:59 PM CDT

Title: Optimisation of Distance Measurement in Autonomous Vehicles using Ultrasonic and LIDAR Sensors

Date: 1/2/26

Content by: Navya

Present: N/A

Goals: To understand if ultrasonic and lidar sensors are good at measuring distances

Content:

Tesla is not using LIDAR sensors costing 75000 dollars per unit. Instead, it uses ultrasonic sensors for car detection and collision prevention. Ultrasonic sensors are a cheap alternative to LIDAR sensors for object detection systems and algorithms in AV. It sends ultrasonic impulses that are then reflected by the obstacle. Therefore, it helps AV to perform according to the barrier. Ultrasonic sensors can range up to 5.5m and have limitations such as difficulty in detecting objects going at a fast speed. The measurement of the ultrasonic sensor is sensitive to temperature and the angle of the target. In addition, some materials are more absorbent than others, and these will reflect less ultrasound. Therefore, it complicates measuring the distance with an ultrasonic sensor alone. For an ultrasonic sensor, an effective indoor operating range with minimum measurement error and maximum detection rate is 2m.

For a LIDAR sensor, the indoor operating range with minimum measurement error and maximum object detection rate is 250 mm. The LIDAR sensor has around a 75% detection rate at a distance value of 500 mm and approximately a 25% object detection rate at a distance value of 1000 mm. It might be possible to use a LIDAR sensor effectively above 250 mm to increase an object detection rate by making it rotate within an angle range continuously in front of an AV with the help of a motor rather than keeping it stationary. It might be possible for the LIDAR sensor to measure more significant size objects with minor measurement error at distance values above 250 mm.

Conclusions/action items:

An ultrasonic sensor and LIDAR sensors appear to be choices that would not be effective for the scope of this project, particularly, their range is too low for what our client requires.

NAVYA JAIN - Apr 23, 2026, 10:00 PM CDT

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 05 | May 2022 www.irjet.net p-ISSN: 2395-0072

Optimisation of Distance Measurement in Autonomous Vehicle using Ultrasonic and LIDAR Sensors

Sandeep Chowdhry[1]

[1]Engineering Consultancy and Trainer, Chandigarh, India

Key Words: Autonomous Vehicles, Full Factorial Design, Ultrasonic sensor, LIDAR sensor, Distance measurement.

1. INTRODUCTION

Download

Optimisation_of_Distance_Measurement_in.pdf (649 kB)

4/2/2026: Ultra-Wide Band Sensors

NAVYA JAIN - Feb 06, 2026, 12:04 PM CST

Title: A Flexible Wireless Sensor Network Based on Ultra-Wide Band Technology for Ground Instability Monitoring

Date: 4/2/2026

Content by: Navya

Present: N/A

Goals: To understand how ultra-wide band technology can be used to monitor ground instability, and see if this application can apply to our project.

Content:

The WI-GIM system is designed to yield accurate measurements of ground movements by defining a *grid* over the soil surface to be used to monitor landslide movements in an efficient and cost-effective way, allowing an easy and quick deployment over a risk area of a large amount of sensors.

A high level design of the Wi-GIM system architecture is shown in Figure 2.

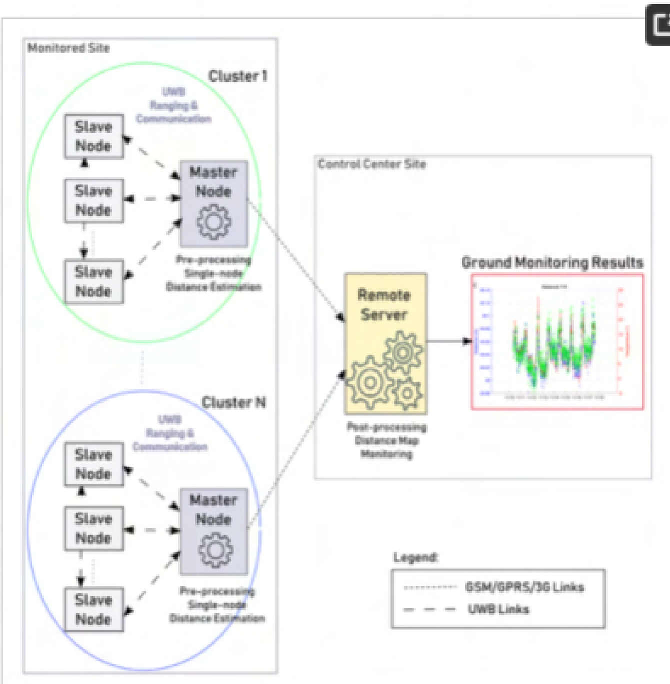


Figure 2. Wi-GIM system architecture.

UWB ranging systems work fine with an inter-nodes distance ranging from 60 m and 110 m. The accuracy obtained working at a distance of 60 m with LOS condition is between 7 cm and 10 cm. The tests have been performed both under laboratory conditions and in the field of application.

Conclusions/action items:

This technology was applied to the application measuring ground instability but I think we can apply this technology to our project as well as the 'ground instability' that it would measure in our case could be how much the walker moves as the patient places the walker on the ground. We would need to change the application of this paper to work within the range of the clinical setting, which would be 10m.

NAVYA JAIN - Feb 06, 2026, 12:04 PM CST


sensors

Article

A Flexible Wireless Sensor Network Based on Ultra-Wide Band Technology for Ground Instability Monitoring

[illegible]

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[2] Department of Earth Sciences, University of Florence, via La Pira 4, 50121 Florence, Italy; [illegible]
[3] National Institute of Geophysics and Volcanology (INGV), via della Faggiola 32, 56126 Pisa, Italy; [illegible]
* Correspondence: [illegible]; Tel.: +39-055-2758639

Received: 19 July 2018; Accepted: 30 August 2018; Published: 5 September 2018

Abstract: An innovative wireless sensor network (WSN) based on Ultra-Wide Band (UWB) technology for 3D accurate superficial monitoring of ground deformations, as landslides and subsidence, is proposed. The system has been designed and developed as part of an European Life+ project, called Wi-GIM (Wireless Sensor Network for Ground Instability Monitoring). The details of the architecture, the localization via wireless technology and data processing protocols are described. The flexibility and accuracy achieved by the UWB two-way ranging technique is analysed and compared with the traditional systems, such as robotic total stations (RTSs) and Ground-based Interferometric Synthetic Aperture Radar (GB-InSAR), highlighting the pros and cons of the UWB solution to detect the surface movements. An extensive field trial campaign allows the validation of the system and the analysis of its sensitivity to different factors (e.g., sensor nodes inter-visibility, effects of the temperature, etc.). The Wi-GIM system represents a promising solution for landslide monitoring and it can be adopted in combination with traditional systems or as an alternative in areas where the available resources are inadequate. The versatility, easy/fast deployment and cost-effectiveness, together with good accuracy, make the Wi-GIM system a possible solution for municipalities that cannot afford expensive/complex systems to monitor potential landslides in their territory.

Keywords: Ultra-Wide Band; wireless sensor networks; monitoring; warning system; ground instability; landslide; time of flight; two-way ranging

1. Introduction

1.1. *Background and Motivation*

Continuous and reliable field monitoring, possibly associated with early warning systems, is essential for hazard assessment and ground instability risk management. Different monitoring techniques are used to measure the relevant parameters, such as ground displacements, ground and surface water conditions and climatic parameters.

Download

sensors-18-02948.pdf (6.49 MB)

15/2/2026: Automatic Recognition of Falls in Gait-slip Training

NAVYA JAIN - Apr 26, 2026, 4:50 PM CDT

Title: Gait-force model and IMUs: A new approach for gait analysis and balance monitoring

Date: 15/2/2026

Content by: Navya

Present: N/A

Goals: To learn how load cells can be used to monitor and measure gait instability

Content:

This work describes a new approach for gait analysis and balance measurement. It uses an inertial measurement unit (IMU) that can either be embedded inside a dynamically unstable platform for balance measurement or mounted on the lower back of a human participant for gait analysis. In single-point gait analysis, an IMU is mounted on the lower back in the proximity of the anatomical COG of the individual being tested. At this location, the counterforce generated from ground contact during each heel strike is mostly damped by the ankle, knee, hip and other joints in the lower extremity of the human participant. Gait-force spectrum (or gait-power spectrum) is another new concept that represents the information extracted from the raw data in the form of a power spectrum in the time domain and consists of repetitive groups of peaks from stride to stride. The vertical axis represents the power level associated with the inflow and outflow of energy. A poor gait form is associated with frequent small and sudden movements that appear as closely spaced sharp peaks. The opposite occurs in the presence of healthy gait forms.

Conclusions/action items:

IMUS would be a very effective way to measure the gait stability and monitor the balance of a patient but IMUS require to be placed in the location of the center of gravity of the patient and the would be kind of hard to do with the design of walker.

NAVYA JAIN - Apr 26, 2026, 4:52 PM CDT

[Download]

IMUSxgait.pdf (1.71 MB)

21/2/2026: Recent Advances in mmWave Radar Based Sensing

NAVYA JAIN - Apr 22, 2026, 1:24 PM CDT

Title: Recent Advances in mmWave Radar Based Sensing, Its Applications, and Machine Learning Techniques: A Review

Date: 21/2/26

Content by: Navya

Present: N/A

Goals: To understand how best to utilise the mmWave radar for the applications of our project

Content:

A mmWave radar has better antenna miniaturization than other traditional radars, and it has better range resolution. A mmWave frequency-modulated continuous wave (FMCW) radar accurately estimates the range and velocity of multiple targets from the radar sensor without the need for more transceivers.

Range—The range is estimated by analyzing the frequency content in the IF signal. As shown in **Figure 2**a, transmitted and received chirps as a function of time for a single object detected. It can be observed that the received chirp is a time-delay version of the transmitted chirp.
The time delay can be measured as:

$$t=2R/C$$

where *R* is the distance to the detected object and *C* is the speed of light.
The initial phase of the IF signal is phi$_0$

$$(phi_0)=4piR/lambda$$

The range is computed as:

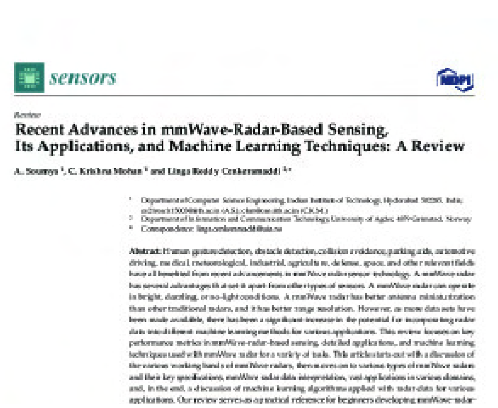
$$R= C\times f_{if}/2S$$

The maximum range is decided via the sampling frequency of this IF signal. The larger the sampling frequency, the better the maximum range capacity of the radar will be. The other deciding factor for the maximum range is the transmission power. There is no hardware constraint on the accurate range estimation of multiple targets. One TX antenna and one RX antenna are sufficient.

Conclusions/action items:

Range is a very important metric for our project so it is important to note the sampling frequency before selecting the mmWave Radar we would like to use.

NAVYA JAIN - Apr 21, 2026, 11:28 PM CDT


sensors

Review

Recent Advances in mmWave-Radar-Based Sensing, Its Applications, and Machine Learning Techniques: A Review

A. Soumya [1], C. Krishna Mohan [1] and Linga Reddy Cenkeramaddi [2,*]

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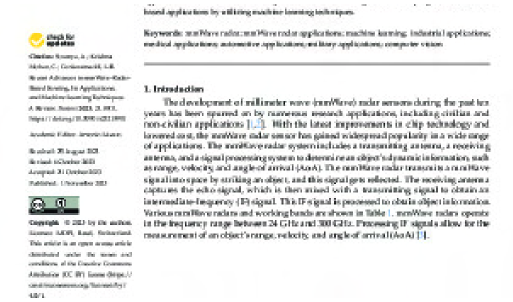
[2] Department of Information and Communication Technology, University of Agder, 4879 Grimstad, Norway
[*] Correspondence

Abstract: Human gesture detection, obstacle detection, collision avoidance, parking aids, automotive driving, medical, meteorological, industrial, agriculture, defense, space, and other relevant fields have all benefited from recent advancements in mmWave radar sensor technology. A mmWave radar has several advantages that set it apart from other types of sensors. A mmWave radar can operate in bright, dazzling, or no-light conditions. A mmWave radar has better antenna miniaturization than other traditional radars, and it has better range resolution. However, as more data sets have been made available, there has been a significant increase in the potential for incorporating radar data into different machine learning methods for various applications. This review focuses on key performance metrics in mmWave-radar-based sensing, detailed applications, and machine learning techniques used with mmWave radar for a variety of tasks. This article starts out with a discussion of the various working bands of mmWave radars, then moves on to various types of mmWave radars and their key specifications, mmWave radar data interpretation, vast applications in various domains, and, in the end, a discussion of machine learning algorithms applied with radar data for various applications. Our review serves as a practical reference for beginners developing mmWave-radar



based applications by utilizing machine learning techniques.

Keywords: mmWave radar; mmWave radar applications; machine learning; industrial applications; medical applications; automotive applications; military applications; computer vision

1. Introduction

The development of millimeter wave (mmWave) radar sensors during the past ten years has been spurred on by numerous research applications, including civilian and non-civilian applications [1,2]. With the latest improvements in chip technology and lowered cost, the mmWave radar sensor has gained widespread popularity in a wide range of applications. The mmWave radar system includes a transmitting antenna, a receiving antenna, and a signal processing system to determine an object's dynamic information, such as range, velocity and angle of arrival (AoA). The mmWave radar transmits a mmWave signal into space by striking an object, and this signal gets reflected. The receiving antenna captures the echo signal, which is then mixed with a transmitting signal to obtain an intermediate-frequency (IF) signal. This IF signal is processed to obtain object information. Various mmWave radars and working bands are shown in Table 1. mmWave radars operate in the frequency range between 24 GHz and 300 GHz. Processing IF signals allow for the measurement of an object's range, velocity, and angle of arrival (AoA) [3].

[Download](#)

sensors-23-08901.pdf (7.63 MB)

26/2/2026: Different mmWave Radars

NAVYA JAIN - Feb 26, 2026, 1:38 PM CST

Title: Recent Advances in mmWave-Radar-Based Sensing, Its Applications, and Machine Learning Techniques: A Review

Date: 26/2/2026

Content by: Navya

Present: N/A

Goals: To understand the differences in different types of mmWave Radars and to see which one would be best for our project

Content:

Operational frequencies within the bandwidth spectrum.

Working Band (GHz)	Bandwidth (GHz)	Resolution
24	0.25 GHz	60 cm
77	4 GHz	3.75 cm
60	7 GHz	2.1 cm
94	2 GHz	7.5 cm
100	9 GHz	1.6 cm
300	40 GHz	0.375 cm
300	20 GHz	0.75 cm

mmWave radars have been implemented to fuse with LiDARs in recent years. By default, radar and LiDAR, both can provide detections in the bird's-eye view (BEV) plane, which is the top view looking onto the ground. However, LiDAR works on the infrared band, which is prone to interference, cost-intensive, and bulky in size. Not many studies have been conducted with associating heterogeneous sensors like cameras or infrared sensors with radars, primarily due to the fact that the camera's and radar's detections are unrelated and difficult to align without certain assumptions. In this case, we are implementing HEM and creating a track-oriented association and fusion algorithm for calibration and tracking.

- Frequency: 60 GHz/77 GHz sensors offer higher resolution and accuracy (shorter wavelength) than 24 GHz.
- Range: 77 GHz is typically used for long-range (up to 250m), while 60 GHz is ideal for intermediate, and 24 GHz is commonly used for short-range

Source: https://digital-library.theiet.org/doi/10.1049/sbra553e_ch5

Conclusions/action items:

A shorter frequency range sensor would work best for our project, specifically the V-LD1 sensor

5/3/2026: IWR6843 vs AWIR1843BOOST mmWave Radar

NAVYA JAIN - Mar 05, 2026, 11:54 AM CST

Title: IWR6843 vs AWR1843BOOST mmWave Radar

Date: 5/3/2026

Content by: Navya

Present: N/A

Goals: To see if this sensor would best suit the requirements of our project

Content:

We had a client meeting yesterday and we learned that the distance that our client is wishing to monitor for his patients are not solely linear, and the range of which he wants to operate the device is larger than we initially thought so we need to change our sensor to one that will work better for this situation. Preliminary research indicated that the IWR6843 mmWave Radar would work best but I found out that the range it works is best up to 20m, but our client wants it to be up to 145m. After that I discovered a mmWave radar called the AWR1843BOOST, while this is more expensive, the frequency range it works in is much greater than that of the IWR6843, which means that it would be able to handle those greater ranges much more efficiently and to a higher degree of accuracy.

One good thing about both of these sensors is that they contain all the antennas and electrical components required to actually measure distance, so no additional hardware would be required.

https://www.digikey.com/en/product-highlight/t/texas-instruments/iwr6843-single-chip-mmwave-sensor

https://www.ti.com/tool/AWR1843BOOST

Conclusions/action items:

Based on my research, it appears that the AWRI1843BOOST would be better suited for this project but due to the high cost associated with this sensor, I would like to discuss the purchase with our client prior to purchasing it.

7/3/2026: Precision and Long Range of mmWave Radar

NAVYA JAIN - Apr 22, 2026, 5:32 PM CDT

Title: A high-precision and robust odometry based on Sparse MMW radar data and a large-range and long-distance radar positioning data set

Date: 7/3/2026

Content by: Navya

Present: N/A

Goals: To understand the range capabilities of mmWave Radar

Content:

Lidar-based or vision-based positioning systems are easily affected by bad weather, and RTK-GNSS inertial navigation systems are prone to reduce positioning accuracy in environments with poor GNSS signals. And using radar for positioning can overcome the challenges of using other sensors for positioning in bad weather. It can be provided a longer target detection range and strong anti-interference ability. Moreover, the detection range of radar is larger than that of lidar, and it can use farther geographical features for positioning. However the greater the range is, the lower the accuracy of the value obtained.

In navigation, odometry is the use of data from the movement of actuators to estimate the change in position over time through devices. Radar odometry is the process of determining equivalent odometry information using sequential radar images to estimate the distance traveled. Compared with lidar, radar has some disadvantages compared with lidar, and it is more challenging to use radar to achieve positioning.

- Radar data is more sparse.
- The range accuracy of radar is lower than that of lidar.
- The sensing result of radar contains a lot of noise.
- The sensing results of radar are all in a two-dimensional plane.

Conclusions/action items:

This radar is good but we need to look at the maximum range capabilities of the mmWave Radar we order as well as how much the accuracy changes as we increase the distance, and see if there is anything specific we need to put in our code.

NAVYA JAIN - Apr 22, 2026, 5:32 PM CDT


2021 IEEE Intelligent Transportation Systems Conference (ITSC)
Indianapolis, USA. September 19-21, 2021

A High-precision and Robust Odometry Based on Sparse MMW Radar Data and A Large-range and Long-distance Radar Positioning Data Set

Bangyuo Huang[1], Kangtao Zhu[1], Shitao Chen*, Tong Xiao, Meng Yang and Nanning Zheng

I. INTRODUCTION

Download

A_High-precision_and_Robust_Odometry_Based_on_Sparse_MMW_Radar_Data_and_A_Large-range_and_Long-distance_Radar_Positioning_Data_Set.pdf (2.47 MB)

10/3/2026: Walking Step Monitoring with mmWave Radar

NAVYA JAIN - Apr 22, 2026, 5:20 PM CDT

Title: Walking Step Monitoring with mmWave Radar in Real Life Environment for Disease and Fall Prevention for the Elderly

Date: 10/3/26

Content by: Navya

Present: N/A

Goals: To understand how the mmWave radar is being used to monitor the walking patterns of elderly patients so we can use that technology and implement it to measure gait metrics.

Content:

Radar technology has appeared as the most suitable candidate for continuous gait monitoring at home due to its safety, simplicity, low cost, lack of contact, and unobtrusiveness while preserving privacy.

The most promising work on using radar for gait parameters extraction, where eleven biomechanical parameters were acquired using two 24 GHz CW radars. However, this work was carried out in a well-controlled environment, with the subjects walking on a treadmill.

The millimeter-wave radar sensor used in this work was the AWR1642BOOST module from Texas Instruments. The sensor operates from 77 GHz and supports a bandwidth of 4 GHz. The module includes two onboard-etched transmitting antennas and four receiving antennas. A data capture board DCA1000EVM was used along with the radar sensor in order to capture the raw data.

Key radar parameters used in the work.

Parameters	Value (unit)
Chirp slope rate	80 (MHz/μs)
Chirp duration	45 (μs)
Sampling rate	6250 (kSa/s)
Start frequency	77 (GHz)
No. chirps per frame	1
Frame-to-frame interval	0.5 (ms)
No. frames	30,000

Different sensor heights and orientations were investigated in order to determine a suitable operating position, and, in the end, the sensor was placed at a height of 8 cm above the floor in order to focus the energy on the lower body parts, i.e., legs and feet, which are of the most interest for step time measurement.As the radar sensor's radiation energy is mainly directed to the lower limb joints, the peaks corresponding to the leg/foot movement are the most prominent and are referred to as cadence. According to the mCS, the cadence for the first four test cases is 60 steps/min, 34 steps/min, 45 steps/min, and 35 steps/min, respectively. These values are in good agreement with the extracted envelope and the video recordings. However, the agreement does not hold for the limping cases. The cadence according to the mCS is 25 steps/min for both cases, which is significantly lower than the actual number of steps.

Conclusions/action items:

The mmWave radar is good tool to measure the gait patterns of an individual but if the limp is severe then it has some issues picking it up, and significant data processing is required to see the patterns as the micro-Doppler signatures are needed, which may be out of the scope for the project for this semester.

NAVYA JAIN - Apr 22, 2026, 5:20 PM CDT


sensors

Article

Walking Step Monitoring with a Millimeter-Wave Radar in Real-Life Environment for Disease and Fall Prevention for the Elderly

Department of Electrical Engineering, Chalmers University of Technology, Gothenburg, Sweden
* Correspondence

Abstract: We studied the use of a millimeter-wave frequency-modulated continuous wave radar for gait analysis in a real-life environment, with a focus on the measurement of the step time. A method was developed for the successful extraction of gait patterns for different test cases. The quantitative investigation carried out in a lab corridor showed the excellent reliability of the proposed method for the step time measurement, with an average accuracy of 96%. In addition, a comparison test between the millimeter-wave radar and a continuous-wave radar working at 2.45 GHz was performed, and the results suggest that the millimeter-wave radar is more capable of capturing instantaneous gait features, which enables the timely detection of small gait changes appearing at the early stage of cognitive disorders.

Keywords: radar; gait analysis; millimeter wave; micro-Doppler; FMCW; CW; fall prevention; disease prediction

1. Introduction

Improvements in public health have led to a significant increase in life expectancy, with the consequence of an increasingly aging population. According to WHO, the proportion of the world's population over 60 years will double from approximately 11% to 22% between 2000 and 2050. The absolute number of people aged 60 years and over is expected to increase from 605 million to 2 billion over the same period [1].

The normal aging process entails declines in both cognitive and physical functions [2] that largely affect the quality of life for the elderly. It has long been known that there is a direct relationship between cognitive impairment severity and increased gait abnormalities [3]. Early motor dysfunction co-exists with or even precedes the onset of cognitive decline in older adults [4]. For example, gait patterns tend to differ from their normal behavior at the early onset of some neurodegenerative diseases, such as Alzheimer's and Parkinson's. A person in the primary phase of Parkinson's tends to make small and shuffled steps and may also experience difficulties in performing key walking events, such as starting, stopping, and turning [5]. Short shuffling steps with difficulty lifting the feet off the ground were reported to be associated with an increased risk of developing dementia [6].

Gait impairments are also associated with fall incidents [7], which are considered to be a major risk for the elderly living independently, as falls often result in serious physical and psychological consequences, or even death. The rapid detection of fall incidents can reduce the mortality rate and raise the chance of surviving the event, but predicting the fall risk and preventing fall occurrence is of the uttermost importance. Several studies have identified gait abnormalities as predictors of fall risk [8–10]. However, the gait changes that appear at the early development stage of neurodegenerative diseases or are associated with fall risk are usually too subtle and discrete to be detected by clinical observation alone. Objective, quantitative, and continuous measurements and assessments of gaits are needed in order to detect these clinically relevant gait changes, enabling the timely introduction of individually tailored interventions.

Citation: Zeng, X.; ... Walking Step Monitoring with a Millimeter-Wave Radar in Real-Life Environment for Disease and Fall Prevention for the Elderly. Sensors 2022, 22, 9901.

Received: 30 October 2022
Accepted: 9 December 2022
Published: 16 December 2022

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sensors-22-09901.pdf (4.87 MB)

12/3/2026: Human Tracking and Identification Through mmWave Radar

NAVYA JAIN - Apr 23, 2026, 9:48 PM CDT

Title: Human Tracking and Identification Through mmWave Radar

Date: 12/3/26

Content by: Navya

Present: N/A

Goals: To understand how an mmWave Radar can measure large distances

Content:

FMCW radar uses a linear ‘chirp’ or swept frequency transmission. The chirp is characterized by a start frequency , bandwidth and duration . When receiving the reflected signal, the radar front-end computes the frequency difference between the transmitter and the receiver with a mixer, which produces an Intermediate Frequency (IF) signal, from which the distance between the object and the radar can be calculated.

As we are interested in identifying people moving in the scene, the background, corresponding to stationary objects, needs to be removed before performing Doppler FFT. This is performed by subtracting a mean for each range bin per antenna across the chirps in a frame. With this step in the processing pipeline, the millimeter wave radar is able to generate a point cloud which does not contain static obstacles. However, this does not guarantee that the point cloud does not contain noise. While the users move in the scene, parts of the background objects are occluded and the reflections from these areas changes over time, leading to noise in the radar point cloud. The longer that the sensor senses the walking pattern of a person, the more likely it is that the person can be identified correctly.

Conclusions/action items:

This paper was discussing the application of using an mmWave Radar to identify people from a security standpoint, e.g airports, but I was more interested how they are able to get the mmWave Radar to measure greater ranges and, just like other papers, it appears to be due to the calculations that the mmWave Radar performs using what it senses, and a lot of this depends on the calibration of the mmWave Radar.

NAVYA JAIN - Apr 23, 2026, 9:49 PM CDT


Ad Hoc Networks

Human tracking and identification through a millimeter wave radar

ARTICLE INFO

ABSTRACT

Download

1-s2.0-S1570870521000421-main.pdf (3 MB)

28/4/2026: IEC 60601 Series

NAVYA JAIN - Apr 28, 2026, 4:50 PM CDT

Title: Risk Management and IEC 60601-1: Assessing Compliance

Date: 28/4/2026

Content by: Navya

Present: N/A

Goals: To see if our design fits this standard series

Content:

IEC 60601-1 is a device standard, it contains requirements for construction, markings, labeling, and testing of medical devices. The standard also recognises that the development technology and/or medical practice will outpace the development of the standard. This is a core international standard for the basic safety and essential performance of medical electrical equipment.

Risk management is used in different ways throughout IEC 60601-1,leading to four different types of requirements:

1. process requirements
2. equivalent safety requirements
3. documentation/definition
4. acceptance requirements

IEC 60601-1 generally treated as a premarket standard.

Risk management process generally is contained within procedures, work instructions, and supporting forms, templates, or references quality system documents.

Part of this standard is that a manufacturer must provide evidence that their risk management process meets ISO 14971, which outlines a structured process that identifying hazards, estimating risks, controlling hazards, and monitoring effectiveness throughout a product's lifecycle.

Conclusions/action items:

I believe that our device complies with this standard and while it is extremely important to take proper documentation through the production, this standard may not be the most applicable one for the scope of our project. I think talking with our advisor or a standards and regulation individual would be needed if we wanted to patent this and make sure our device is compliant with all standards and regulations.

NAVYA JAIN - Apr 28, 2026, 4:50 PM CDT

Perspectives on Risk Management

Risk Management And IEC 60601-1: Assessing Compliance

Alex Grob, Brian Biersach, and Jeremi Peck

About the Authors

14971:2000 and to provide evidence related to specific risks for approximately 140 clauses in

- What are the requirements for risk management in IEC 60601-1?

Download

60601.pdf (176 kB)

28/4/2026: ISO 11199

NAVYA JAIN - Apr 28, 2026, 5:26 PM CDT

Title: ISO 11199 Series

Date: 28/4/2026

Content by: Navya

Present: N/A

Goals: To see if our product is compliant with ISO 11199 series

Content:

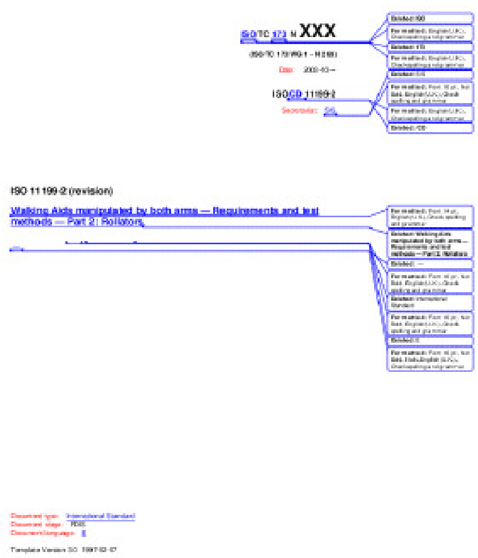
This class of standard of used for Assistive Walking Devices that requires both hands. This document specifies requirements and test methods for walking frames used as assistive products for walking, manipulated by both arms, without accessories, unless specified in the particular test procedure. This document also gives requirements relating to safety, ergonomics, performance and information supplied by the manufacturer, including marking and labelling.

The requirements and tests are based on everyday use of walking frames as assistive products for walking for a maximum user mass as specified by the manufacturer. This document includes walking frames specified for a user mass of no less than 35 kg.

Conclusions/action items:

Because we are already using a walker that is compliant with ISO 11199 series, I believe that our device will also be complaint with this series as well as all the electrical components are also housed and contained.

NAVYA JAIN - Apr 28, 2026, 5:26 PM CDT



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iso11199.pdf (145 kB)

28/4/2026: IEC 62366

NAVYA JAIN - Apr 28, 2026, 10:15 PM CDT

Title: IEC 62366

Date: 28/4/2026

Content by: Navya

Present: N/A

Goals: To make sure that our product fits this IEC standard

Content:

IEC 62366-1:2015 (with 2020 amendment) is the international standard for applying usability engineering (human factors engineering) to medical devices, specifically targeting safety. It requires manufacturers to analyze, specify, develop, and evaluate user interfaces to minimize risks from use errors and ensure safe, effective use.

Key Aspects of IEC 62366

- User Interface Evaluation: Requires formative (developmental) and summative (validation) usability testing to prove the device can be used safely.
- Documentation: Manufacturers must maintain a usability engineering file that documents the entire process.
- Parts: Part 1 covers the required process (IEC 62366-1), while Part 2 (IEC/TR 62366-2) provides guidance on usability aspects beyond just safety.

- Focus on Safety: The standard focuses on user interface design related to safety.
- Process-Driven: It provides a structured process for usability engineering, including identifying intended users, use environments, and high-priority use scenarios.
- Risk Management Integration: It is inextricably linked to ISO 14971, where usability engineering is used to assess and mitigate risks related to normal use and use errors

Conclusions/action items:

I believe that our device would fit this standard because all of the electrical components are encased in their own electrical housing unit and when using the walker, the patient is never coming in contact with the walker.

NAVYA JAIN - Apr 28, 2026, 10:16 PM CDT


IEC 62366-1

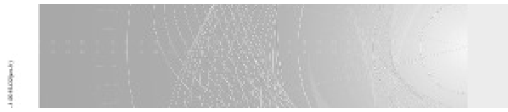
Edition 1.0 2015-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Medical devices –
Part 1: Application of usability engineering to medical devices

Dispositifs médicaux –
Partie 1: Application de l'ingénierie de l'aptitude à l'utilisation aux dispositifs médicaux



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IEC-62366-1.pdf (1.59 MB)

27/1/2026: Camino Smart Walker

NAVYA JAIN - Jan 30, 2026, 11:18 AM CST

Title: Camino Smart Walker

Date: 27/1/2026

Content by: Navya

Present: N/A

Goals: To learn about current smart walkers on the market

Content:

Mainly meant for support in walking when going up or down hill. Has features such as auto-brake that would help the patient have some support if they were unable to have enough strength to brake on their own when on an incline. Has an app associated with it.

Battery life is 1 day.

Extremely light weight.

Camino's lithium battery is certified for air travel and use in medical facilities. Inside the device, microcomputers are usinf AI to track and measure gait.

Citation: “Camino : The World’s First Smart Walker,” *Camino Mobility*. https://caminomobility.com/

Conclusions/action items:

An associated app is a good idea because it would allow the patient to see their progress.

29/1/2026: Flexible Pressure Sensors

NAVYA JAIN - Jan 30, 2026, 11:54 AM CST

Title: Recent Developments for Flexible Pressure Sensors

Date: 29/1/2026

Content by: Navya

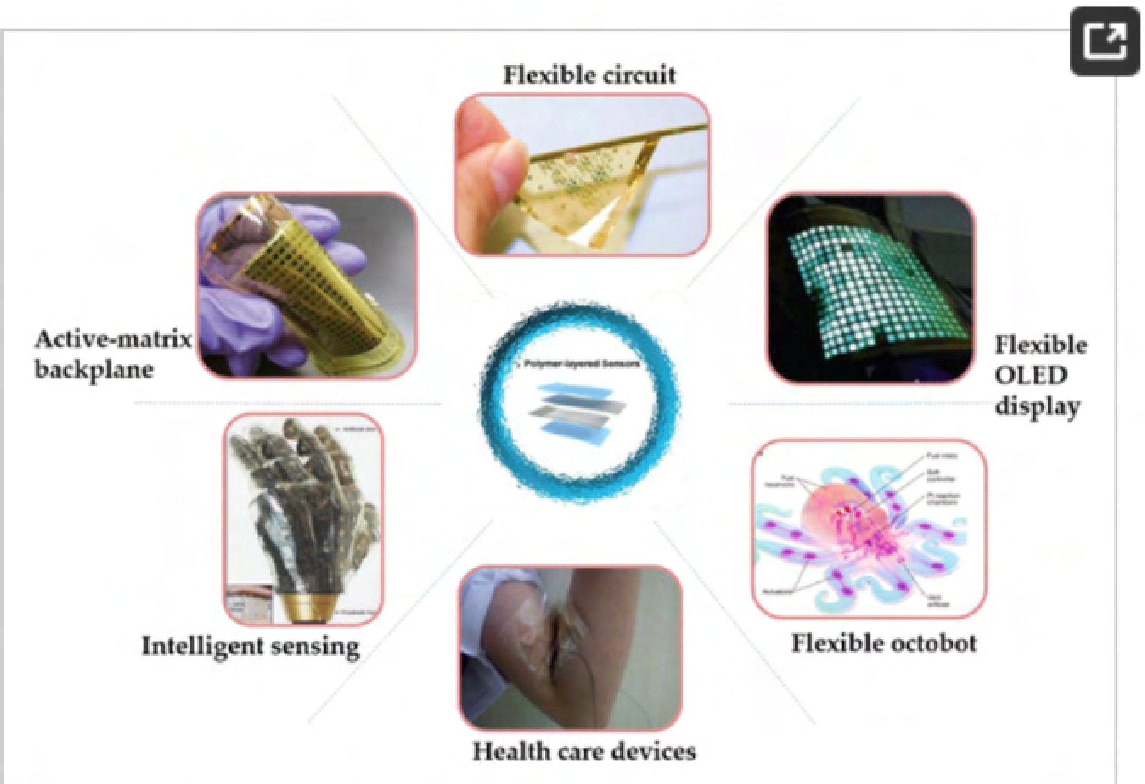
Present: N/A

Goals: To learn about recent developments for flexible pressure sensors

Content:

Flexible pressure sensors are attracting great interest from researchers and are widely applied in various new electronic equipment because of their distinct characteristics with high flexibility, high sensitivity, and light weight; examples include electronic skin (E-skin) and wearable flexible sensing devices.

In the last decade, flexible devices demonstrated great potential in various fields. One of the most important applications is flexible electronic skin (E-skin) for pressure sensing, which is firstly introduced with polymer-based switching matrices for displays, robots, and others.



The piezoresistive effect-based sensors distort the composite via exerting external force, indirectly changing the distribution and contact status of conductive fillers inside, and then resulting in the resistance of composite changing regularly. Thus, they do not require complex sensor structure, and a low power consumption, wide range of pressure test, and simple manufacturing process cause this kind of sensors to be studied extensively compared with capacitive and piezoelectric pressure sensors.

There are various flexible substrates used for sensors applied in various fields. Polyimide (PI), which has high mechanical and dialectical properties, as well as high chemical stability and thermostability, is widely used in flexible substrates. Its application scope is limited by its characteristic of yellow transparency, however, its cost is high. PET film is widely used because of its low price and comprehensive performance, such as remarkable transparency, toughness, tensile strength, and thermal resistance. Stretchability is drawing the interest of researchers for applications in E-skin and wearable devices.

Citation: F. Xu *et al.*, “Recent Developments for Flexible Pressure Sensors: A Review,” *Micromachines*, vol. 9, no. 11, p. 580, Nov. 2018, doi: https://doi.org/10.3390/mi9110580.

Conclusions/action items:

Materials for flexible devices should not only have an appropriate elastic modulus, but also high mechanical and electrical performances required in large-area arrays.
There are still some difficulties when introducing temperature sensing into practical applications, such as new sensitive materials, especially its matrix arrangement design.

NAVYA JAIN - Jan 30, 2026, 11:55 AM CST


micromachines

Review

Recent Developments for Flexible Pressure Sensors: A Review

Beijing Engineering Research Center of Printed Electronics, Beijing 102600, China
State Key Laboratory of Advanced Technology for Materials Synthesis and Processing, Wuhan University of Technology, Wuhan 430070, China
These authors contributed equally to this work.

Received: 5 September 2018; Accepted: 2 November 2018; Published: 7 November 2018

Abstract: Flexible pressure sensors are attracting great interest from researchers and are widely applied in various new electronic equipment because of their distinct characteristics with high flexibility, high sensitivity, and light weight; examples include electronic skin (E-skin) and wearable flexible-sensing devices. This review summarizes the research progress of flexible pressure sensors, including three kinds of transduction mechanisms and their respective research developments, and applications in the fields of E-skin and wearable devices. Furthermore, the challenges and development trends of E-skin and wearable flexible sensors are also briefly discussed. Challenges of developing high extensibility, high sensitivity, and flexible multi-function equipment still exist at present. Exploring new sensing mechanisms, seeking new functional materials, and developing novel integration technology of flexible devices will be the key directions in the sensors field in future.

Keywords: flexible pressure sensor; transduction mechanism; e-skin; wearable sensors; sensibility

1. Introduction

Nowadays, there is rapid development of high-performance smart materials, as well as intelligent home and internet of things (IoT) technology; therefore, sensors technology has gradually stepped into people's lives and attracted widespread interest from researchers, especially in flexible pressure sensors. The flexible pressure sensors have a wide range of applications because they have excellent mechanical and electrical properties, such as high flexibility, high sensitivity, high resolution ratio, and rapid response, among others [1]. Studies on flexible wearable sensor devices have been rapidly increasing in the last decade.

In the last decade, flexible devices demonstrated great potential in various fields. One of the most important applications is flexible electronic skin (E-skin) for pressure sensing, which is firstly introduced with polymer-based switching matrices for displays, robots, and others [2]. Recently, many review papers focused mainly on the development of flexible electronic devices for E-skin [3–5]. Tactile-sensing simulation of the human skin characteristics with high sensitivity, high resolution ratio, and fast response to temperature and pressure is a highly interesting but difficult challenge for applications in health care monitoring and robotic artificial intelligence [6].

Takei et al. [7] developed a flexible pressure sensor array (18 × 19 pixels) with macroscale (7 × 7 cm^2) integration of parallel nanowire (NW) arrays as the active-matrix backplane employed as

Download

micromachines-09-00580-v2.pdf (2.89 MB)

17/2/2026: Bure Rise & Go

NAVYA JAIN - Apr 21, 2026, 11:04 PM CDT

Title: Bure Rise & Go

Date: 17/2/2026

Content by: Navya

Present: N/A

Goals: To look at the competing designs for walkers that are commercially available

Content:

The Bure Rise & Go is a cost-effective walker enhanced with a patented power rise function. Thanks to the electric power rise function, Bure Rise & Go acts as a combined stand-up, mobility and walking aid all in a single product. Rise & Go is now also available with electric walking frame widening. Flexible widening combined with the lower height above the walking frame enhances versatility regardless of the patient's situation in hospital or at home.

The main electric component of this walker is the electrically driven frame widening; electrically driven frame widening makes it easy to move the walker right up close to users without worrying about wheelchair width, chair width or bed design.

Conclusions/action items:

This smartwalker does not do what we intend for ours to do, so so far we have not come across any commercially available smartwalkers that do that.

3/3/2026: Monitoring Walking Assistive Device (copy)

NAVYA JAIN - Apr 22, 2026, 5:09 PM CDT

Title: Monitoring Walking Assistive Device: A Novel Approach Based on Load Cells and Optical Distance Measurement

Date: 3/3/2026

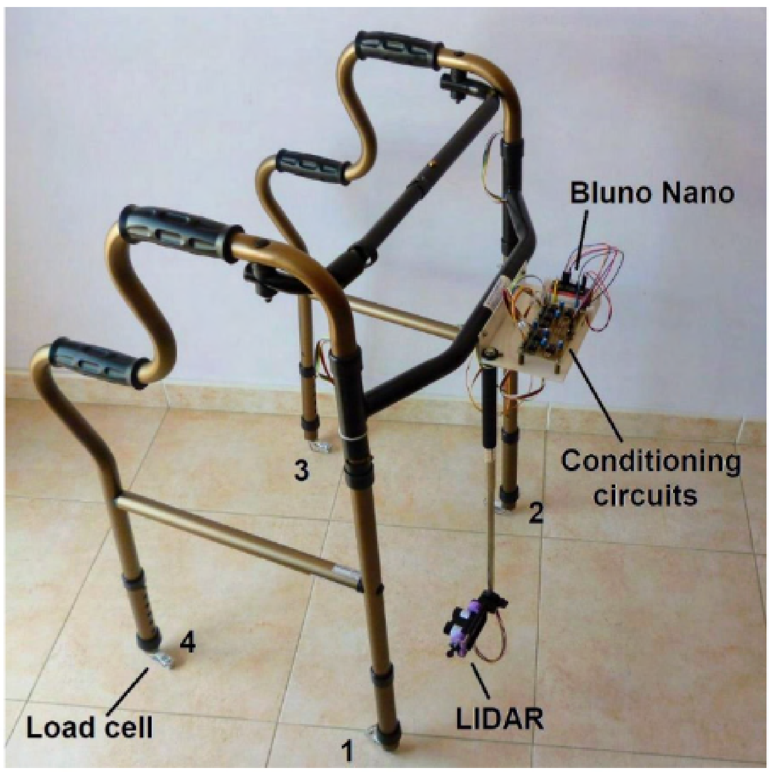
Content by: Navya

Present: N/A

Goals: To see how other prototypes and see if they are similar to our idea

Content:

This walker is designed to monitor unbalance and motor incoordination in elderly patient. The measurement system includes four load cells to sense the force applied on the walker legs, a LIDAR to measure the travelled distance, a data acquisition board with Bluetooth link and software to process and present data.



Conclusions/action items:

While this design is similar to ours, the way they have integrated the system is not in a manner in which we would be. We want our system to be easily attachable and removable, which is not the case for this design. Additionally, this design is programmed for shorter distance ranges and doesn't get the gait speed of the patient as well. I think our design is a novel one which could have components, such as the end cap design that are patentable.

NAVYA JAIN - Apr 22, 2026, 5:09 PM CDT


sensors

Article

Monitoring Walker Assistive Devices: A Novel Approach Based on Load Cells and Optical Distance Measurements †

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[3] ISCTE—Instituto Universitário de Lisboa, 1649-077 Lisboa, Portugal
[4] Instituto Superior Técnico, Universidade de Lisboa, 1049-001 Lisboa, Portugal
* Correspondence: [illegible]; Tel.: +351-265-790-000
† This paper is an extended version of our conference paper: Dias Pereira J.M., Viegas V., Postolache O., Girão, P.S. Combining distance and force measurements to monitor the usage of walker assistive devices. 2017 IEEE International Instrumentation and Measurement Technology Conference, Torino, Italy, 22–25 May 2017.

Received: 14 December 2017; Accepted: 7 February 2018; Published: 10 February 2018

Abstract: This paper presents a measurement system intended to monitor the usage of walker assistive devices. The goal is to guide the user in the correct use of the device in order to prevent risky situations and maximize comfort. Two risk indicators are defined: one related to force unbalance and the other related to motor incoordination. Force unbalance is measured by load cells attached to the walker legs, while motor incoordination is estimated by synchronizing force measurements with distance data provided by an optical sensor. The measurement system is equipped with a Bluetooth link that enables local supervision on a computer or tablet. Calibration and experimental results are included in the paper.

Keywords: force measurement; distance measurement; walker assistive device; gait analysis; usage monitoring

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1. Introduction

It is estimated that by the year 2025, in the United States and Canada, 25% of the population will be over 65 years old [1–3]. Moreover, it is expected that in the European Union the life expectance for the year 2060, for women and men, will be around 89 and 84.5 years, respectively [4]. Thus, topics related with the mobility of elderly people have an increased importance, particularly in which concerns the proper usage of mobility aiding devices [5,6]. The careful and conscientious use of these devices can avoid harmful injuries [7–9], namely the ones caused by elderly people falls. Besides the improvements related with elderly people, in terms of quality of life and extension of the time they can live autonomously at home, mobility adding devices are also very important for patients during rehabilitation processes.

Several solutions were developed to address these problems [10–14] but many of them are too complicated, too expensive or too impractical for day-to-day applications. Many solutions make use of accelerometers and Inertial Motion Units (IMU) to extract kinematic parameters related with human gait [15–17]. However, these solutions require complex algorithms to improve measurement accuracy, in particular to mitigate the problems related with time integration of signals that contain persistent DC offsets (as it happens with low-cost accelerometers).

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sensors-18-00540.pdf (4.93 MB)

8/3/2026: Smart and Assistive Walker

NAVYA JAIN - Apr 23, 2026, 2:04 PM CDT

Title: Smart and Assistive- ASBGo: Rehabilitation Robotics: A Smart-Walker to Assist Ataxic Patients

Date: 8/3/2026

Content by: Navya

Present: N/A

Goals: To learn about other smart walkers being developed

Content:

An ataxic patient suffers from a neurological condition characterized by impaired balance, coordination, and fine motor control, often appearing as drunk-like stumbling, slurred speech, and unsteady, wide-based walking. This means that they need help walking and the application of this device is similar to our project.

ASBGo∗ seeks to fill a gap in the literature by including a wooden table with a curvature in the removable trunk contact area, which allows a postural control, increased stability and decreased tremors and dysmetria in patients with ataxia. The ASBGo walker also includes a similar system through an electric lifting columns and the support provided by the wooden table, allowing assistance to patients in the transition from sitting to standing. In addition, from a rehabilitation point of view, an autonomous guidance functionality is paramount for SW to provide safe navigational decisions and collision avoidance, consequently, allowing the patient to fully concentrate on their gait pattern and mobility. This feature is also known as sensorial and cognitive assistance, once this type of interface does not require the user to produce any specific command to produce walker motion, being particularly, suitable for individuals with visual or cognitive dysfunctions.

Moreira, R., Alves, J., Matias, A., Santos, C. (2019). Smart and Assistive Walker – ASBGo: Rehabilitation Robotics: A Smart–Walker to Assist Ataxic Patients. In: Sequeira, J. (eds) Robotics in Healthcare. Advances in Experimental Medicine and Biology, vol 1170. Springer, Cham. https://doi.org/10.1007/978-3-030-24230-5_2

Fig. 2.2

ASBGo prototypes' iteration. From left to right the frist, second and third models

Full size image ›

Conclusions/action items:

The application of this prototype is to support patients in walking rather than to measure their rehabilitation progress as they are walking so this application is not similar to ours, illustrating the novelty of our project.

12/2/2026: Sensor Idea

NAVYA JAIN - Feb 13, 2026, 10:50 AM CST

Title: Ultra-wide Band Sensors incorporated into a Wi-GIM Network

Date: 12/2/2026

Content by: Navya

Present: N/A

Goals: To come up with an idea for the sensors

Content:

I did some research on ultra-wide band sensors and I found that they work best when there are no occlusions present in the environment, which is the environment in which the smart walker would be used. I also found that in environments that are land-slide prone, engineers use a Wi-GIM Network to measure ground instability, and I was thinking if we use the network on the smart walker itself, it could measure the stability of the patient and how sturdy of a walk they have, providing another metric of the patient's rehabilitation progress.

Conclusions/action items:

Incorporating a Wi-GIM (Wireless Ground Instability Monitoring) network involves deploying a cluster-based system using Ultra-Wide Band (UWB) technology to monitor ground movements. It consists of a master node (with GSM/GPRS for remote reporting) and several slave nodes (for distance measurement) arranged in a grid over the area

12/2/2026: Endcap Idea

NAVYA JAIN - Feb 13, 2026, 10:55 AM CST

Title: Endcap Sensors

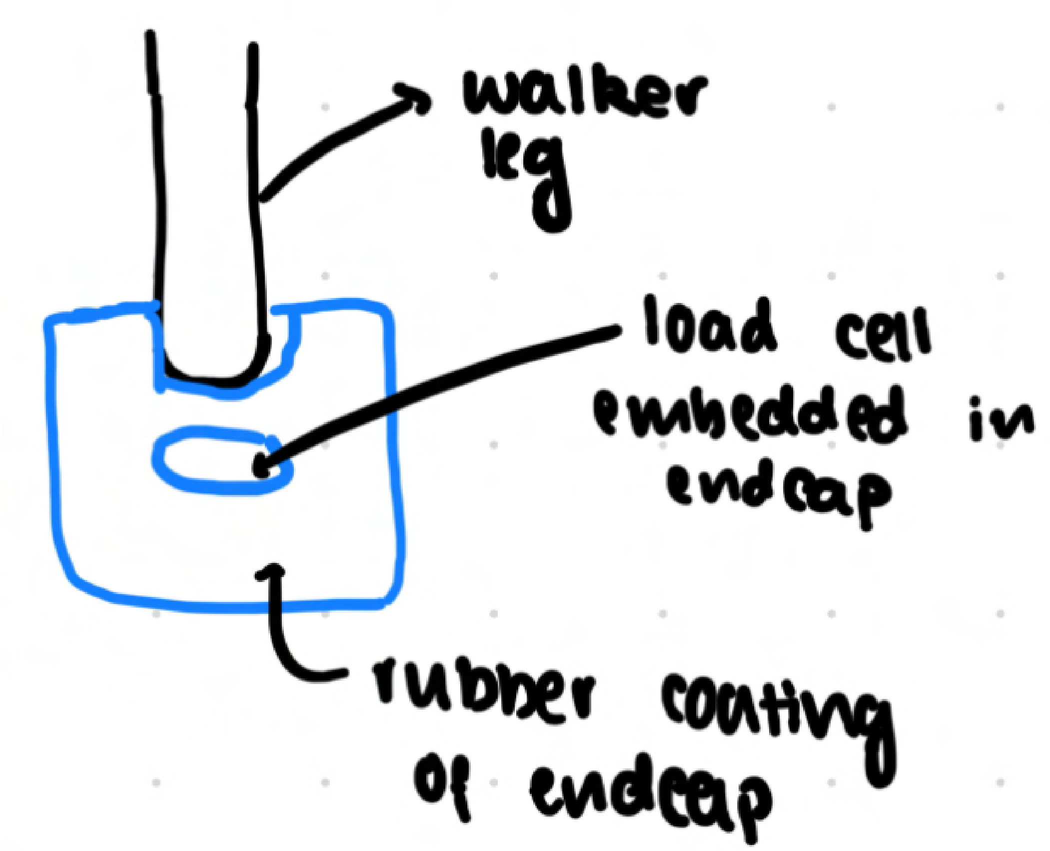
Date: 12/2/2025

Content by: Navya

Present: N/A

Goals: To come with an endcap design

Content:



Conclusions/action items:

In this design, I was thinking of having the rubber part of the endcap in a square shape rather than the a circular so that there is greater surface area on the bottom and it would take a greater amount of time for the endcap to wear out as it will take more friction for the endcap to wear out with the greater SA, as by the stress formula of F/A.

19/3/2026: Chemical Safety Training

NAVYA JAIN - Apr 28, 2026, 10:49 PM CDT

Title: Chemical Safety: Fume Hood Safety Training

Date: 19/3/2026

Content by: Navya

Present: N/A

Goals: To complete the training

Content:

Learning Objectives

1) To identify what is a fume hood and what is not a fume hood.

2) To describe safe practices of fume hood use including keeping fume hoods clear of objects, adjusting the sash position, avoiding rapid movement and avoiding multiple electrical outlets.

3) To identify chemicals that always need to be used in a fume hood.

4) To describe the steps to follow if an alarm continues in response to low air velocity.

5) To describe the UW fume hood policy.

Conclusions/action items:

I completed the training and learnt about Fume Hood Safety

NAVYA JAIN - Apr 28, 2026, 10:50 PM CDT

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

This certifies that Navya Jain has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety 102: Bloodborne Pathogens for Laboratory and Research	Biosafety 102: Bloodborne Pathogens Safety in Research Quiz 2025	11/28/2025	11/28/2026
Biosafety Required Training	Biosafety Required Training Quiz 2024	10/17/2024	10/17/2029
Chemical Safety: Fume Hood Safety Training	Fume Hood Final Quiz	3/19/2026	3/19/2031
Chemical Safety: Sharps Training for Chemical Manipulations	Sharps Final Quiz	11/28/2025	
Chemical Safety: The OSHA Lab Standard	Final Quiz	10/15/2024	
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	9/14/2025	9/14/2028

Data Last Imported: 03/19/2026 11:25 PM

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Screenshot_2026-03-19_at_23.40.32.png (275 kB)

28/1/2025: Lecture 1

NAVYA JAIN - Jan 28, 2026, 1:52 PM CST

Title: Article Searching, source evaluation and Site Management

Date: 28/1/2025

Content by: Anne

Present: N/A

Goals: To learn how to better use tools to search for specific things I may want to research

Content:

ChatGPT/AI:

- are predictive text generators, not search engines
- do not evaluate for accuracy, bias, or credibility
- generate factually incorrect statements
- can make up sources
- doesn't respond to prompts consistently

Evaluating your sources: what if this source about? who created it? why was this written and how does that affect the information? when was this source created?

Use the word AND to specify searches

Use the word OR to broaden searches

Zotero: citation manager

- You can write your own abstract
- Can take all sources, there is no limitation on the date of the source

Technical reports publish the results of scientific or technical research, often using federal funds. The research is performed and reports are produced by companies, universitites, and government laboratories.

Conclusions/action items:

The library has a live-chat tool where I can talk to a library and they can help me with my searches. I realised there are a lot more tools available on campus to help with my research than I realised.

4/2/2026: Lecture 2

NAVYA JAIN - Feb 04, 2026, 1:59 PM CST

Title: Interview and Cover Letter Review

Date: 4/2/2026

Content by: Navya

Present: N/A

Goals: To get feedback on my resume and cover letter

Content:

We split off into groups of 3-4 and got feedback on our resume and cover letter based on a specific job posting. It was a helpful task to learn how I can improve especially because I thought my resume was already good and didn't need modifications.

Conclusions/action items:

The main feedback I got was, in one of my internships I was the youngest person on the team and that I could expand on this and say how I proactively sought guidance to be successful in this field and to expand on my role as BMES president.

25/2/2026: Lecture 5

NAVYA JAIN - Feb 25, 2026, 1:48 PM CST

Title: Lecture 5- Diversity and Inclusion

Date: 25/02/206

Content by: Navya

Present: N/A

Goals: To understand the principles of diversity in energy

Content:

What does diversity mean in engineering design:

- Thinking about how all groups of individuals are included in engineering design
    - Accessibility
    - Respecting religion and cultural beliefs
    - Age groups
    - Values
    - Equality
    - Safety
    - Wide variety of educational perspectives
    - Testing designs with multiple demographics

Diversity- some are obvious, some are not

- ethnicity
- socioeconomic status
- culture

What does universal design mean?

- Universal accessibility
- diversifying product markets
- global collaborations
- larger market growth
- global investment
- Paedatric vs adults

7 Principles of Universal Design

1. Equitable Use
    1. the design is useful and marketable to people with diverse abilities
2. Flexibility in Use
    1. the design accommodates a wide range of individual preferences and abilities
3. Simply and Intuitive Use
    1. use of the design is easy to understand, regardless of the users experience, knowledge, language skills, or current concentration level
4. Perceptible information
    1. the design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities
5. Tolerance for Error
    1. the design minimises hazards and the adverse consequences of accidental or unintended actions
6. Low Physical Effort
    1. the design can be used efficiently and comfortable and with a minimum of fatigue
7. Size and Space for Approach and Use

1. appropriate size and space is provided for approach, reach, manipulation, and use regardless or user's body size, posture, or motility

Conclusions/action items:

This lecture helped me consider multiple facets of my design and see how it can help as many as possible, while taking into considerations the cultural and religious beliefs of others, and making sure that your product is suitable for all groups of people.

4/3/2026: Lecture 6

NAVYA JAIN - Mar 04, 2026, 1:50 PM CST

Title: Library Session 2: Patents, Standards, and Other Resources for Design

Date: 4/3/2026

Content by: Navya

Present: N/A

Goals: To understand and learn about all the resources I have

Content:

Standards

What the libraries have:

- Full text via databases
  - ASTM
  - ASABE
  - IEEE
- Historial Print Collection

Freely available online: ASSIST quick search, EverySpec, FDA, International Telecommunications Union, NASA, NFPA, among others.

Patents and Prior Art- Search

- Patent examiners evaluate applications against prior art, wich includes
  - Inventions disclosed in the US and Foreign Patents and Patent Applications
  - Inventions disclosed in publications
  - Inventions currently for sale or in public use

Patents and Prior Art- Evaluation

- Independent Claims
  - Standalone
  - Contain all limitations

Conclusions/action items:

I didn't know that I had so many resources and using the lens.org website is a great tool to determine what existing art already exists around the topic

6/3/2026: Tong Lecture

NAVYA JAIN - Mar 06, 2026, 12:55 PM CST

Title: From Imagination to Implantation: Turning Science Fiction into Brain Technologies

Date: 6/3/2026

Content by: Navya

Present: N/A

Goals: To learn from Dr Williams about his experience and to gain advice in pursuing a career in BME.

Content:

Dr Williams came from a very small rural town where it was not common to go to college, let alone become an engineer.

Dr Williams has developed many successful startups.

- NeuroNexus
  - In between was bouth by Greatbatch but then in 2018 he has the company again because he bought it back
  - #1 world wide seller of electrophysiology equipment for world-wide seller, now
  - Renamed to neuroengineering lab
- NeuraWorx
- NeuroOne

NeuroOne: Sometimes less is more

Building thin film electrodes but their first design was one-size-fits-all so the doctor wanted it to be better. They started working with flexible electronics.

Issues with the flexible electronic electrodes still arose so one of the engineers suggested that they remove some material. This links back to the idea of sometimes less is more.

The company now controls 12% of the epilepsy research now.

His device was featured on greys anatomy!! They didn't ask for his permission before showing it.

BrainSync: Market and Timing is everything.

Created a device where you could do things just by thinking, like creating tasks. His inventions was in the Times Top 10 Inventions in 2009.

Conclusions/action items:

As engineers we want to make really fancy and complex devices, but sometimes the world is not ready for that and we just need to have an intermediate product. You need to always thinking about the end user.

11/3/2026: Lecture 7

NAVYA JAIN - Mar 11, 2026, 1:37 PM CDT

Title: Protocol Development

Date: 11/3/2026

Content by: Navya

Present: Navya, Nic, Shreya

Goals: To come up with prototyping and fabrication plans

Content:

Preliminary Testing/Analysis

- Low fidelity prototyping
- Circuit diagrams and circuit testing
- Fitting (connection points)
- Simple calculations
- Free body diagrams
- Mechanics of materials

Planning general concepts for fab and testing

- Materials - detailed list = match material expense table
    - Name of the material
    - Concentration, amount or starting dimensions
    - Manufacturer and part number
    - Purpose of the material
    - List of equipment needed
    - Include references to papers or research in other parts of the notebook
- Methods: step by step plan- list
    - Mix- for how long and with what vigor etc.
    - Cut- with what tool and what size etc.

3D Printing

- Same rules apply- plus more
- Materials
    - Manufacturer and model of the printer
    - Filament material, diameter, and model number
- Methods- printer settings
    - Layer thickness
    - Infill, speed, etc.
    - Support type and style
- gCode file

Manufacturing

- Consider throughout the process
- Cannot manufacture anything before you 3D print
- Common Methods
    - Molding- blow, injection, thermoforming, extrusion, rotational
    - Machining/subtractive manufacturing- mill, lathe, waterjet
    - Joining- welding, soldering, screwing, riveting, adhesives

Conclusions/action items:

Make sure you have a very comprehensive plan on what you want to make and how you will make.

Before you can fabricate something, make sure that you have 3-D printed the deisgn.

18/3/2026: Lecture 8

NAVYA JAIN - Mar 18, 2026, 1:28 PM CDT

Title: Elevator Pitches

Date:

Content by:

Present:

Goals:

Content:

Purpose of elevator pitches

- Succinctly and effectively communicate your ideas
- Seize opportunities
- Use an elevator ride to pitch = short
- Goal
  - capture attention
  - generate interest
  - leave a memorable impressible
  - hopefully come away with a win

Crafting you pitch:

- Know your audience: tailor your pitch to the interests and needs of your audience
- Practice, practice, practice
- Be authentic
- Keep it simple
- Adapt and iterate

General structure of elevator pitch:

- Attention grabber
- Introduction
- Value proposition
- Benefits
- Call to action

Conclusions/action items:

Even though it is important to practice your elevator pitch, you do not want to come across like a robot and it being too rehearsed.

Lecture 10- 8/4/2026

NAVYA JAIN - Apr 08, 2026, 1:37 PM CDT

Title: Engineering Judgement

Date: 8/4/2026

Content by: Navya

Present: N/A

Goals: To learn about engineering judgement

Content:

How do you learn engineering judgement?

- Real-world engineering problems
- Open-ended problems
- Teamwork and collaboration with others
- Critical thinking- evaluation solution
- Communication
- Handling uncertainty
- Intuition
- Ask questions
- Embrace life-long leanring

3 Components of the Model

- Attitudes
- Behaviours
- Cognitive

Conclusions/action items:

It is important to evaluate every single component of the situation before making your decision

Lecture 11: 15/4/2026

NAVYA JAIN - Apr 15, 2026, 1:47 PM CDT

Title:

Date: 15/4/26

Content by: Navya

Present: Navya, Nic, Shreya

Goals: To identify what makes a good poster and to prepare for the poster presentation

Content:

What makes a good poster

- good graphics
- limit words
- limit blank space
- data analysis--> graphs
- no raw data
- cohesive colours
- limit hanging bullets

What makes a bad poster:

- long sentences

- ugly

-no pictures

- data analysis in words

- no citations

Poster: Good practice

read the requirements and evaluation form

include relevant and correct contact information

descriptive title and subtitles

have a storyline

show your best results, not all

Conclusions/action items:

When creating a poster it is very important that the reader can understand the project just from the poster, and to make sure that the pictures aid the information and don't make it more confusing.

13/2/2026: BPAG Meeting

NAVYA JAIN - Feb 13, 2026, 12:17 PM CST

Title: BPAG Meeting

Date: 2/13/2026

Content by: Navya

Present: Navya

Goals: To understand the responsibility as BPAG and to understand the proper method for procuring materials.

Content:

Need to have all expenses approved by client prior to purchase.

Any purchase over $1000 needs to be approved by BME department

Keep track of all purchase.

Client and project type matters

- UW Affiliation but not BME
- UW Affiliation and BME
- NO UW Affiliation

If they have UW affiliation, have to ask if they want to use UW Funds. If they say no, very simple, just between you and client. If the client wants to use UW Funds, client has to buy for you and it is a very last resort for BPAG to pay. Need to make sure materials are not available through preferred vendors. UW is tax exempt, and if you pay you will not get the tax refund. Need to work with client's accountant for reimbursement within 90 days.

If you are ordering through UW Funds, shipping address must be UW address, can even send to Dr P: 1550 Engineering Drive, Room 1080 ECH, Madison, WI 53706-1609. If I do this way, need to include John Puccinelli as well as design project name as it appears on the website.

UW provides $50 per team, name of account is BMEDesign. If exceed $50, client can set up their own account at the Makerspace, link for this in BPAG slides and on makerspace website. Fill out the team information excel sheet and sent to client if I do this, because client needs to upload it when creating account. Client cannot set up account if they are outside UW.

Conclusions/action items:

Shop UW+ is only needed if client is using UW Funds, and the client would need to make the purchase not me.

Make sure to get reimbursement if I pay. Client has expressed will just venmo. I should only receive the money, no one else on my team.

2026/01/29 - U.S. Environmental Protection Agency: Cleaning Up Electronic Waste (E-Waste)

Shreya Venkatesh - Jan 29, 2026, 9:57 AM CST

Title: U.S. Environmental Protection Agency - Cleaning Up Electronic Waste (E-Waste)

Date: 29/01/2026

Content by: Shreya Venkatesh

Link: https://www.epa.gov/international-cooperation/cleaning-electronic-waste-e-waste

Citation: [1] US EPA, "Cleaning Up Electronic Waste (E-Waste)," *US EPA*, Nov. 15, 2023. https://www.epa.gov/international-cooperation/cleaning-electronic-waste-e-waste

Goals: Learn about ways we can think about electric waste recycling and the impact of our sensors and design on a large scale

Content:

- EPA works with other governments, environmental officials, and governmental plans to enhance the management of electronics through the product lifecycle
- E-waste stands for electronic waste or end-of-life elecrtonics and it is meant for products that are nearing the ned of useful life and therefore discarded into landfill or not disposed of adequetly
- A lot of undetermined e-waste is shipped from the US to other developing countries that lack the ability, standards, and enforcement to handle these materials properly
- There are a variety of safety concerns that have to be kept in consideration, such asthe unsafe handling of e-waste, have affects on human health and the surrounding enviornment
    - Open air burning - exposure to harmful substances, toxic materials, high levels of lead, mercury, cadmium, arsenic
        - Impact: cancers, miscarriages, neurological damage, IQ
    - Acid baths
- In 2009, US consumers and businesses discarded a total of 2.37 million tons of ewaste which only 25% was appropriately recycled
- Our project requires the use of at 3-4 sensors per device, and as we are performing our iteration process, there are aspects that we need to consider when disposing of or leaving our e-waste
    - EPA suggests looking for local e-waste collection,s and we can inquire at the DoIT Help Desk or Makespace, as they have established projects where they have electronics recycling
    - Sensors that are not nearing the end of their lifecycle can be kept in the design room and suggested for future group use.

Conclusions/action items: I think this information is definitely relevant to our project. Obviously, smart walkers can be reused and recycled at hospitals, but the project/attachment we are making has a significant environmental impact if not handled properly after its lifespan.

2026/01/29 - Incidence and dynamics of mobility device use among community-dwelling older adults in the United States

Shreya Venkatesh - Jan 29, 2026, 10:16 AM CST

Title: Incidence and dynamics of mobility device use among community-dwelling older adults in the United States

Date: 29/01/2026

Content by: Shreya Venkatesh

Link: https://pmc.ncbi.nlm.nih.gov/articles/PMC12288708/

Citation: [1] X. Liu, S. E. Baumann, A. L. Rosso, E. M. Venditti, Y. Yao, and S. M. Albert, “Incidence and dynamics of mobility device use among community-dwelling older adults in the United States,” *Journal of Elder Policy*, Sep. 2024, doi: https://doi.org/10.1002/jey2.12011.

Goals: Understand the true impact of mobility for older patients and some data behind it

Content:

- Global trends of aging have projected that older adults will comprise a larger portion of the disability population in the future decadesThe
- ICF framework has viewed disability as a dynamic and continuous state that comes from the interaction between health conditions and contextual factors:
  - Environments (assistive technology, social attitudes, political, legal, and social structures)
  - Internal personal factors (coping styles, motivation, self-esteem)
- 41.7% of US adults aged 65 and over report having some sort of disability and 64.5% of indivudals as experiecining mobility disability
- There are a number of available mobility device such as walking aids (WAs), wheeled and seated mobility devices (WSMDs)
  - WAs - canes, crutches, walking frames, rollators - one of both arms for support - this is what a walker is
  - WSMDs - wheeled and seated mobility devices
- There were 2,943 new instances of mobility device use among 2,591 older adults over 47,722 person-years of observation
- Results from the study:
  - Older adults using WSMDs or changing devices tended to be in more dire or vulnerable health states
  - People who used a mix of devices had poor user experiences
  - Many users of WAs stopped using them within a year
  - A lot of users with WAs tend to be in their intermediate phase to recovery or declining health, but most commonly the user would stop WAs after sufficient improvement (has an impact and therefore is vital that quantitative impact should be tracked through a smart device as we are making)
  - WAs are one of the best intermediate steps to determine growth and future health!

Conclusions/action items: The study highlighted the importance of a smart walker as a walking aid. The results showed that it was one of the best devices for predicting future health and improvement, and most people stopped after a year. This makes it even more important to have quantitative number tracking of walker use, so that health can be determined and compared to the last walker use or help clinicians make a different plan.

2026/04/01 - Executive Summary Research on Brain Injury Statistics

Shreya Venkatesh - Apr 29, 2026, 11:14 PM CDT

Title: Brain Injury Statistics

Date: 01/04/2026

Content by:

Link: https://www.ninds.nih.gov/

Citation: [1] NINDS, “National Institute of Neurological Disorders and Stroke |,” *Nih.gov*, 2019. https://www.ninds.nih.gov/

Goals: Learn about statistics to use in the poster and executive summary

Content:

- Traumatic brain injury - damage to the brain caused by external force -> blow to the head, fall, vras
- Range from mild to severe -> severe can lead to permanent disability or death
- Types
  - Penetrating - object enters the brain
  - Non-penetrating - brain moves with the skull
- Symptoms
  - Dizziness, nausea
  - Imbalance
  - Vision issues
  - Gait impairment
- Effects on consciousness
  - Coma
  - Brain death
- Brain affect
  - Damage can cause focal (one area) or diffuse (spread across the brain)
- Injuries
  - Concussiion
  - Hematomas (brain bleeding)
  - Skill fractures
- Risk age group
  - Adults 65+
  - Young children
  - Men
  - Vehicle accidents
- Diagnosis
  - Neurological exams
  - Symptom assessment
  - Brain imaging
- Treatnment
  - Depend on location/severity
  - Early intervention

Conclusions/action items: We can use this information for the executive summary.

2026/01/28 - Development of a smart walker for clinical settings: a protocol of an exploratory mixed-methods study

Shreya Venkatesh - Jan 29, 2026, 9:41 AM CST

Title: Development of a smart walker for clinical settings: a protocol of an exploratory mixed-methods study

Date: 29/01/2026

Content by:

Link: https://pmc.ncbi.nlm.nih.gov/articles/PMC12766821/

Citation: [1] N. Strutz, Thorsten Meyer-Feil, René Schwesig, S. Schulze, and H. Gissendanner, “Development of a smart walker for clinical settings: a protocol of an exploratory mixed-methods study,” *BMJ Open*, vol. 15, no. 12, p. e105342, Dec. 2025, doi: https://doi.org/10.1136/bmjopen-2025-105342.

Goals: Learn about the process of rehabilitation for patients using a walker and what is currently available

Content:

- Mobilisation and mobility in clinical settings are one of the number one concerns in the recovery process post-surgery and for trauma-related issues.
- Advancing age and acute chronic illness can severly impair mobility through multifactorial mechanisms:
  - Age-related
  - Disease-related impact on sensory perception
  - Motor control
  - Sensorimotor integration
  - Alterations in motor activity
  - Processing speed
  - Movement amplitudes
  - Postural stability
  - Psychological factors (mobility fears)
- Targeted mobility can also impact the care continuum and reduce the length of stay at the hospital
- Some challenges include limited personnel and time for promoting activities and monitoring mobilization.
  - There continues to be a shortage of healthcare workers
  - A lot of patients also avoid independent mobilisation due to fears or disorientation
- Study: develop a smart walker that can be used by patients in a geriatric ward in the hospital

1. Literature review

- Scoping review, interviews with patients, interviews with professionals, caregivers, and therapists
- User centered acessement (these are important social, public health, and safety considerations in the context of both the patient and doctors)
  - What are the mobility barriers in hospital spaces?
  - What are patients afraid of (falls, confidence, navigation)?
  - What do clinications need (workflow efficiency, safety, monitoring)

2. First iteration - could these be valid testing procedures?

- Validated questionnaires, observations, and short interviews

3. Scoping review - there are some testing we could also think of doing

- Gait analysis, clinical markers

Conclusions/action items: I think this study, although not completed, gives a good picture of the why, what the factors are to highlight in preliminary design research, and also possible future testing. The article is structured similarly to how this project has been run, so it is a great initial reference.

2026/01/29 - Walker-assisted gait in rehabilitation: a study of biomechanics and instrumentation

Shreya Venkatesh - Jan 29, 2026, 10:45 AM CST

Title: Walker-assisted gait in rehabilitation: a study of biomechanics and instrumentation

Date: 29/01/2026

Content by: Shreya Venkatesh

Link: https://ieeexplore.ieee.org/document/918282

Citation: [1] R. A. Bachschmidt, G. F. Harris, and G. G. Simoneau, "Walker-assisted gait in rehabilitation: a study of biomechanics and instrumentation," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, vol. 9, no. 1, pp. 96–105, Mar. 2001, doi: https://doi.org/10.1109/7333.918282.

Goals: Understanding current solutions in the market for intrumented walker s

Content:

- In 1990, 1,690,000 noninstitutional walker users in the United States
- Walker is a simple device that provides external mechanical support and reduces weight bearing on the lower limbs
  - There are studies that follow basic gait metrics, user satisfaction, and oxygen consumption/heart rate
- The study instrumented the walker to measure forces and movement patterns so that they could analyze how users interact with it physically
  - Overall: reflective markers were placed on key spots, and a motion-capture camera tracked body-part movements. Strain gauges were attached to the walker's handles and frame to measure forces and moments during testing. They also checked it dynamically on force plates to confirm readings were accurate.
  - Subjects and testing
    - Motion capture tracked with reflective markers (6 markers)
    - Walker height, handle placement was adapted according to subject
    - All sensors will be adequately recalibrated, and additional testing was performed.
  - Walker dynamometer and instrumentation
    - Finite element model - modeled as a walker as a 3d grame to determine forces on each hand and account for structural crosstalk MARC software used for stress/strain analysis
    - 12 strain gauges measured 3 forces + 3 moments per hand
  - Upper Extremity Biomechanical Model
    - Trunk, upper arm, forearm, hand
    - Joint calculations: used marker data and Euler angles to calculate rotations, inverse dynamics used ot compute internal joint forces and moments
    - Anthropometrics
  - Data Analysis: temporal, spatial, kinematics, kinetics
  - Results: Walker-assisted gait is biomechanically demanding on arms, elbows, and shoulders
    - Walker substitutes the legs' role to support body weight
    - In addition to normal rehabilitation using a walker, there should be additional strength training. Additionally, there should be additions to reduce upper-limb impact for patients already struggling with mobility.

Conclusions/action items: This study was incredibly helpful for understanding the types of instrumentation and sensors used to measure forces and movement in a walker. We can definitely use some of these ideas for validation testing to cross-check results and the quality of certain products. I also like how they thought about aspects of ergonomics and technical constraints when it came to safety,

2026/01/30 - Tekscan Smart Walker using FlexiForce

Shreya Venkatesh - Apr 29, 2026, 11:12 PM CDT

Title: Tekscan Smart Walker using FlexiForce

Date: 30/01/2026

Content by: Shreya Venkatesh

Link: https://www.tekscan.com/applications/smart-walker-using-flexiforce-sensors

Citation: [1] "Smart Walker using FlexiForce Sensors | Tekscan," *Tekscan.com*, 2015. https://www.tekscan.com/applications/smart-walker-using-flexiforce-sensors

Goals: Learn about other products in the market

Content:

- Uses two smart Flexiforce sensors in the walker hand supports
- DC motors to the front wheels
- Microcontroller to read the force applied by the user and adjust the walker speed
- Bluetooth connected to laptop
- No direct tracking of distance and speed, focused on weight distribution
- FlexiForce sensors
    - thin/flexible
    - Accurate force
    - low cost
    - customization for applications
- Not available in the market, research project by a Mexican research institute as a prototype rehabilitation device
- r&d stage

Figure 1: FlexiForce Sensors by Tekscan

Conclusions/action items: It isn't meant for speed/distance measurements and has no app. I wonder if these sensors are available to us?

2026/01/29 - Review Fall 2025 Poster

Shreya Venkatesh - Jan 29, 2026, 10:55 AM CST

Title: Fall 2025 Poster Presentation

Date: 29/01/2026

Content by: Shreya Venkatesh

Goals: Review past groups' projects and understand what new research/changes need to be implemented

Content:

- Key quantitative data: pressure exerted, distance, and speed (in real time)
  - Reliable for 10m of travel, 30 mins of use
  - Supports up to 140kg (300lb) of patient weight
- Sensors used: lidar, pressure sensors
  - Pressure sensors (Load cells): Change in electrical resistance when deformed under pressure; the change is measured and converted to voltage. The HX711 amplifier is used to amplify the small analog signals from the load cells and convert them to a digital output
    - 50kg each, 75kg overload capacity
- Future work:
  - Do further testing with the battery and other electronics
  - Implement a fall detection system
  - Find a new and more reliable load sensor
  - Add a method to easily export data with a secure HIPAA-approved connection

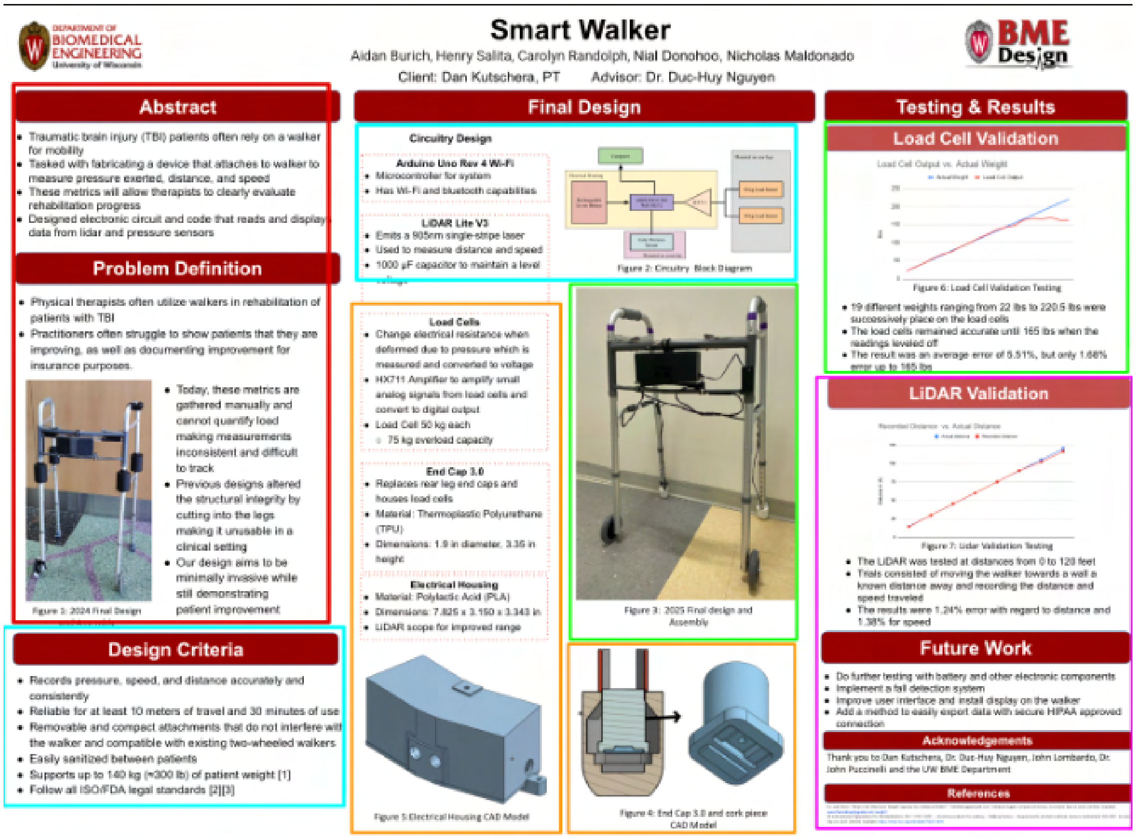


Figure 1: Smart Walker Fall 2025 Poster

Conclusions/action items: I think this week I will start by focusing on doing some research on new load cells

2026/02/05 - Final Report of Fall 2025

Shreya Venkatesh - Apr 29, 2026, 11:31 AM CDT

Title: Final Report of Fall 2025

Date: 05/02/2026

Content by: Shreya Venkatesh

Goals: Gain a better understanding of how the circuit board works with the load cell and solutions on how to separate the different parts

Content:

- The weight-tracking component cell changes the electrical resistance measured by the Wheatstone bridge circuit, producing a voltage proportional to the force.
    - A Wheatstone bridge measures unknown resistance very precisely
        - The bridge is made up of 4 different resistors, and the Vout can be measured across the middle.
        - R1/R3 = R2/R4, which means the voltage output is 0
        - If one of the resistors changes, the voltage output will change
- The load cells can withstand up to 75 kg each, for a total of 150 kg.
- A load cell are bunch of strain gauges glued to a metal element
    - When pressure is applied, the metal deforms
    - The deformation stretches or compresses the strain gauges
    - Stretching increases resistance and compression decreases resistance
- The materials used for the 3D print were an insert made from Polyvinyl Alcohol (PLA) with 50% infill, and the endcap design is made from Thermoplastic Polyurethane (TPU).
- To ensure the load cells send a strong signal, a load cell amplitifier of HX711 was used, which takes in weak/small voltage output from the load cells and amplifies the signal to the high voltage
    - It also gets rid of electrostatic noise to allow for a cleaner signal output

Conclusions/action items: I have a stronger understanding of the electrical side, so I think I know what to look for if we need to buy new load cells. Ideally, it should be able to withstand more than 75kg each and also not produce too much noise.

2025/02/10 - Distance Sensors

Shreya Venkatesh - Apr 29, 2026, 11:19 AM CDT

Title: Distance Sensor Types

Date: 10/02/2026

Content by: Shreya Venkatesh

Link:

1. https://oceanservice.noaa.gov/facts/lidar.html

2. https://pmc.ncbi.nlm.nih.gov/articles/PMC9231255/

3. https://product.tdk.com/en/products/sensor/ultrasonic/tof/index.html

4. https://www.seeedstudio.com/blog/2020/01/08/what-is-a-time-of-flight-sensor-and-how-does-a-tof-sensor-work/?srsltid=AfmBOorUWhY2DHnQ2OluR1dhDV00DPx9u7RISpnZAIxbFbUgSGYzoZVS

5. https://www.ti.com/product-category/sensors/mmwave-radar/overview.html

Citation:

[1]NOAA, “What is LIDAR?,” *National Ocean Service*, Jan. 20, 2023. https://oceanservice.noaa.gov/facts/lidar.html

[2] G. Tiberi and M. Ghavami, “Ultra-Wideband (UWB) Systems in Biomedical Sensing,” *Sensors*, vol. 22, no. 12, p. 4403, Jun. 2022, doi: https://doi.org/10.3390/s22124403.

[3] “Ultrasonic ToF (Time-of-Flight) Sensors,” *TDK*, Aug. 18, 2025. https://product.tdk.com/en/products/sensor/ultrasonic/tof/index.html

[4] yida, Ed., “SEEED Studio,” *https://www.seeedstudio.com/blog/2020/01/08/what-is-a-time-of-flight-sensor-and-how-does-a-tof-sensor-work/?srsltid=AfmBOorUWhY2DHnQ2OluR1dhDV00DPx9u7RISpnZAIxbFbUgSGYzoZVS*, May 27, 2022.

[5]“mmWave radar sensors | TI.com,” *Ti.com*, 2025. https://www.ti.com/product-category/sensors/mmwave-radar/overview.html

Goals: Evaluate discussed options for sensors other than LiDAR, since it was having issues with people intervening in the data

Content:

1. LiDAR

- Lots of reflective surfaces (glass, metal)
- LiDAR systems interface
- Walking through the beam

2. UWB - ultrawide band

- sends tiny rdio pulses between two devices and measures
- Uses
- Pros: wide-r

3. Ultrasonic (time of flight)

- Pros: cost-effective, works in low light, not impacted by visual occlusion like LiDAR, short-range sensing
- Cons: low accuracy, wide beam (picks up people walking), slow

4. Infrared (time of flight) - ie. VL53L0X, VL53L1X

- Pros: compact, stronger than ultrasonic, faster than ultrasonic, short-range precisions
- Cons: affected by ambient IR light, line-of-sight dependent

5. mmWave Radar

- Pros: works in all lighting conditions, good range and resolution,

- Cons: Higher power consumption, expensive, higher processing requirements

Conclusions/action items: These are all interesting options for our distance sensor design matrix. I think the mmWave Radar seems to align with our expectations the most, but I will need to do some extra research on these options.

2025/02/11 - mmWave Radar Sensor

Shreya Venkatesh - Feb 13, 2026, 10:44 AM CST

Title: mmWave Radar Sensor

Date: 11/02/2026

Content by: Shreya Venakatesh

Link: https://www.murata.com/en-us/products/connectivitymodule/mmwave-radar/overview/basic/about

Citation: [1] “What is mmWave radar? Understanding the mechanism and features of mmWave radar from the basics | mmWave Radar Sensor Modules | Murata Manufacturing Co., Ltd.,” *Murata Manufacturing Co., Ltd.*, 2026. https://www.murata.com/en-us/products/connectivitymodule/mmwave-radar/overview/basic/about (accessed Feb. 11, 2026).

Goals: Understand the features of the mmWave Radar Sensor and if it applies to our application

Content:

- How does it work
  - mmWave-wave radar, or Millimeter-wave radar, works by transmitting electromagnetic (radio) waves from 1mm to 10mm and frequencies in the 30GHz to 300GHz range
    - Emits radio waves at a target and receives reflected waves to measure distance, speed, and angle of the target.
  - mmWave uses
    - FMCW method (frequency modulation), which changes the frequency of the transmission signal over time, and the signal with a frequency that increases or decreases over times procides a chirp signal
    - CW method (continuous wave) uses continuous radio waves emitted for a set period of time. The reflected wave is used to track the signal at a frequency that changes over time, enabling calculation of the target's speed and distance.
- The short wavelengths allow for the mmWave radar to provide high resolution and work in conditions such as fog, darkness, and dusk
- Recent semiconductor technologies are expected to make mmWave radar more compact and inexpensive, making it more suitable for a wider range of fields
- This sensor is commonly used in automotive sensing, industrial automation, and security systems.
- Features
  - High resolution
    - Wavelengths of radio waves are short, ranging in mm, so it can secure a wider bandwidth and detect mutliple target seperately
  - Obstacle penetration (resistance to fog, smoke, dust)
    - Radio waves can propagate a larger scale than fine particles, so the effects of absorption and other hindrances are small
    - Absorption by water molecules in raindrops and fog is lower than that of visible light
- Advantages compared to other sensors
  - Infrared sensors
    - Infrared sensors are limited by temperature change and presence detection, mmWaves can measure distance and speed
  - Ultrasonic sensors
    - Ultrasonic sensors use sound waves, and reflections can disturb data due to background noise (mostly used for short distances), but mmWave radar works well at long distances.
  - Optical sensors
    - Cameras depend on the light source, and their performance can be affected by other movements, lighting, and fog. mmWave radar uses radio waves, so it can function in any lighting/room.
  - Laser radar (LiDAR)
    - This is susceptible to rain and fog, which affects detection performance. mmWaves have longer wavelengths, making them less susceptible to such effects.
- Circuit Configuration and Detection in FMCW mmWave Radar
  - Distance is determined by measuring the frequency difference between the transmitted chirp signal and the reflected signal

        - After mixing and digitizing the IF signal, a Fourier transform is applied using DSP to extract the frequency components, which are then used to calculate the object's distance
    - Angle detection
        - The angle is calcualted usiong multiple receiving antennas, and each antenna receives the reflected wave at slightly different times, a phase difference occurs between the signals
        - By analyzing this phase difference, the radar system determines the direction of the target
    - Speed detection
        - Speed is measured using phase changes between consecutive chirp signals. When an object moves, the phase of the IF signal shifts due to the Doppler effect. By comparing the phase differences before and after movement, the system calculates the object's velocity.

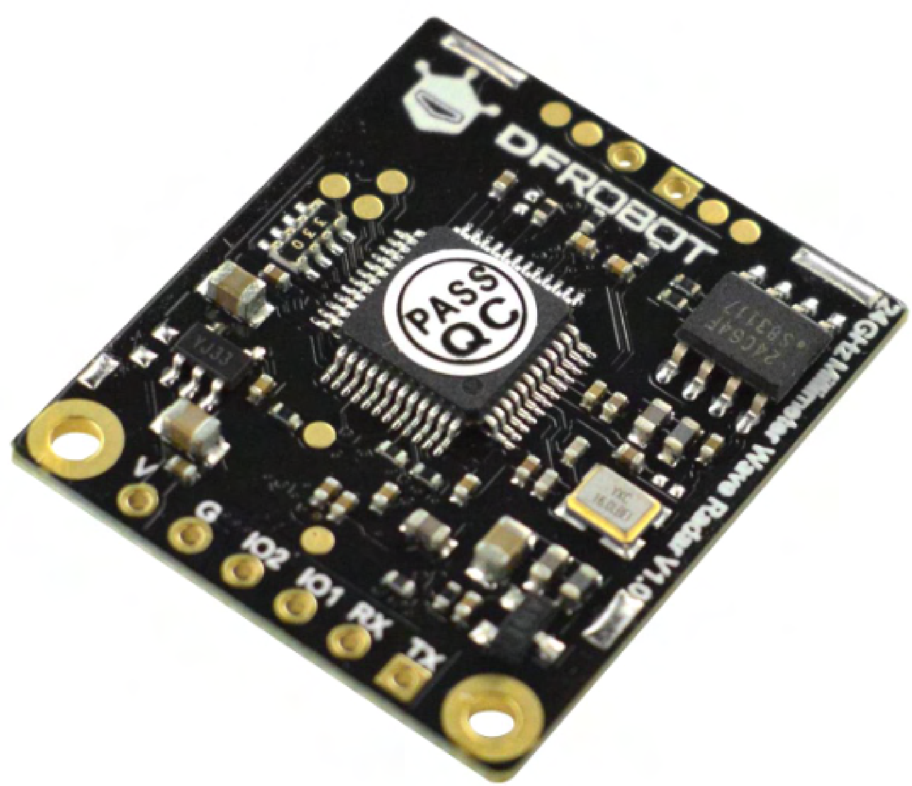


Figure 1: mmWave Radar

Conclusions/action items: This could be a great option to add to our design matrix. It's susceptible to very few occlusions, which solves our big problem with LiDAR right now.

Shreya Venkatesh - Feb 13, 2026, 10:50 AM CST

Title: mmWave Radar Sensor Cost

Date: 12/02/2026

Content by: Shreya Venakatesh

Link:https://www.lintechtt.com/mmwave-radar-sensor-pricing-guide/

Citation: [1] lintechtt, "mmWave Radar Sensor Pricing Simplified for Everyone," *LintechTT - Access Control Parts Supplier*, Feb. 26, 2025. https://www.lintechtt.com/mmwave-radar-sensor-pricing-guide/

Goals: Cost evaluation of mmWave Radar

Content:

- Low-cost modules: range from $10 - $20 per unit
- Automotive-grade sensor in bulk: range from $10.49 - $3195 per unit
- Mid-range sensor: $50 - $200 each
- High-end, specialized mmWave radar sensors (long range, high precision, wide bandwidth): $200 - $500

Content/action items: I think that we will be looking at mmWave radars around the mid-range category, which is still quite affordable compared to the other sensors on our design matrix. I think we can expect to pay $50 to $100 per unit.

2026/04/20 - The fundamentals of millimeter wave radar sensors

Shreya Venkatesh - Apr 29, 2026, 11:31 AM CDT

Title: The fundamentals of millimeter wave radar sensors by TInspire

Date: 20/04/2026

Content by: Shreya Venkatesh

Link: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.ti.com/lit/wp/spyy005a/spyy005a.pdf?ts=1777462702386&ref_url=https%253A%252F%252Fwww.google.com%252F

Citation:[1] “Analog | Embedded Processing | Semiconductor Company | TI.com,” *Ti.com*, 2020. https://www.ti.com

Goals: Learn about the distance measurement equation and how numerically it is calculated

Content:

- How it works:
  - FMCW radar transmits a chirp signal
    - frequency increases over time, and the reflected signal returns with a delay
    - difference between transmitted and received signals reveals object properties
  - Range measurement (distance)
    - Distance is determined by the time delay between transmitted and reflected signals:

$$\tau = \frac{2d}{c}$$

    -
  - Range resolution (dependent on chirp bandwidth)

$$d_{res} = \frac{c}{2B}$$

    -
  - Velocity measurement
    - Comparing phase differences between chirps
      - Radar transmits two chirps
      - Reflected signals produce the same distance peak
      - Phase shift indicates motion
      - Speed calculated from phase differences
  - Velocity resolution
    - improves when frame duration and number of chirps increase
    - Longer observation = better speed precision -> works for our application as TBI patients will walk slowly with walkers
  - Angle measurement
    - Uses receive antennas
    - Signal reach antennas at different times, and phase differences are created
    - Phase difference helps to find the angle of arrival

Conclusions/action items: Based on the equations, it seems we won't need many coding changes to accommodate the larger distance range, and the speed values should remain accurate since we are moving the walker at a slow speed. I need to identify at least one variable we can manually adjust to account for the wider range the mmwave radar can achieve.

2026/02/01 - ISO Walking Device Safety Standards

Shreya Venkatesh - Apr 29, 2026, 1:10 PM CDT

Title: ISO Walking Device Safety Standards

Date: 01/02/2026

Content by: Shreya Venaktesh

Link: https://www.iso.org/obp/ui/en/#iso:std:iso:11199:-2:ed-3:v1:en

Citation: [1] *Iso.org*, 2024. https://www.iso.org/obp/ui/en/#iso:std:iso:11199:-2:ed-3:v1:en

Goals: Learn about requirements for Wheeled Walkers

Content:

With the attachments, the walker should reliably pass all required tests as shown below and meet the requirements.

1. Rollator breaks

- stop reliably
- lock securely
- reachable

2. Wheels

- wheel stability
- rolling resistance limits
- safe steering
- Attachment should not:
    - provide weight on the wheels
    - restrict wheel rotation
    - reduce ground clearance

3. Durability

- Structural stress testing
    - fatigue
    - tipping
    - weight capacity
    - Repeated loading cycles
- Attachments should not:
    - shift the center of gravity
    - add weight
    - mount stress points

Conclusions/action items: I think an older team used something in the wheel itself, which makes it hard to maintain stability and balance. It also risks the system's structural integrity. So, for our new design, we must ensure we don't affect the walker design itself.

2026/02/01 - IEC 60601-1 Medical Electrical Equipment Safety

Shreya Venkatesh - Apr 29, 2026, 1:20 PM CDT

Title: IEC 60601-1 Medical Electrical Equipment Safety

Date: 01/02/2026

Content by: Shreya Venkatesh

Link: https://www.intertek.com/medical/regulatory-requirements/iec-60601-1/

Citation: [1] Intertek, "IEC 60601: Product Safety Standards for Medical Devices," *Intertek.com*, 2020. https://www.intertek.com/medical/regulatory-requirements/iec-60601-1/

Goals: Learn about the requirements of the Medical Electrical Equipment Safety

Content:

- Electric shock
  - Insulation between electronics and user contact surfaces
  - safe connectors and wiring
  - safe ground
- Mechanical hazards
  - sensors, battery, and displays must not loosen, detach, tipping risk
  - no sharp edges
  - secure mounting modules
- High temperatures
  - battery overheating protection
  - enclosure temperature limits
- Fire hazards
  - short-circuit protection
- Electromagnetic Compatibility
  - does not interfere with medical equipment
  - keeps working near phones/WiFi

Conclusions/action items: These requirements outline key safety factors we need to consider. All the wiring and the system must be contained within an electrical housing where the clinician and the patient would need limited interaction. For mechanical hazards, if the electrical housing is attached away from the user, it can help prevent accidents. Something we can consider for the distance/speed sensor enclosure is adding curved edges to the housing or buying corner pads for it. Additionally, the phone will be kept within a 50m distance from the device, and we would need to perform some temperature and short-circuit tests prior to user feedback.

2026/02/01 - Summary of the HIPAA Privacy Rule

Shreya Venkatesh - Apr 29, 2026, 2:28 PM CDT

Title: Summary of the HIPAA Privacy Rule

Date: 01/02/2026

Content by: Shreya Venkatesh

Link:https://www.hhs.gov/hipaa/for-professionals/privacy/laws-regulations/index.html

Citation: [1] U.S. Department of Health and Human Services, "Summary of the HIPAA privacy rule," *HHS.gov*, Mar. 14, 2025. https://www.hhs.gov/hipaa/for-professionals/privacy/laws-regulations/index.html

Goals: Learn about HIPPA privacy requirements

Content:

- Our project handles PHI - health data, personally identifiable information
  - during gait monitoring
  - trend reports
  - ability to export patient data
- Data privacy protection
  - there must be consent from the patient and clinician on what type of data is collected, how and where it will be used
- Secure data transmission
  - encrypted bluetooth
  - secure cloud storage
- Access control
  - only authorized individuals (patient, clinician) can use the data
- Data storage
  - there must be protections through encryption of the password, firmware changes
- Timed results with a purpose is required
- Systems of data must be able to be tracked

Conclusions/action items: There are several aspects in terms of data transmission and safety that we could look into next semester because I am not sure how far we can get through the app this semester, but some important aspects would be to have updates, security on the personnel that can use the data, and transparency on where information is going.

2026/03/04 - Arduino Nano ESP32 vs. Arduino Nano 33 BLE at the Makerspace

Shreya Venkatesh - Apr 29, 2026, 11:12 AM CDT

Title: Arduino Nano ESP32 vs. Arduino Nano 33 BLE at the Makerspace

Date: 04/03/2026

Content by: Shreya Venkatesh

Link: https://www.seeedstudio.com/XIAO-ESP32S3-p-5627.html?srsltid=AfmBOoqOB7_6qCTZQXFjHuinCEB5woQCVS-XvluYpRQ5pro3bNN_xE-M

Citation: [1] “Seeed Studio XIAO ESP32-S3,” *Seeedstudio.com*, 2026. https://www.seeedstudio.com/XIAO-ESP32S3-p-5627.html?srsltid=AfmBOoqOB7_6qCTZQXFjHuinCEB5woQCVS-XvluYpRQ5pro3bNN_xE-M (accessed Apr. 29, 2026).

Goals: Understand which Arduino is more applicable for our needs, and see the material availability in the makerspace

Content:

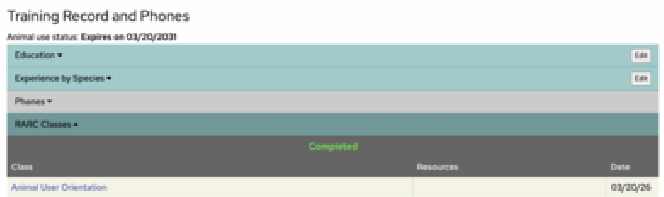
- Bluetooth - run website on a laptop (browser api to look for a device)
- Arduino exists as a server (through wifi)
- Old circuit problem that Arduino WiFi was also running the website
- Option to use current Arduino: Create a joint program that runs on a computer and Raspberry Pi (talk to the Arduino)
- ESP32 available at the makerspace:
  - A smaller number of ports available (10 data pins)
  - Same Arduino IDE, 240 MHz (15x more effective than the current Arduino)
  - Cost = $7.50
  - Width = 0.7in

Figure 1: Seed Studio ESP32 available in the Markerspace

Conclusions/action items: I think the best course of action is to buy the ESP32 available on campus, as it is inexpensive and supposed to have higher processing speeds/power.

20/03/2026 - RARC - Animal User Orientation

Shreya Venkatesh - Mar 20, 2026, 12:06 AM CDT



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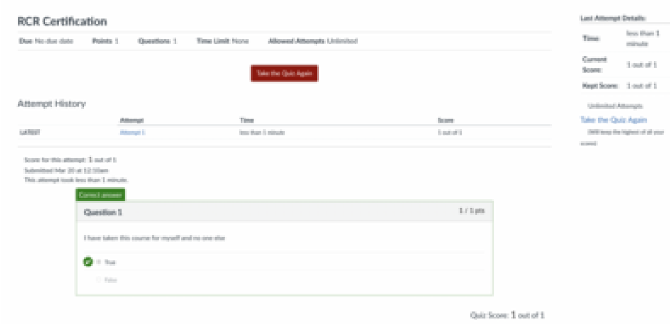
20/03/2026 - Responsible Conduct of Research

Shreya Venkatesh - Mar 20, 2026, 12:16 AM CDT



[Download](#)

Screenshot_2026-03-20_at_12.16.36_AM.png (817 kB)

20/03/2026 - Biosafety 106: Autoclave Use

Shreya Venkatesh - Mar 20, 2026, 9:03 AM CDT

Course	Assignment	Completion	Expiration
Biosafety 102: Bloodborne Pathogens for Laboratory and Research	Biosafety 102: Bloodborne Pathogens Safety in Research Quiz 2024	2/28/2024	2/28/2025
Biosafety 106: Autoclave Use	Biosafety 106: Autoclave Use: Safety and Efficacy - Verification Quiz	3/20/2026	No Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	2/28/2024	2/28/2029
Chemical Safety: The OSHA Lab Standard	Final Quiz	9/1/2024	
Responsible and Ethical Conduct of Research (RECR)	RCR Certification	3/20/2026	No Expiration
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	10/30/2025	10/30/2028

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Screenshot_2026-03-20_at_9.02.51_AM.png (509 kB)

2026/01/28 - Lecture 1 - Library session 1: Article Searching, Source Evaluation, and Citation Management

Shreya Venkatesh - Jan 28, 2026, 3:58 PM CST

Title: Library session 1 - Article Searching, Source Evaluation, and Citation Management

Date: 28/01/2026

Content by: Shreya Venkatesh

Goals: Learning about how to find reliable sources and citations

Speaker: Anne

Content:

- How technology works
  - AI chatbots
    - Not accurate, hallucinations, do not respond to prompts consistently
    - Not up to date
    - Not a reliable source
  - Evaluating sources
    - Relevance: what is the source abotu
    - Authority: who created this
    - Quality: why was this wirten and how does it affect information
    - Currency: when was this source created
  - You can add an article to the relevant folder on Zotero
- Technical reports - results of scienfiical and technical research using federal funds (recommended defense)
  - Lots of up-to-date information

Conclusions/action items: This information will be helpful for the literature search assignment and progress in learning about the project.

2026/02/04 - Lecture 2 - Providing Peer Resume Feedback

Shreya Venkatesh - Feb 04, 2026, 2:00 PM CST

Title: Providing Peer Resume Feedback

Date: 04/02/2026

Content by: Shreya Venkatesh

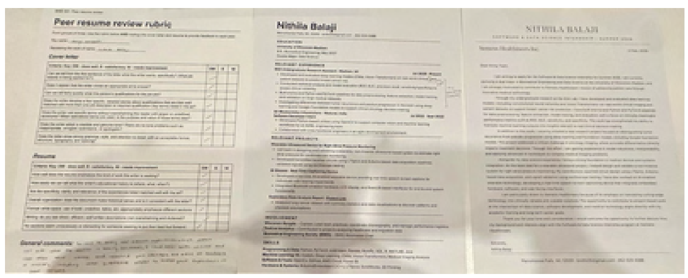
Goals: Learn about internships opportuntiies/job prospects and get feedback on my resume/cover letter

Content:

- Give peer feedback for a job application with a resume and a cover letter
- Rubric, annotations of cover letter, annotations of resume

Conclusions/action items: I think this was a helpful activity for gaining a different perspective on my resume, and I plan to make several changes. First of all, I think I can add some stuff into my cover letter that highlights the skills required on the job posting, and I think I need to cut my resume down to one page as well. I can do this according to the role, by cutting out experiences that are not as relevant.

Shreya Venkatesh - Feb 04, 2026, 1:58 PM CST



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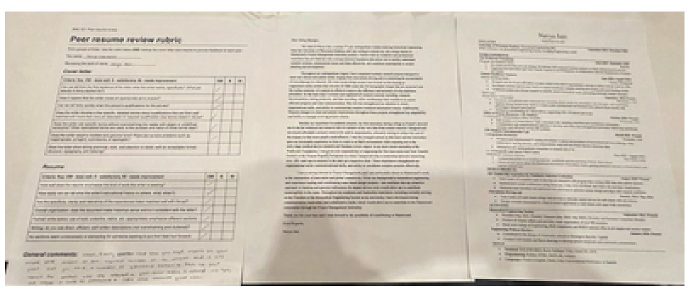
Shreya Venkatesh - Feb 04, 2026, 1:58 PM CST



Download

IMG_4739.png (4.25 MB)

2026/02/11 - Lecture 3 - Presentation tips and job interviews

Shreya Venkatesh - Feb 11, 2026, 4:23 PM CST

Title: Lecture 3 - Presentation tips and job interviews

Date: 11/02/2026

Content by: Shreya Venkatesh

Goals: Learn tips for prelim presentation and interviews

Content:

- Tips for preliminary presentation
    - Figure captions
    - No hanging bullets
    - Possible highlighting of old data
    - No CAD drawing, but a visualized view with clear labels
    - No handwritten sketches and removed background
    - Comparison between graphs should have similar values on the axis
    - Visualize & describe the context of use (workflow, interaction, environment, range of motion) - incorporate more graphics that show the internal frameworks
- Tips for interviews
    - Bring a small portfolio
    - Talk about leadership
    - Highlight both technical and softskills

In class activity:

- Answer the following prompts and upload your responses to canvas in the text box or as a pdf by the end of the day for this lecture:
- List your three chosen questions, and the questions picked by others in your group.
- 1. Talk about a weakness or challenge you've had to overcome in your life.
  2. Consider your most recent engineering job or academic engineering project: tell us one thing that you've learned recently from that job or experience.
  3. Give me an example of a time when another person really tried your patience.
- Type your responses to your questions.

  1. A weakness I have had for a long time is that I like to micromanage the teams that I work with. I am a very organized person and tend to stick to introductions and rubrics, which does allow the teams I work with to do well on assignments, but limits the creative link that is just as important. Last semester, I was the leader of my design team, and all my team members were very capable, but I was constantly worried about whether they had all the resources they needed or could complete the tasks I assigned to them. Over the course of the semester, I realised that the team members were hesitant to share their own work and unique ideas, as they were worried I might have already done the task for them. This caused the development to go stagnant. I decided instead of trying to work with everyone every work session, I will assign them to tasks with specific deadlines and provide an overall check-in time. This allows them to truly have the chance to complete the task, and for me not to overstep. This worked very well, and I actually saw their skills grow from the beginning of the semester. It showed me that instead of doing tasks for people, it is more valuable to build a format for them to succeed.

  2. In my second-year engineering project, it was the first project to be a continuous team effort. There 5-6 teams prior, and the project was close to completion. However, because I worked on different parts of the project each time, it became a large task for my team to put everything together and find all the resources and materials without reinventing the wheel. We had access to their notebooks, but some aspects were not properly detailed. Luckily for us, some of the older students were still present on campus and were willing to sit down with us and go through our questions in an orderly fashion. However, it made me realise the importance of documenting every part of the design process and being as detailed as possible. When closing out the team, we made sure to update all required information.

3. In my engineering magazine club, we are assigned to specific articles, and within each article, there are roles with their own deadlines. So the writer has to complete the interview to finish the article, the photographer should ideally be at the interview to take photos, and the graphic designer can only start the design after the writer is finished. In my team, a group member was assigned as the team's writer, but they were taking a long time to complete their tasks. After several conversations, they continued to make excuses and were unwilling to change their ways. I offered to help them out and even make questions for their interview, but they kept saying they have other commitments. My patience was running out, and I didn’t want to delay the publication, so I took it upon myself to complete the article and have a candid conversation with the team member to remember expectations when joining the team. Although it was a difficult task, I believe it was required to move the project forward.

- Describe one thing each of your peers did well during their answers, and one thing they can improve.
    1. Peer 1: Yeanne
        1. She did a great job talking through a structure by first outlining the problem, then discussing the solution, and finally the impact. It was easy to understand and straight to the point without dragging on.
        2. I think she could be a little more specific about the thought process behind the intervention she had with her teammate, who was not completing work. In addition, she could've mentioned more about how she applied these learnings towards future team projects.
    2. Peer 2: Megan
        1. I really liked how she gave context to the individual without painting them in a negative light. She said they weren't aware they were coming off as not wanting to collaborate, but from her perspective, they needed to communicate better. She did a great job at providing perspective from an objective sense.
        2. Overall, I thought her answer was solid. Similar to Yeanne, I thought maybe she could’ve gone into more detail about what she learnt from this experience and how she applied it to other situations as a nice conclusion.
- After discussing your answers with your group, how could you improve your answers?
    1. Overall, my team members said the story followed the question well. They mentioned that I sounded a little nervous and repeated myself a couple of times, so they recommended writing down key points and practicing in a normal conversation.
- How might you improve your interview skills?
    1. As my teammates said, I should keep practicing and, most importantly, be able to see myself. I can do this through recording my voice or video to see what my habits are and if I use any filler words. This will help me come off as more confident and ready.

Conclusions/action items: Overall, this session was great practice in being straight to the point and in public speaking. I tend to get nervous and jumble my words. I really need to create a document outlining a plan for all these questions, then keep practicing and building confidence in myself.

2026/02/18 - Lecture 4 - Preliminary Presentation Feedback

Shreya Venkatesh - Feb 18, 2026, 2:42 PM CST

Title: Preliminary Presentation Feedback

Date: 18/02/2026

Content by: Shreya Venkatesh

Goals: Get feedback on my team's preliminary presentation

Content:

- Get into groups of three and provide feedback to other group members
- From the group feedback, we got some good tips about changes we have to make before thursday. The feedback mentioned having consistent capitalization, cut down words on slide, and change the slide format of our circuit overall design.

Conclusions/action items: I will go in and make the required changes tonight and complete the cad designs for the end cap.

2026/02/25 - Lecture 5 - Diversity and Inclusion

Shreya Venkatesh - Feb 25, 2026, 1:50 PM CST

Title: Lecture 5 - Diversity and Inclusion

Date: 25/02/2026

Content by: Shreya Venkatesh

Goals: Learn about diversity and engineering

Content:

What does Diversity mean in engineering design?

- Thinking about how all groups of individuals are included in engineering design
  - Accessibility
  - Respecting religion and cultural beliefs
  - Age groups
  - Values
  - Equality
  - Safety
  - Wide variety of educational perspectives
  - Product isn't a limiting factor
  - Testing designs with multiple aspects and facets
  - Accommodations for size

What does Universal design mean?

- Universal accessibility
- Diversifying product
- Global collaboration
- Larger market growth
- Investment
- Increased stake of equity

7 principles of universal design

- Equitable Use - useful and marketable
- Flexibility in Use - accommodates a wide range of individual preferences and abilities
- Simple and Intuitive Use - use of design is easy to understand regardless of users' experiences, knowledge, language skills, or current concentration level
- Perceptible information - design communicates information effectively to the user
- Tolerance of Error - the design minimizes hazards and the adverse consequences of accidental
- Low Physical Effort - the design can be used efficiently and comfortably and with a minimum of fatigue
- Size and Shape for Approach and Use - Appropriate size, design, shape

How does this relate to ethics?

- Ensuring that no groups of individuals are left out. But in terms of manufacturin,g it is also vital that aspects of safe working conditions, environmental footprint, and investement from legal places

Conclusions/action items: This lecture helped me consider a variety of perspectives and how we can adjust aspects of our design team criteria to make them more accessible and adaptable to non-clinical settings.

2025/03/04 - Lecture 6 - Library Session 2: Patents, Standards, and Other Resources for Design

Shreya Venkatesh - Mar 04, 2026, 2:07 PM CST

Title: Lecture 6 - Library Session 2: Patents, Standards, and Other Resources for Design

Date: 04/03/2026

Content by: Shreya Venkatesh

Goals: Understanding the patents and standards available through university resources

Content:

- Standards at the library
  - ASTM (American Society of Testing and Materials) - includes all ASTM standards and many ISO and IEC standards
  - IEEE (Institute of Electrical and Electronics Engineers)
  - ASABE (American Society of Agricultural and Biological Engineers)
  - Historical Print Collection
- Market/Industry Sources
  - Business databases
  - Library guides to start with the databases
    - Company research
    - Industry research
    - Market research
  - Specifics:
    - Data Axle Reference Solutions - demographic/business, lifestyle information
    - IBISWorld Industry Reports - market research reports on over 700 US industries
    - ProQuest One Business - journals, newspapers, dissertations, industry reports
- Patents and Prior Art - Searching
  - Review
    - Patent examiners evaluate applications against prior art, which includes
      - Inventions disclosed in US and Foreign Patents and Patent Applications
      - Inventions Disclosed in Publications
      - Inventions Currently for Sale or in Public Use
- What are strategies that can be used to expand the search for additional relevant patents and patent applications?
  - The first way is to use the filter bar and opt for title, abstract, and claims
  - Some key terms we can search is 'Smart Walker', 'Walker Data Collection'
  - OR instead of AND
  - Citations (check for patents, current patents, etc)
  - Classification Explorer
- Patents and Prior Art - Evaluation
  - Claims
    - Independent claims - stand alone
    - Dependant claims - must refer to a previous claim
      - Must further limit the claim
      - Includes all limitations
  - Claims analysis
    - Comparison
      - Differences: The second one is more formal and talks about the mechanism of action. The second one also mentions squirrels as the user, and the first one explicitly doesn't.
      - Language: The second is more formal
      - How did the inventors of the later patent work around the claims of the earlier patent: mention more requirements in the first claim to avoid confusion
      - Cannot patent, but market, using different wording, audience (no protection though)
- Tips
  - Group by Simple Family

    - Cassication search from results using Classifications filter
    - Classifcations searching from indivudal records
    - Searching by citation
    - Google patent comparison for more information
- Preliminary Research
    - https://www.lens.org/lens/patent/041-435-518-252-73X/frontpage?l=en - this patent only has a proximity sensor
    - https://www.lens.org/lens/patent/101-919-685-760-673/frontpage?l=en - sense surrounding enviornment

Conclusions/action items: When we do a market analysis to apply for awards, we would need to review patents and other products in the market. I think it would be highly effective to start researching earlier, using websites like Lens.

2026/03/06 - Tong Lecture

Shreya Venkatesh - Mar 06, 2026, 1:00 PM CST

Title: Tong Lecture

Date: 06/03/2026

Content by: Shreya Venkatesh

Speaker: Prof. Williams

Goals: Learning about From Imagination to Implantation - Turning Science Fiction Into Brain Technologies

Content:

- Inspired by science fiction, making and fixing things
- He came from a rural community and went to South Dakota (running + mech e)
  - Started to work for Daktronics (scoreboard manufacturing, LED) - he wanted to make something new
- Went to masters to Arizona State for pHD - neurodevices companies
- Went to the University of Michigan and started collab with Madison
  - First startup (BRL) failed
  - Second startup in (Neurointervention technology) failed
    - Bought over by Gore to shelve the company
  - Third startup NeuroNexus
    - Buy out Greatbatch, which will put the company on its shelves
  - Fourth startup NeuroEngineering Laboratory - number 1 worldwide technology for neuro research - successful
- Learnings from startup experiences: Sometimes less is more
- Epilepsy Surgery
  - Thin film electrodes - flexible electronics
  - NeuroOne
    - Public IPO (NASDAQ)
  - Brainsync
    - Learning: Market and timing are key to success
    - Brain-computer interface
    - Not many investor interested (small pool of users - 100,000)
      - Looking at a larger audience pool (mind to text)
        - Texting using thinking through non-invasive EEG
      - Neuralink - 50 best inventions in 2009
  - Expanding clinical need
    - Focus on stroke, brain injury patients, etc.
    - Brainsync stroke rehabilitation
      - Detect movement stimulation from the brain (increased brain activity)

Conclusions/action items: It was interesting to learn how understanding the market, target audience, and timing as so key towards innovation success. Prof. Williams discussed how the market for his products was initially small, but they were able to analyze the market and see where their product could help a larger number of people and bring in more investment.

2026/03/11 - Lecture 7 - Protocol Development

Shreya Venkatesh - Apr 29, 2026, 11:01 PM CDT

Title: Protocol Development

Date: 11/03/2026

Content by: Shreya Venkatesh

Goals: Learn about Product Development

Content:

- What was wrong in the sample fabrication/test?
    - No units
    - Too many sigfigs
    - Only one trial of weight per tablet
    - The table title is quite detailed
- Sample protocol
    - Write in detail (timing, container, etc)
    - Where are the products from (manufacturing company)
    - What is the molarity and concentration of each material
    - What is the pH range? Make it smaller (+/- range)?
    - What are the tablets made of?
- Manufactiring
    - Consider through the process
    - Not everything 3d printed can be manufactured
    - Methods
        - Molds - blow, injection, thermoforming, extrusion, rotational
        - Machining - mill, lathe, waterjet
        - Joining - weigldiong, soldering, screwing, riveting, adhesives

Conclusions/action items: We need to edit the protocols from last year and get feedback from our TA and advisor.

2026/03/18 - Lecture 8 - Brevity of Communication

Shreya Venkatesh - Mar 18, 2026, 2:26 PM CDT

Title: Lecture 8 - Brevity of Communication

Date: 18/03/2026

Content by: Shreya Venkatesh

Goals: Figure out the next steps for the project and plan the design process

Content:

- Apply for awards:
    - Tong awards
    - Overall excellence award
- Work on pitch and call to action
    - Figure out integration with the mmwave radar and Arduino.

Conclusions/action items: Apply for the Tong award and plan a work session with the team

2026/03/25 - Lecture 9 - Ethics

Shreya Venkatesh - Mar 25, 2026, 2:28 PM CDT

Title: Lecture 9 - Ethics

Date: 25/03/2026

Content by: Shreya Venkatesh

Goals: Learn about ethics in bme

Content:

- Where do ethics come from? religion, experience, peers, family
- Ethical problem - solving is similar to the design process
- Making Process
  - Awareness - understand when you're faving a problem with ethical dimensions
  - Stakeholders - imagine their needs, put yourself in their position
  - Options - generate a range of possible actions
  - Analysis of options - test the actions
    - Harm test - does this option have fewer negative consequences (both short and logn term) than the other options
    - Ethics Case Study Notes:

1. The Guidant VPs: Most of the VP's at Guidant are very much against reporting the data to the FDA. (a) How might they continue to justify their case? (b) What would be the moral foundations of their perspective?

- They might argue that if they reported data to the public or FDA, there could be panic amongst users and other people affected. They could argue that the harm had already been done, so additional warning cannot help the situation.

- Utilitarianism, because they could argue that they were disclosing information in the best interest of the public and protecting them from mass hysteria. In addition, an issue like this could cause a great impact to the rest of the medical device industry.

2. Patients and doctors: Think about the position of those directly impacted: primarily patients who might be candidates for this surgery, and the doctors who use the device: (a) what arguments would those people want to ensure are considered by both the VPs and the design engineers about whether to report or not report the complications data? (b) What might be the ethical foundations of their perspective?

- (a) the transparency of risks of implantation, the safety of patients, the public trust in the medical and health care system etc.
  (b) VP and design engineers want to act at patients' interest, which their product could have maximized benefits for their customers. Patients need fair treatment and full risk disclosure before implantation, and they have right to be fully informed before making decisions.

3. The design engineers: (a) What else can they say or do? (b) What arguments can they try to make, and to whom?

1. The design engineers can formally document their concerns in writing to create an internal paper trail that shows their objection on record. They can present the quantitative failure mode data to leadership, framing disclosure not just as an ethical obligation but a legal one.

2. To the VPs, the engineers can argue that a cover-up carries far greater long-term legal and reputational liability than the defects themselves, especially keeping in mind historical cases that show how concealment often leads to worse outcomes than transparency. Legal and compliance teams should cite specific FDA reporting obligations. If all internal channels are exhausted, engineers have both the right and professional duty to escalate externally, including reporting it to the FDA

4. The design engineers: What options do they have? Generate a list of possible options (a minimum of 3 from the perspective of the design engineers), describe how each stakeholder is affected, then analyze them using the BME Code of Ethics (https://www.bmes.org/2025/cmbeconference/codeofconduct) and a couple of tests from the ethical decision-making system. Explain in detail the best option you would consider trying to act on.

1. Comply: Patients will remain uninformed and at risk, doctors cannot provide accurate counsel, and engineers become complicit in concealment. This option violates the BMES code of ethics, which prioritizes public safety over employer loyalty. It fails the

transparency tests(No engineer would like to see this go public), and the reversibility test(since a patient death from a preventable failure cannot be undone).

2. Internal escalation: the company will have a chance to solve the problem internally, but the patients are still under risk, and protections are delayed. This may still violate the code of ethics since this might be ineffective and does not fully prevent patients from avoidable risk and problems.

3. Report to FDA: All data has been collected properly and maintained in meticulous records, which can still be provided. In addition, they would’ve had to do prior animal and human testing in the past, so they can show data where the product worked, and future issues with the product can be avoided.

5.Our Project Application

What components of your design have ethical dimensions (be specific and list at least 2)?
An ethical dimension that needs to be addressed is ensuring that safety mechanisms and protocols are transparently shared with both the user and the doctor. Two concerns could be the wire from the load cell popping out during device usage or the box encapsulation lid falling off when moving the different modulated sections.

2. How will your team address the ethical dimensions? (What is your action plan?)

    On our side, we are working to create a compact design that doesn’t pose hazards that could inhibit or harm patient movement. However, if any aspects are at risk, we need to compile a list of them for the user to be aware of and watch out for. We could make a small poster/pamphlet that the therapist can hang up in the office or walker usage space and refer to before every session to ensure utmost safety.

Conclusions/action items: While we think about ethnics in design simply, there are ways that ethics can be at risk during usage regardless of protocols and design interventions. We need to make something towards the users and clinicans where they can see all the risks and are ready for any issues that could occur.

2026/04/08 - Lecture 10 - Engineering Judgment

Shreya Venkatesh - Apr 08, 2026, 2:07 PM CDT

Title: Lecture 10 - Engineering Judgment

Date: 08/04/2026

Content by: Shreya Venkatesh

Goals: Learn about Engineering Judgment

Content:

- Real-world engineering problems
- Open-ended problems
- Teamwork and collaboration with others
- Critical thinking-evaluation solution
- Communication
- Handling uncertainty
- Intuition
- Ask questions
- Embrace life-long learning

- Model
  - Attitudes (internal) - what you feel/believe about a certain issue
  - Behaviors (external) - how you demonstrate and act upon your knowledge and attitudes
  - Cognitive (internal/external) - what you know about, and are able to do, to address a specific issue

- Individual: Last year, during BME 300, our client had proposed a new project at the start of the semester, and the scope was very broad. There were not many expectations and research in the exact application, which caused us to worry if we could meet the outcome as a team. So, we outlined all the aspects of the project that were available to us, such as programming, integration with an augmented reality headset, and tracking mechanisms, and talked to an expert available on campus in order to have a frank discussion about what can be completed in the given time period. Based on the discussions, we found a realistic timeline and shared our insights with the client as realistic expectations.

Conclusions/action items: I think that the concepts learned in class really helped me put into perspective all the pathways to approach problem solving and finding solutions. All these concepts are those are important to keep in mind for the last leg of the semester when encountering issues with our design project.

2026/04/14 - Lecture 11 - Poster Presentation

Shreya Venkatesh - Apr 15, 2026, 2:38 PM CDT

Title: Lecture 11 - Poster Presentation

Date: 15/04/2026

Content by: Shreya

Goals: Learn about requirements for the poster presentation

Content:

- Good poster
  - no raw data
  - limit works
  - limit blank space
  - data analysis
  - cohesive colors
  - limit hanging bulletS
- Bad poster
  - Ugly formating
  - No pictures
  - No citations
  - data analysis in words
- In the executive summary, we should mention the process of manufacturing and what our goals are for that.

Conclusions/action items: We need to finish the executive summary and get the electronics working this week. Early next week, we need to start with testing and getting the poster together

2026/04/22 - Lecture 12 - Poster Feedback

Shreya Venkatesh - Apr 22, 2026, 1:45 PM CDT

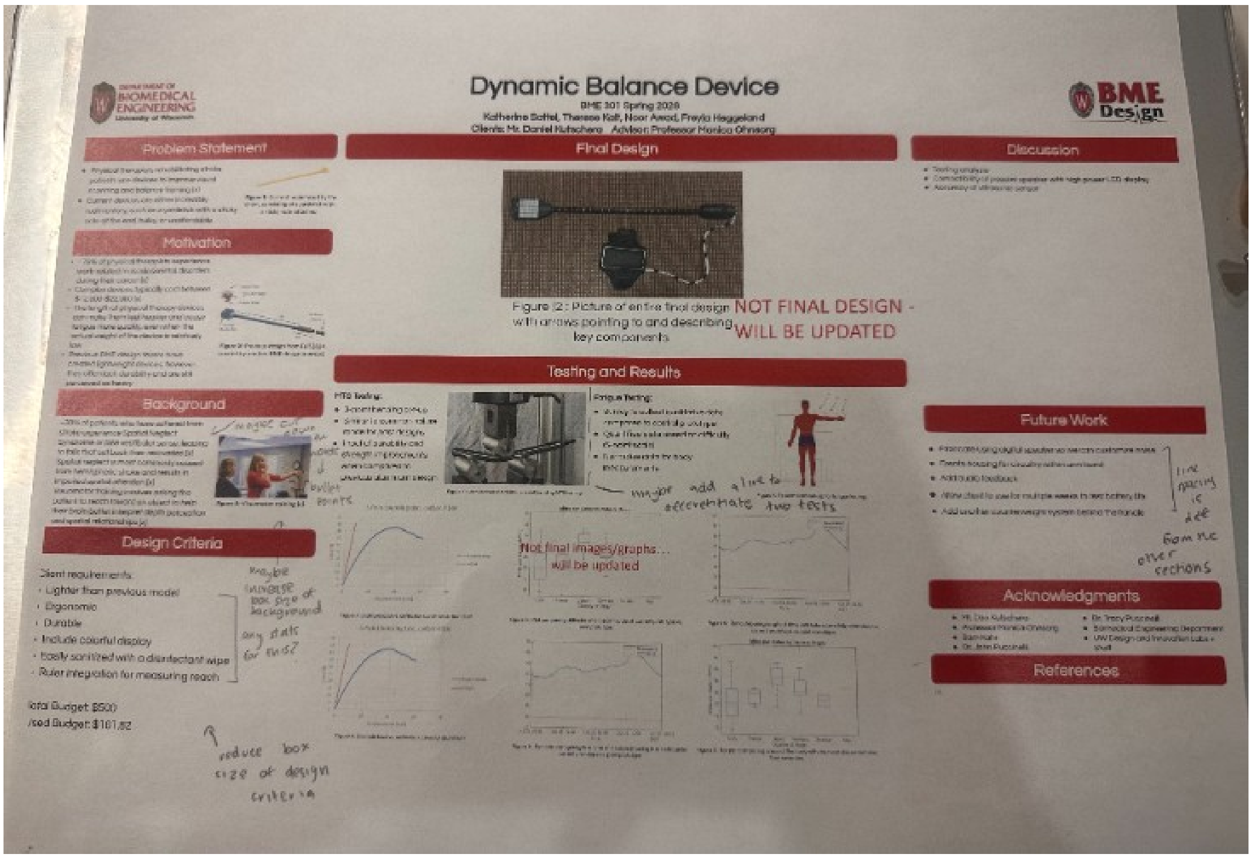
Title: Lecture 12 - Poster Feedback

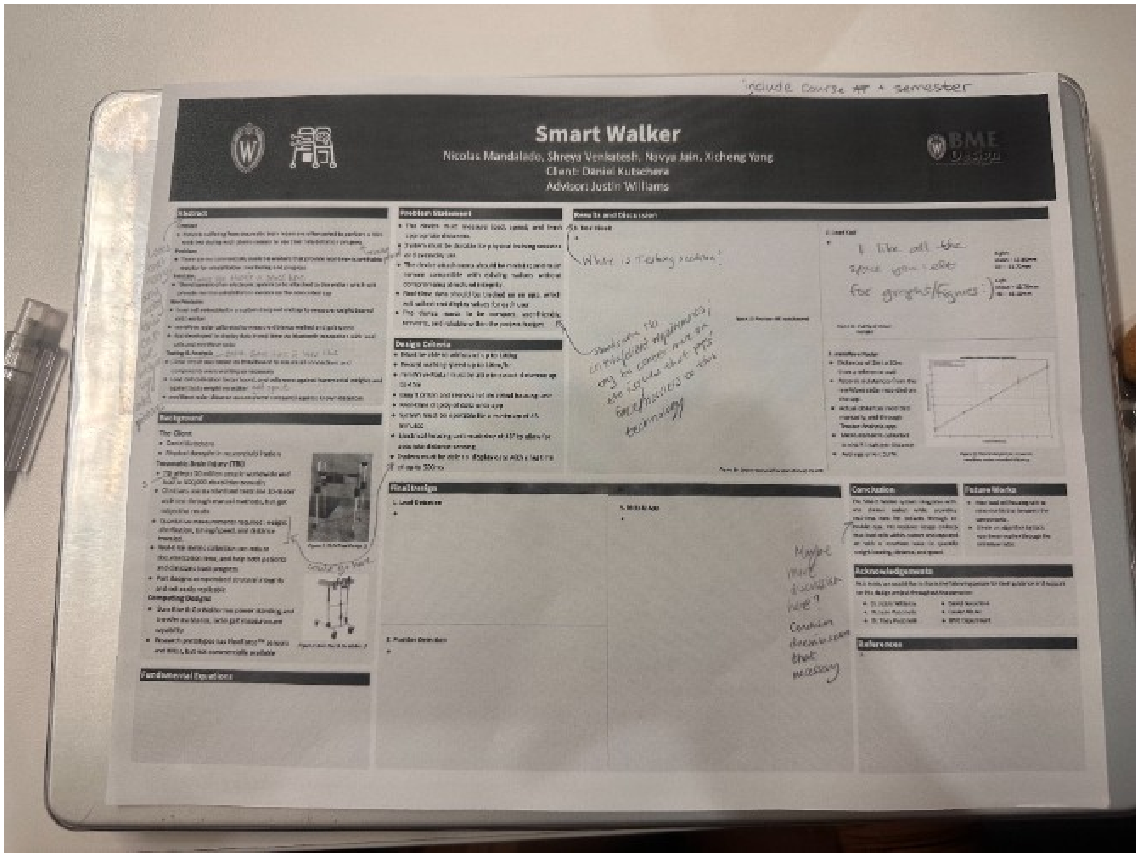
Date: 22/04/2026

Content by: Shreya Venkatesh

Goals: Get some feedback on the current poster

Content:





Conclusions/action items: Based on the feedback, we need to add more photos, and maybe reduce the number of words per section (simpler to read). We will start printing by tonight.

2026/02/19-TBI

XICHENG YANG - Feb 20, 2026, 8:06 PM CST

Title: TBI - traumatic brain injury

Date: 2026/02/19

Content by: Xicheng Yang

Goals: find out the walking disability level of TBI patients

Reference:

Dever, A., Powell, D., Graham, L., Mason, R., Das, J., Marshall, S. J., Vitorio, R., Godfrey, A., & Stuart, S. (2022). GAIT Impairment in Traumatic Brain Injury: A Systematic review. *Sensors*, *22*(4), 1480. https://doi.org/10.3390/s22041480

Content:

1. TBI spectrum
    1. mTBI (mild)
    2. modTBI (moderate)
    3. sevTBI (severe)
2. traditional gait assessments:
    1. subjective observations
    2. pen-and-paper testing
    3. BESS
        1. The BESS consists of 6 stance positions including two-legged firm... | Download Scientific Diagram
3. mostly used instruments
    1. motion capture systems
        1. expensive
        2. not portable
    2. inertial measurement units (IMU)
        1. low cost
        2. reliable
4. gait outcome measures
    1. spatiotemporal, kinematic, kinetic
    2. gait speed
        1. most frequently reported
        2. but not disease specific
    3. kinematics abnormalities observed
        1. report impaired dynamic stability
    4. dual-task gait
        1. Single- and dual-task assessment schematic for (A) standing with feet... | Download Scientific Diagram
        2. cognitive-motor inference
        3. may reveal subtle deficits missed in single-task

Conclusions/action items:

1. current stage TBI patient gait assessment:
    1. IMU is most promising and dominates the field

2. severe lack of standardization
    1. each TBI case have different brain regions affected and different recovery phases
    2. clinicians around the world use different gait metric framework and evaluation method

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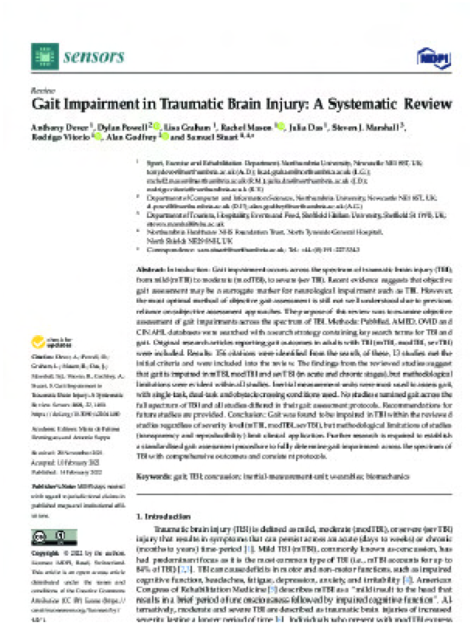
XICHENG YANG - Feb 20, 2026, 8:09 PM CST


sensors

Review

Gait Impairment in Traumatic Brain Injury: A Systematic Review

Anthony Dever[1], Dylan Powell[2], Lisa Graham[1], Rachel Mason[1], Julia Das[1], Steven J. Marshall[3], Rodrigo Vitorio[1], Alan Godfrey[1] and Samuel Stuart[1,4,*]

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sensors-22-01480-v2.pdf (1.55 MB)

2026/02/05-Smart mobility aids

NICOLAS MALDONADO - Feb 17, 2026, 3:32 PM CST

Title: Smart mobility aids

Date: 2026/02/05

Content by: Xicheng Yang

Goals: get some brief idea of competitive designs currently available on market

Reference:

https://www.rehabmart.com/product/bure-rise-go-walker-47525.html

https://www.gogrit.us/rollz-motion-rhythm-neuro-rollator/

https://www.performancehealth.com/u-step-neuro-walker

https://www.tekscan.com/applications/smart-walker-using-flexiforce-sensors

https://link.springer.com/chapter/10.1007/978-3-319-13117-7_182

https://caminomobility.com/pages/meet-camino

Content:

1. TR Equipment
    1. $7746
    2. main function: standing assistance

1. 

3. does not quantify gait or pressure metrics
4. equipped with a electricity powered remote control and casters with brake

1. 

5. takeaways from this one: an accessible brake could be useful for safety concerns. even better if it could be controlled by doctors remotely

2. Rollz
   1. $1999

    2. 

    3. the closest product found so far to smart walker
        1. described as "a premium neuro rollator tailored for individuals with Parkinson’s or other neurological gait disorders"
        2. incorporate three cueing systems to promote steady walking
            1. laser
            2. audio
            3. vibration
        3. those sensors could be personalized at a remote phone app connected with bluetooth
    4. foldable
        1. 
    5. takeaways: upgrading the data transmission tech from wifi to bluetooth is a planned upgrade to be done this semester. our website could adopt a similar design as their phone app.
3. U-Step
    1. $124
        1. 

    2. just a standard walker, could support balance for patients
    3. takeaways: a hand brake is something we didn't have.
4. FlexiForce Sensors
    1. they only have a prototype, not yet commercialized
        1. "Researchers at the Centro De Investigación y De Estudios Avanzados Del Instiuto Politécnico Nacional created a smart walker prototype using FlexiForce™ sensors to help patients achieve a more "natural" gait."
        2. paper not available at uw library online: https://doi.org/10.1007/978-3-319-13117-7_182, requested a copy, got no reply yet.
    2. the difference is that the speed are not monitored
        1. instead "The walker's speed is controlled by a microcontroller that uses a pulse width algorithm. The microcontroller communicates via bluetooth, translates the force applied and sends it to the laptop for processing."
    3. takeaways: they use inertial measurement unit (IMU) instead of direct speed measurements to quantify gait metrics. could be a potential upgrade.
5. Camino
    1. $2999
    2. details of this product is already included in the PDS
    3. not a data monitoring tool, but a advanced walking assistance with functions like auto-boost, auto-brake, lighting, and phone app
    4. 

Conclusions/action items:

1. most competitive designs on market focus on mobility assistance instead of metrics measurement and rehabilitation progress monitoring
2. Those ones with basic sensors integrated as extremely expensive (>$1000). But those with reasonable prices (around $100) have no electronics integrated, just an advanced walker.
3. Some functions our smart walker currently missing:
    1. foldability
    2. remote control
    3. brake, either by feet or hands
    4. blue tooth connectivity

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ARTICLE AUTHOR:	Pineda, M. A.
VOLUME:	49
ISSUE:	VI Latin American Congress on Biomedical Engineeri
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YEAR:	2015
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XICHENG YANG - Feb 11, 2026, 8:15 PM CST

update 02/11:

paper mentioned attached

2026/01/29-indoor distance measuring

XICHENG YANG - Jan 29, 2026, 1:09 PM CST

Title: Indoor distance measuring

Date: 2026/01/29

Content by: Xicheng Yang

Goals: comparing our current distance measuring solution LiDAR with its possible alternatives: RF and ultrasonic

Reference:

Geok, T. K., Aung, K. Z., Aung, M. S., Soe, M. T., Abdaziz, A., Liew, C. P., Hossain, F., Tso, C. P., & Yong, W. H. (2020). Review of Indoor Positioning: Radio Wave Technology. Applied Sciences, 11(1), 279. https://doi.org/10.3390/app11010279

Ijaz, F., Yang, H. K., Ahmad, A. W., & Lee, C. (2013, January). Indoor positioning: A review of indoor ultrasonic positioning systems. In 2013 15th International Conference on Advanced Communications Technology (ICACT) (pp. 1146-1150). IEEE.

Wu, Z., Song, Y., Liu, J., Chen, Y., Sha, H., Shi, M., Zhang, H., Qin, L., Liang, L., Jia, P., Qiu, C., Lei, Y., Wang, Y., Ning, Y., Zhang, J., & Wang, L. (2024). Advancements in Key Parameters of Frequency-Modulated Continuous-Wave Light Detection and Ranging: A Research review. *Applied Sciences*, *14*(17), 7810. https://doi.org/10.3390/app14177810

Content:

1. LiDAR
    1. measure from reflected light
    2. TOF and FMCW:
        1.

	TOF	FMCW
Distance measurement	High precision	Extremely high precision
Speed Measurement	Indirect measurement with high latency and low accuracy	Direct measurement with low latency and high accuracy
Interference Resistance	Weaker	Strong
Signal-to-Noise Ratio	Lower	High
Dynamic Range	Narrow	Wide
Multi-echo detection	Weaker	Strong
Adaptability to Harsh Environments	Weaker	Strong
Cost	Low	Short-term costs are high, with significant potential for cost reduction following solid-state integration.

        2. FMCW has better interference resistance
    3. it is line-of-sight to the target surface. items or people walking through could became the new nearest reflector instead of the wall.
2. RF ranging
    1. estimate distance from radio signal properties
    2. possible signal kinds:

1.

Technologies	Parameters	Advantages	Disadvantages
Wi-Fi	RSS/AOA TDOA/TOA RTT/CSI	Moderate power (216.71 mW on average). No extra hardware. Easy deployment. Cover large regions.	Affects time-varying RSS. Difficult to finish the task of building a smart city. Accuracy depends on the amount of access points.
Bluetooth	RSS/TOA TDOA AOA/TOF	Low power (0.367 mW on average). Easy deployment. Has a much higher data rate than ZigBee.	Needs extra hardware. Affect time-varying RSS. Interferes with same frequency band. Accuracy depends on its access point. Has a much shorter range than ZigBee.
RFID	RSS/TOA DOA/AOA TDOA PDOA	No contact and NLoS nature. Simultaneous and fast reading of multiple tag. Resilience to environmental changes. Reduce sensitivity regarding user orientation.	Needs extra hardware. Multipath effect and signal fluctuation. Large error with more target tags to locate. Limited capabilities of the passive tags.
ZigBee	RSS/TOA TDOA/AOA	Lower power (17.68 mW on average). No require much network bandwidth. Has higher latencies	Needs extra hardware. Interference and strength of signals. Difficult to create a connection with the smart phone.

2.

Technologies	Parameters	Advantages	Disadvantages
UWB	AOA/TOA TDOA RSS/DOA	High accuracy. Unaffected by interference. Fewer effects on humans. Suitable for body-centric and wearable network.	Short range, high cost. Challenges in NLoS. Needs extra hardware. Provides high accuracy.
NFC	RSS	Low cost, high accuracy. Provides secure and private navigation.	Accuracy depends on the number and proper placement of tags.
LoRa	RSS TOA TDOA	Long range. Extremely low energy. Covers large area.	Signal attenuation and multipath. Long-range between server and device. Operate outdoor-to-indoor
SigFox	RSS TOA	Long range, covers large area. Serves larger active nodes. Very low energy.	Long-range between server and device. Operate outdoor-to-indoor signal attenuation.
Cellular 1G/2G/3G 4G/5G Long-term evolution (LTE)	TOA/CSI TDOA/RSS RSRP/RSRQ	Long-range. High accuracy. No extra cost.	Requires synchronized based stations.
Hybrid	RSS /TDOA RSRQ/RSRP PDOA/TOA AOA/DOA	Improve the performance. Overcome the limitations. Better than pure algorithm solution. Reduces system complexity.	Not enough information with single network

3. RF's main advantage is being multi path, but it's performance can degrade in complex indoor environments
    1. non-line-of-sight, no extra hardware needed
    2. prone to noise

3. ultrasonics
    1. distance measured from time of flight of sound in air.
    2. could achieve centimeter level accuracy.
    3. but speed of sound varies with the environment
        1. humidity and temperature matter
        2. many systems require temperature sensing to prevent large error
    4. comparison of common ultrasonics systems:
        1.

System	Spreading and Channel access	update rate	Measurement method	Accuracy (cm)	Orientation (degrees)	Structure	Cost
Cricket	-	Low (1 Hz)	TDOA	10 cm	3-5	Decentralized	Low
Buzz	-	High (33 Hz)	TOA	4-10 cm	Not supported	Centralized, decentralized	Low
Dolphin	Gold Codes / CDMA	High (20 Hz)	TOA	3 cm	Not supported	Centralized	Medium
D	Kasami codes FHSS	High	TOA, AOA	1.5 cm	4.5	Centralized	High
E	Gold Codes / CDMA	High	TOA	2 cm	Not supported	Centralized	

Conclusions/action items:

1. most doable LiDAR upgrade seems to be RF, but more research needed to decide which kind of technology and set of parameter should we use.
    1. non-line-of-sight is not a drawback in our use case, instead the ability of stable measurements with occasionally environmental interference is exactly what we want (measurement still works when like someone walked in front of the smart walker)
    2. may look into UWB

XICHENG YANG - Jan 29, 2026, 12:39 PM CST


applied sciences

Review

Review of Indoor Positioning: Radio Wave Technology

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XICHENG YANG - Jan 29, 2026, 12:39 PM CST

Indoor Positioning: A Review of Indoor Ultrasonic Positioning systems

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Indoor_positioning_A_review_of_indoor_ultrasonic_positioning_systems.pdf (361 kB)

XICHENG YANG - Jan 29, 2026, 12:40 PM CST

applied sciences

Review

Advancements in Key Parameters of Frequency-Modulated Continuous-Wave Light Detection and Ranging: A Research Review

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applsci-14-07810.pdf (9.84 MB)

2026/01/29-UWB

XICHENG YANG - Jan 29, 2026, 1:29 PM CST

Title: UWB

Date: 2026/01/29

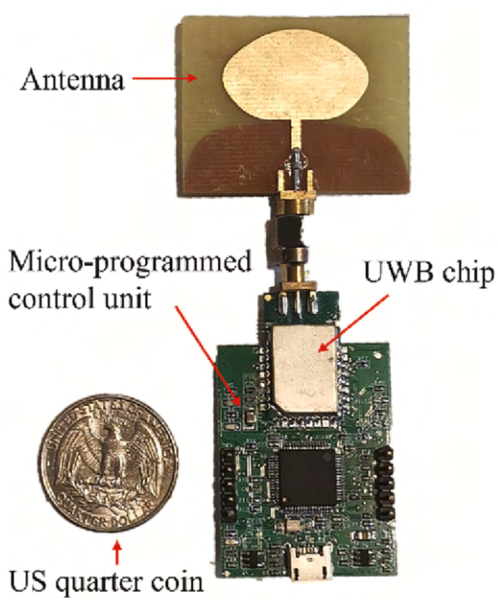
Content by: Xicheng Yang

Goals: following last research entry, look into specifically UWB (ultra wide band)

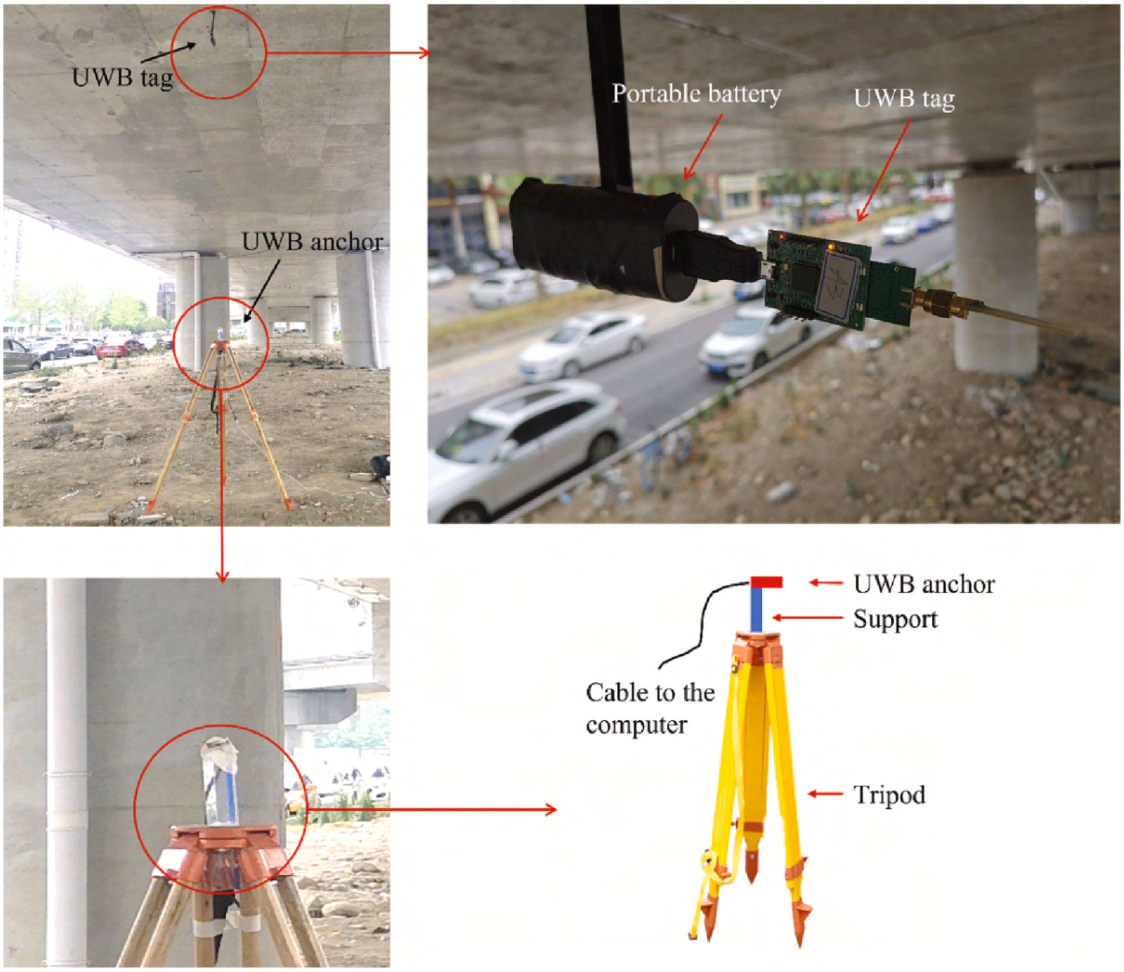
Reference:

Liu, Y., & Bao, Y. (2023). Real-time remote measurement of distance using ultra-wideband (UWB) sensors. Automation in Construction, 150, 104849.

Content:

1. radio frequency tech using time-of-flight of short electromagnetic pulses exchanged between two transceivers
    1. does not require line of sight
    2. inherently resistant to lighting conditions, visual occlusion and environmental clutter
    3. centimeter to millimeter scale rating accuracy
2. structure of a UWB sensor:
    1. 

3. a real world employment case of UWB sensors

1. 

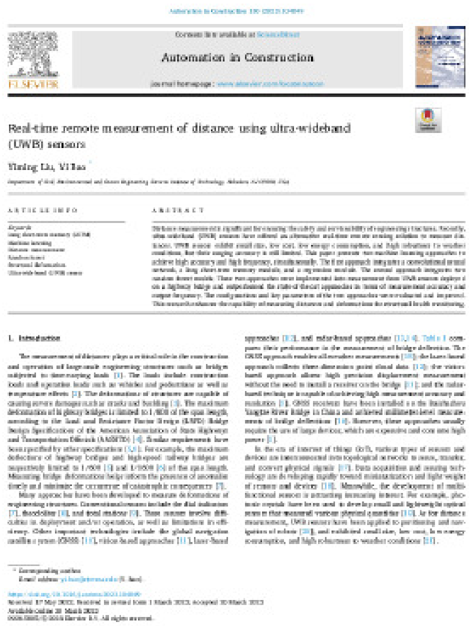
4. availability of UWB sensors
    1. this sensor is generally available with a cost of about $50
    2. Arduino SKU ASX00074 protena uwb shield
        1. https://store-usa.arduino.cc/products/portenta-uwb-shield
        2. illustration video: https://youtu.be/-lwlYGlWyXY
    3. tech spec
        1.

Connectivity	Ultra-Wideband via Truesense DCU150 UWB Module based on NXP Trimension™ SR150 UWB IC, with 3 Pcb embedded Antennas: • Channel 5, 9 • Frequency range 6.24GHz~8.24GHz • 14.1dBm @ CH9 • Ranging Mode 2D Ranging	Dimensions	53.4 mm x 37.5 mm x 9 mm
Interface	2x 80-pins High-Density Connectors	Power	3.3 V DC from Portenta Main Board
Compatible boards	Portenta C33	Operating Temperature	-30 °C to +80 °C

Conclusions/action items:

1. seemingly a pretty good choice
    1. difference toward LiDAR: need a transmitter and a receptor, but LiDAR only need one transmitter
    2. thus an extra attachment need on the wall
    3. may limit the use location of our smart walker
2. suitable for our around 10 meters indoor measurements and have premade module for Arduino control.

XICHENG YANG - Jan 29, 2026, 1:30 PM CST



Automation in Construction

Real-time remote measurement of distance using ultra-wideband (UWB) sensors

Yiming Liu, Yi Bao

Download

1-s2.0-S0926580523001097-main.pdf (9.08 MB)

2026/02/12-occlusion sensing

XICHENG YANG - Feb 13, 2026, 12:11 AM CST

Title: occlusion sensing

Date: 2026/02/12

Content by: Xicheng Yang

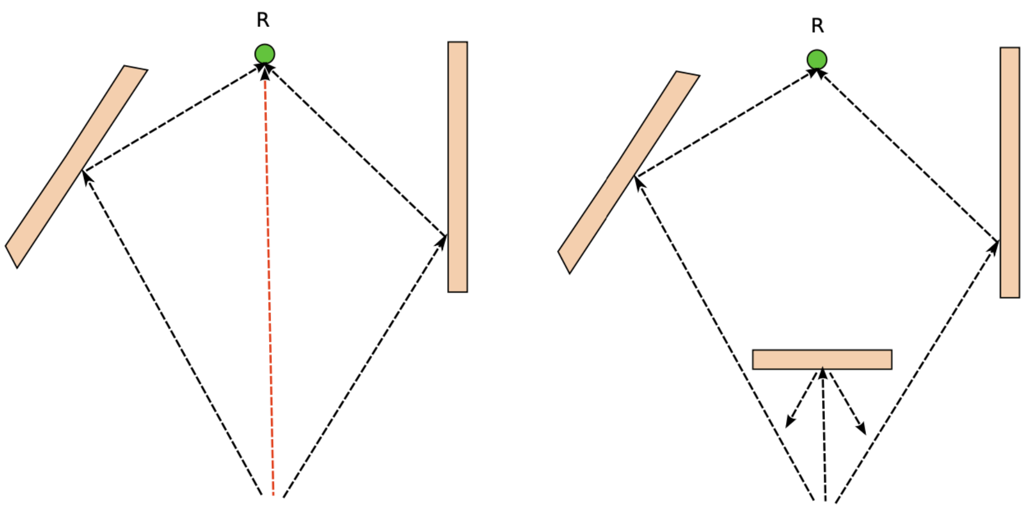
Goals: evaluate sense occlusion of three possible distance measuring tech

Reference:

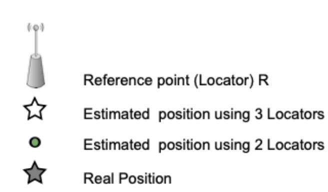
Alarifi, A., Al-Salman, A., Alsaleh, M., Alnafessah, A., Al-Hadhrami, S., Al-Ammar, M. A., & Al-Khalifa, H. S. (2016). Ultra wideband indoor positioning technologies: Analysis and recent advances. Sensors, 16(5), 707.
Gu, Z., He, X., Fang, G., Xu, C., Xia, F., & Jia, W. (2024). Millimeter wave radar-based human activity recognition for healthcare monitoring robot. arXiv preprint arXiv:2405.01882.
Fan, L., Wang, J., Chang, Y., Li, Y., Wang, Y., & Cao, D. (2024). 4D mmWave radar for autonomous driving perception: A comprehensive survey. IEEE Transactions on Intelligent Vehicles, 9(4), 4606-4620.
Titterton, D., & Weston, J. L. (2004). Strapdown inertial navigation technology (Vol. 17). IET.

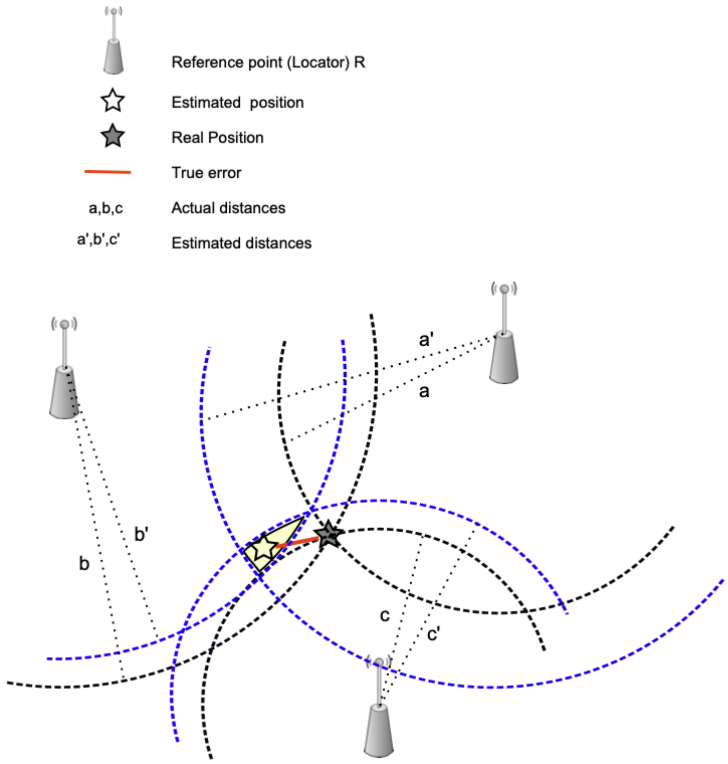
Content:

1. sensors usually lost clear line-of-sight in real world sessions
2. need distance tracking still work under partial blockage
3. UWB



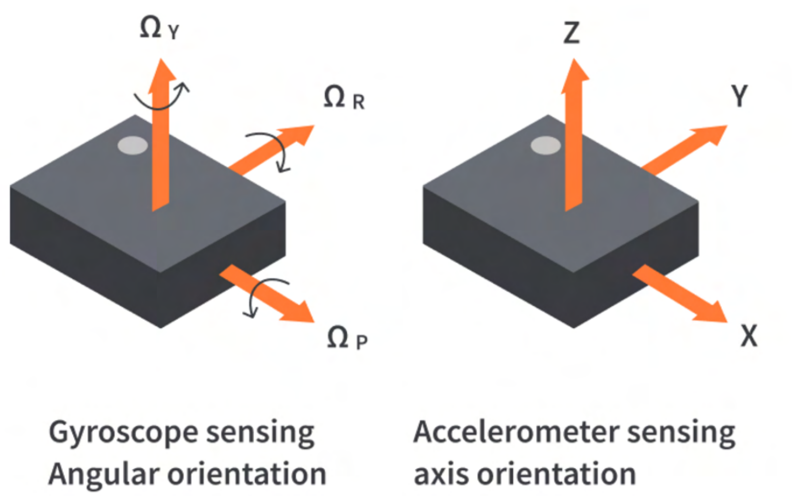
1. (a) LOS (b) NLOS
2. performance drops under NLOS
3. algorithms could be used to reduce error: AOA and ToA



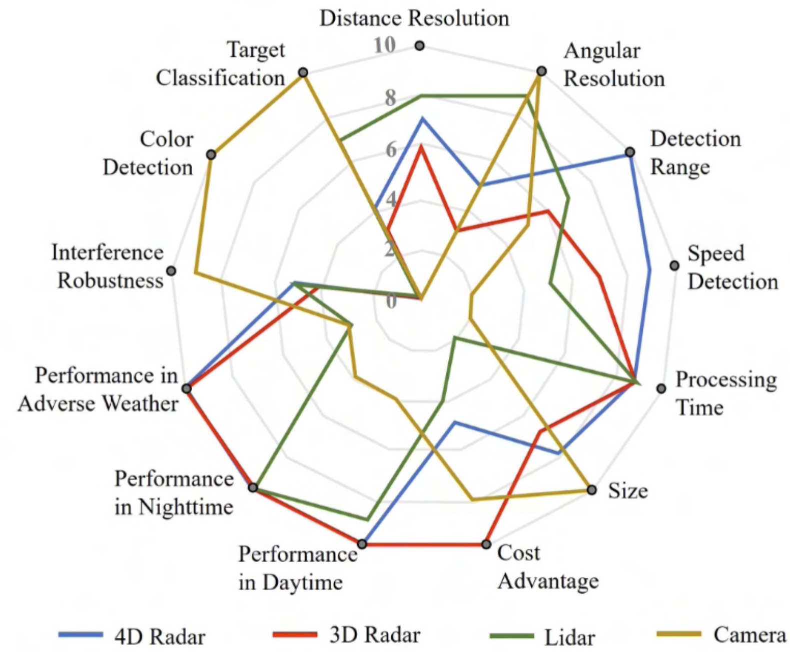
1. 

2. **Figure 5.** Time of arrival (ToA)-based algorithms.

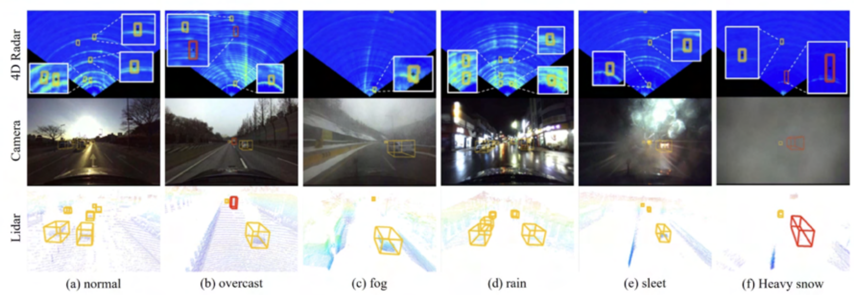
    4. works okay in clinics but still sensitive to obstruction

4. gyroscope + accelerometer
    1. 

    2. not affected by occlusion, measure motions directly, no external signal needed
    3. but no environmental reference
        1. drift could accumulate over time
        2. cause irreversible long term error
5. mmWave radar
    1. comparison against our current LiDAR solution

1. 

2. most robust to occlusion
    1. signals could partially penetrate or diffract around objects
    2. works well in complex environments



        1. Examples of K-Radar dataset across diverse weather conditions [43].
    3. maintain detection even when partial blockage occurs

Conclusions/action items:

1. a overall comparison

Table 5. Comparison between Indoor Positioning Technologies.

Technology	Common Measurement Methods	Advantages	Disadvantages
RFID	Proximity, RSS	Penetrate solid, non-metal objects; does not require LOS between RF transmitters and receivers [25].	The antenna affects the RF signal, the positioning coverage is small, the role of proximity lacks communications capabilities, cannot be integrated easily with other systems [27], RF communication is not inherently secure and consumes more power than IR devices [25].
UWB	ToA,TDOA	High accuracy positioning, even in the presence of severe multipath, effectively passes through walls, equipment, and any other obstacles; UWB will not interfere with existing RF systems if properly designed [25].	High cost of UWB equipment [27]; although UWB is less susceptible to interference relative to other technologies, it is still subject to interference caused by metallic materials [3].
Infrared	Proximity, Differential Phase-shift, AoA	Since IR signals cannot penetrate through walls, it is suitable for sensitive communication because it will not be accessible outside a room or a building [25].	Does not penetrate walls, therefore it is typically used in small spaces such as one room; IR communication is blocked by obstacles that block light which includes almost everything solid [25]; requires LOS between sender and receiver when using direct IR; One problem with diffuse infrared systems is their poor performance in locations with direct sunlight or fluorescent lighting because the infrared emissions (of the light sources) may interfere with the signals [25].
Ultrasonic	ToA, TDOA	Does not require LOS; do not interfere with electromagnetic waves [25]	Does not penetrate solid walls; there may be loss of signal because of obstruction; false signals because of reflections; and interference caused by high frequency sounds (e.g., keys jangling) [25].
Zigbee	RSS, Phase Shift Measurement	Its sensors require very little energy [25,27], and Low cost [25].	ZigBee which operates in unlicensed IS bands seems vulnerable to interference caused by a wide range of signal types (using the same frequency). This might disrupt radio communication [20]; it is suitable for networks in which conversation between two devices takes some few milliseconds which allows the transceiver to switch to sleep mode quickly [25].
WLAN	RSS	Use existing communication networks that may cover more than one building; the majority of devices available nowadays are equipped with WLAN connectivity; WLANs exist approximately in the majority of buildings; LOS is not required [20].	A major drawback of WLAN fingerprinting systems is the recalculation of the predefined signal strength map in case of changes in the environment (e.g., open/closed doors and the moving of furniture in offices). [20].
Cellular Based	RSS	No interference with devices that operate at the same frequency; the hardware of customary mobile phones can also be used [20].	Low reliability due to varying signal propagation conditions [20].
Bluetooth	Proximity, RSS	Does not require LOS between communicating devices [25]; a lighter standard and highly ubiquitous; it is also built into most smartphones, personal digital assistants, *etc.* [3].	The greater the number of cells, the smaller the size of each cell and hence better accuracy, but more cells increase the cost; requires some relatively expensive receiving cells; requires a host computer to locate the Bluetooth radio. Because the 2.4 GHz spectrum that Bluetooth is using is unlicensed, new uses for it are to be expected, and as the spectrum becomes more widely used; radio interference is more likely to occur [25].
Dead Reckoning	Tracking	Does not require additional hardware such as sensors	The DR calculates only an approximate position [41].
Image based technologies	Pattern recognition	They are relatively cheap compared with other technologies such as ultrasound and ultra wideband technologies [42].	Requires LOS, coverage is limited [27].
Pseudolites	RSS	They allow to extend the coverage area much farther to several kilometres and provide great flexibility in deployment that can be optimized for a particular application and they are also compatible with existing GPS receivers [43].	They are negatively affected by multipath, signal interference among pseudolites, weak time synchronization due to less accurate clocks within pseudolites and carrier phase ambiguities [35].

1. for design matrix
    1. mmWave > UWB > accelerometer

XICHENG YANG - Feb 12, 2026, 11:28 PM CST


Book Review

Strapdown Inertial Navigation Technology – 2nd Edition

David Titterton and John Weston
The Institution of Electrical Engineers, London, United Kingdom
2004, 558 pages, Hard cover,

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Strapdown_inertial_navigation_technology_-_2nd_edition_-_Book_review.pdf (546 kB)

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4D mmWave Radar for Autonomous Driving Perception: A Comprehensive Survey

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MILLIMETER WAVE RADAR-BASED HUMAN ACTIVITY RECOGNITION FOR HEALTHCARE MONITORING ROBOT

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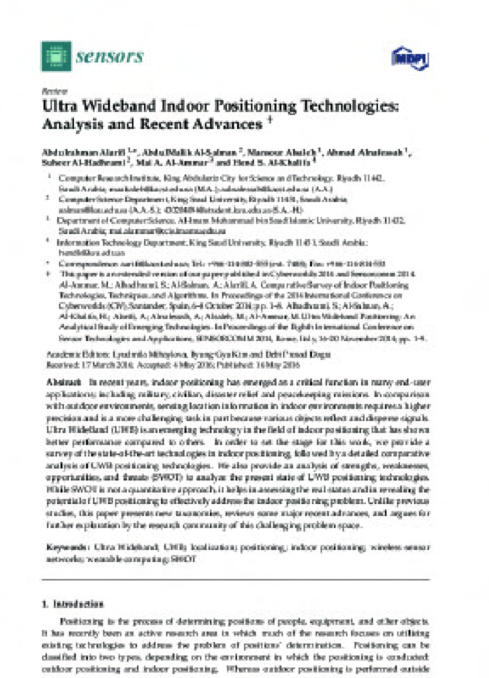

sensors MDPI

Review

Ultra Wideband Indoor Positioning Technologies: Analysis and Recent Advances †

Abdulrahman Alarifi [1,*], AbdulMalik Al-Salman [2], Mansour Alsaleh [1], Ahmad Alnafessah [1], Suheer Al-Hadhrami [2], Mai A. Al-Ammar [3] and Hend S. Al-Khalifa [4]

1 Computer Research Institute, King Abdulaziz City for Science and Technology, Riyadh 11442, Saudi Arabia
2 Computer Science Department, King Saud University, Riyadh 11451, Saudi Arabia
3 Department of Computer Science, Al-Imam Mohammad bin Saud Islamic University, Riyadh 11432, Saudi Arabia
4 Information Technology Department, King Saud University, Riyadh 11451, Saudi Arabia
* Correspondence

† This paper is an extended version of our paper published in Cyberworlds 2014 and Sensorcomm 2014. Al-Ammar, M.; Alhadhrami, S.; Al-Salman, A.; Alarifi, A. Comparative Survey of Indoor Positioning Technologies, Techniques, and Algorithms. In Proceedings of the 2014 International Conference on Cyberworlds (CW), Santander, Spain, 6–8 October 2014; pp. 1–8. Alhadhrami, S.; Al-Salman, A.; Al-Khalifa, H.; Alarifi, A.; Alnafessah, A.; Alsaleh, M.; Al-Ammar, M. Ultra Wideband Positioning: An Analytical Study of Emerging Technologies. In Proceedings of the Eighth International Conference on Sensor Technologies and Applications, SENSORCOMM 2014, Rome, Italy, 16–20 November 2014; pp. 1–9.

Academic Editors: Lyudmila Mihaylova, Byung-Gyu Kim and Debi Prosad Dogra
Received: 17 March 2016; Accepted: 4 May 2016; Published: 16 May 2016

Abstract: In recent years, indoor positioning has emerged as a critical function in many end-user applications; including military, civilian, disaster relief and peacekeeping missions. In comparison with outdoor environments, sensing location information in indoor environments requires a higher precision and is a more challenging task in part because various objects reflect and disperse signals. Ultra WideBand (UWB) is an emerging technology in the field of indoor positioning that has shown better performance compared to others. In order to set the stage for this work, we provide a survey of the state-of-the-art technologies in indoor positioning, followed by a detailed comparative analysis of UWB positioning technologies. We also provide an analysis of strengths, weaknesses, opportunities, and threats (SWOT) to analyze the present state of UWB positioning technologies. While SWOT is not a quantitative approach, it helps in assessing the real status and in revealing the potential of UWB positioning to effectively address the indoor positioning problem. Unlike previous studies, this paper presents new taxonomies, reviews some major recent advances, and argues for further exploration by the research community of this challenging problem space.

Keywords: Ultra WideBand; UWB; localization; positioning; indoor positioning; wireless sensor networks; wearable computing; SWOT

1. Introduction

Positioning is the process of determining positions of people, equipment, and other objects. It has recently been an active research area in which much of the research focuses on utilizing existing technologies to address the problem of positions' determination. Positioning can be classified into two types, depending on the environment in which the positioning is conducted: outdoor positioning and indoor positioning. Whereas outdoor positioning is performed outside

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sensors-16-00707-v2.pdf (674 kB)

2026/02/12-End Cap reproducibility

Title: end cap reproducibility

Date: 2026/01/29

Content by: Xicheng Yang

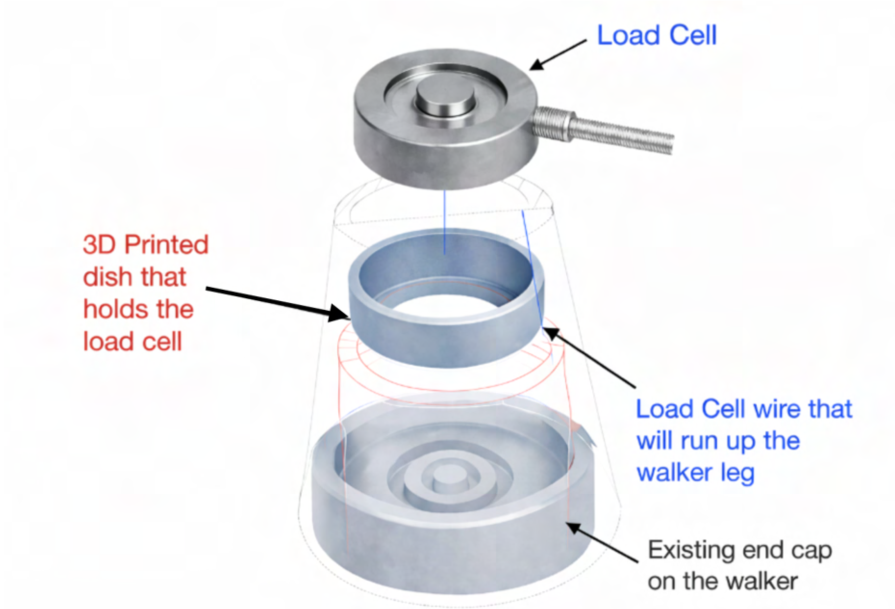
Goals: design matrix end cap reproducibility scoring research note

Reference:

https://www.amazon.com/Universal-Replacement-Coaster-Medical-Walkers/dp/B0BR6C9FTN/ref=sr_1_1_sspa?dib=eyJ2IjoiMSJ9.5nIkeYzwiclhiNjBe3ZYAzgmJHFjG0ET015jMiexUm-k_Vtfw0OFMHblc_8_d2R-O3UCJw4ukjM3mUw_5iYwsMFXdPO-ecuYEmQxL90iRwR5RzzlRu7v4tEDxs0n6RUdNQJ6EWjLj_yG_IlaacRZmlnpVbx3IXx_Yc48dMldKDZhC9YMvZmrw8TM7WezYWbmZu8B6IweajBChXM8u1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&psc=1

Content:

1. integrated end cap
    1. a picture from former team, our current solution



    2. use already standardized end caps
        1. walker manufactures already control dimensions tightly
        2. low chance of installation variation
    3. only need a small insert and hole for wiring
2. custom end cap design
    1. the idea is a custom cap that fully encapsulates the load cell and fit onto the walker legs
    2. redesign and fabricate entire end cap
        1. 3d printing only works for small amount, also not really consistent
        2. consistent molding by ourselves is even more difficult
    3. it is reproducible, but still needs tighter quality control
3. sled design
    1. already available on market

1. 
2. basically just the first design with a mini ski sled added to the bottom
3. two ways to fabrication, leads to different reproducibility
    1. print only the sled, glue to the existing end cap bottom
        1. only attachment methods (glue/heat) would impact wearing
    2. 3D print / mold the entire foot, similar to design 2
        1. share the same problem: quality control matters
        2. harder to maintain identical setups across locations

Conclusions/action items:

1. for design matrix
    1. integrated > custom = sled

2026/03/15-mmWave radar software

XICHENG YANG - Mar 15, 2026, 1:14 AM CDT

Title: mmWave radar software

Date: 2026/03/15

Content by: Xicheng Yang

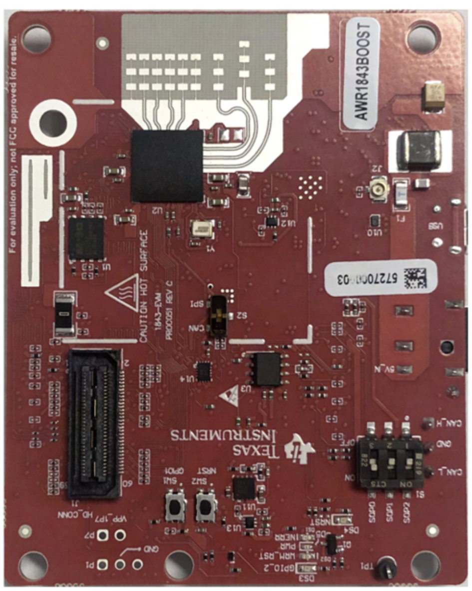
Goals: research on the rdar model we selected and find out how to incorporate it with arduino

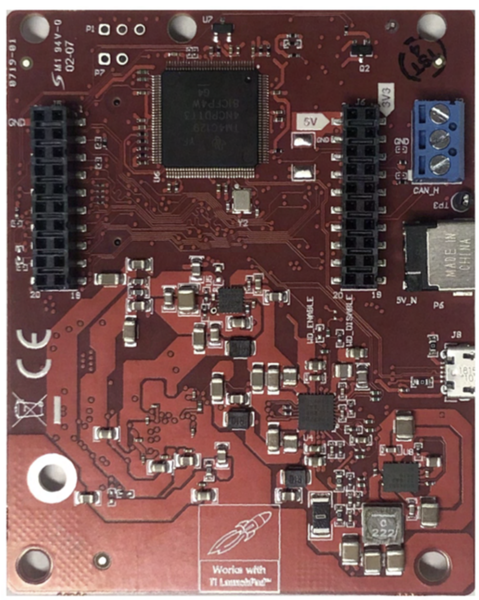
Reference:

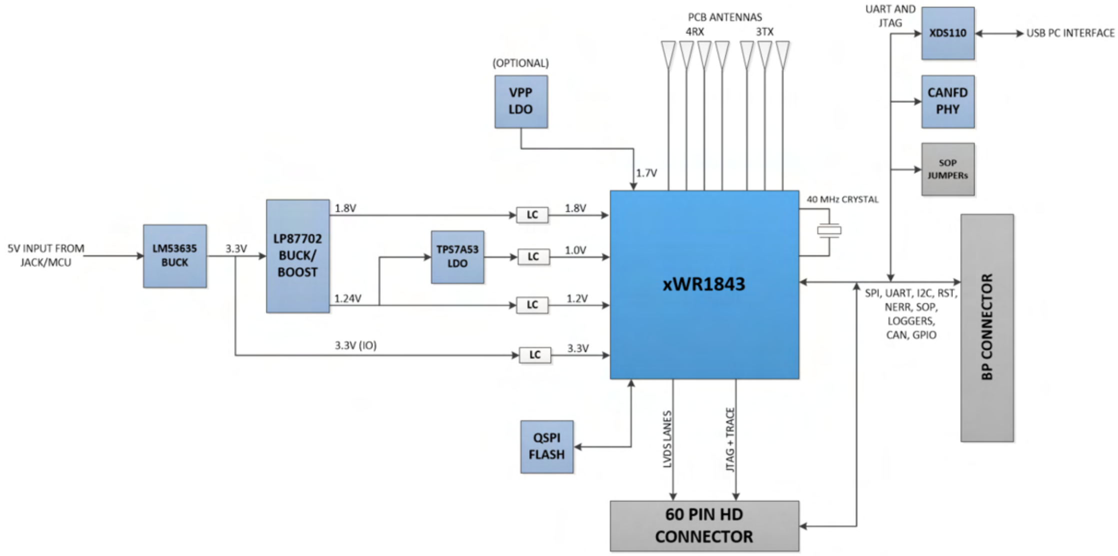
https://www.ti.com/tool/AWR1843BOOST#description

https://www.ti.com/tool/MMWAVE-SDK

Content:

1. TI xWR1843 BoosterPack
    1. 76-81 GHz mmWave
    2. antenna: 3 TX + 4 RX (onboard etched PCB antennas)
    3. \~±28° horizontal, ~±14° elevation (3dB)
    4. Onboard C67x DSP + ARM R4F
    5. communication: UART, SPI, I2C, CAN-FD
    6. power 5V, >2.5A via barrel jack
    7. 



8. 

2. data output are through the UART pins
    1.

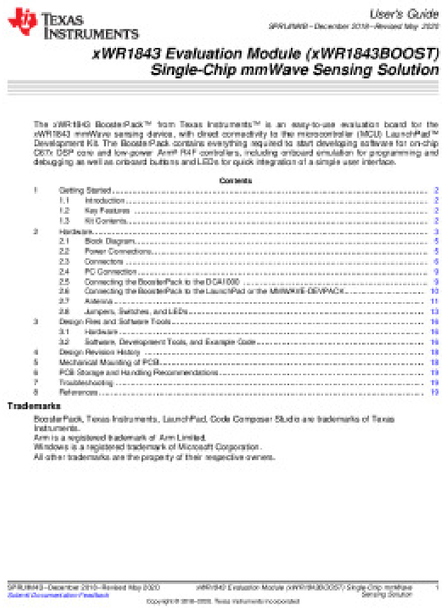
Pin Number	Description	Pin Number	Description
1	3V3	2	5 V
3	NC	4	GND
5	RS232RX (Tx from AWR device)	6	ANA1 (1)
7	RS232RX (Rx into AWR device)	8	ANA2 (1)
9	SYNC_IN	10	ANA3 (1)
11	NC	12	ANA4 (1)
13	SPI_CLK	14	PGOOD (onboard VIO) (2)
15	GPIO0	16	PMIC Enable (3)
17	SCL	18	SYNC_OUT
19	SDA	20	PMIC CLK OUT

    2. J6 Pin 5: RS232 TX (data from radar)
    3. J6 Pin 7: RS232 RX (data into radar)
3. UART
    1. universal asynchronous receiver transmitter
    2. TX: speaking
    3. RX: listening
    4. thus:
        1. radar TX -> arduino RX
        2. radar RX <- arduino TX
    5. parameters
        1. 115200 8n1
        2. 115200 baud
            1. https://en.wikipedia.org/wiki/Baud
        3. 8 data bits
        4. no parity
        5. 1 stop bit
4. SOP
    1. flash boot: run programmed firmware
    2. functional mode: run radar application
    3. programming mode: load firmware from PC
    4. debug mode
5. shared ground needed

Conclusions/action items:

1. I hate this part
2. it is always so difficult to come up with a conclusion

XICHENG YANG - Mar 15, 2026, 12:16 AM CDT


User's Guide

xWR1843 Evaluation Module (xWR1843BOOST) Single-Chip mmWave Sensing Solution

The xWR1843 BoosterPack™ from Texas Instruments™ is an easy-to-use evaluation board for the xWR1843 mmWave sensing device, with direct connectivity to the microcontroller (MCU) LaunchPad™ Development Kit. The BoosterPack contains everything required to start developing software for on-chip C67x DSP core and low-power Arm® R4F controllers, including onboard emulation for programming and debugging as well as onboard buttons and LEDs for quick integration of a simple user interface.

Contents

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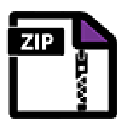
spruim4b.pdf (6.99 MB)

XICHENG YANG - Mar 15, 2026, 12:26 AM CDT



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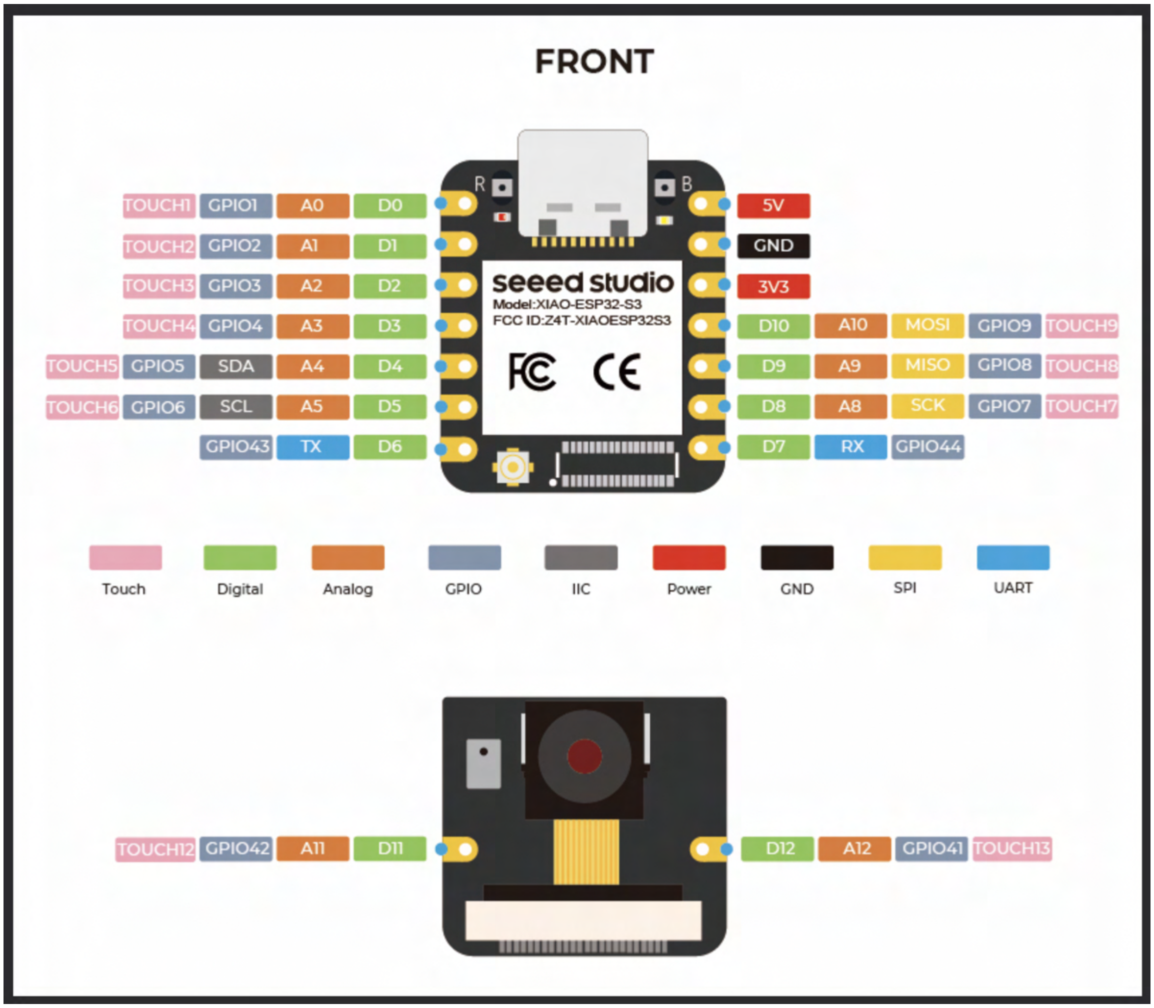
xWR1843BOOST_Schematic_Assembly_Files_and_BOM.zip (5.46 MB)

XICHENG YANG - Mar 20, 2026, 11:06 AM CDT

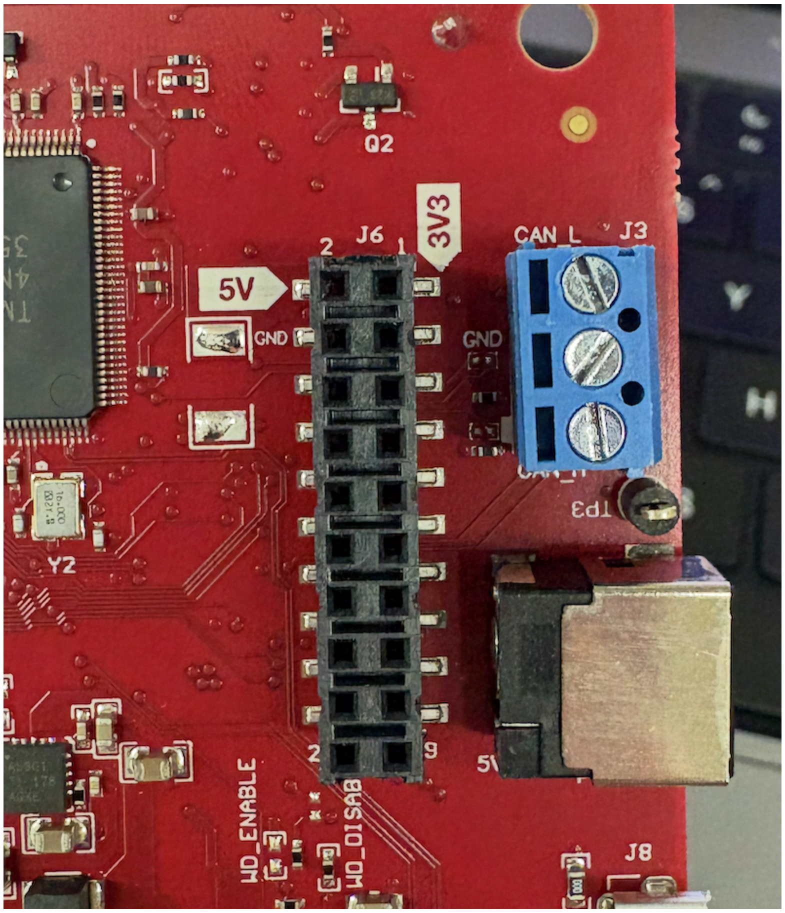
update 3.20

1. uart pins on the arduino we use:

1. 

2. TX and RX marked in blue

2. uart pins on sensor

1. 

3. so the wiring should be
   1. J6 pin5 -> D7
   2. D6 -> J6 pin7

XICHENG YANG - Mar 20, 2026, 11:06 AM CDT

ESP32-S3 Series
Datasheet

2.4 GHz Wi-Fi + Bluetooth® LE SoC
Supporting IEEE 802.11 b/g/n (2.4 GHz Wi-Fi) and Bluetooth® 5 (LE)

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esp32-s3_datasheet.pdf (1.19 MB)

2026/03/12-arduino code reading

XICHENG YANG - Mar 12, 2026, 10:12 PM CDT

Title: arduino code reading

Date: 2026/03/12

Content by: Xicheng Yang

Goals: read the arduino control code from last semester's group

Reference:

source code attached

https://github.com/F4llenDeath/smart-walker

Content:

1. HX711
    1. read walker loading cell force
    2. calibration factor signal to lbs: -18760
    3. pins: DOUT 3, CLK 2
2. LiDAR
    1. LiDARLite sensor via I2C
    2. distance measured in cm
        1. converted to ft
        2. inline float cmToFeet(int cm) { return cm * 0.0328084f; }
3. speed calculation
    1. inst_speed_ft_s = (prev_ft - dist_ft) / dt_s;
    2. EMA smoothing
        1. alpha = 0.25f
        2. https://en.wikipedia.org/wiki/Exponential_smoothing
4. rate limiting
    1. interval = 50 ms
    2. ~20 Hz sampling
5. serial output
    1. weight_lbs:value
       distance_ft:value
       speed_ft_s:value
    2. use arduino serial plotter

Conclusions/action items:

1. parts to keep
    1. HX711
    2. speed calc
        1. EMA smoothing could be moved to app instead of arduino
    3. rate
2. parts to change

1. no more LiDAR
    1. need to fit in new mmWave sensors
2. no more basic arduino serial plotter
    1. move the plot function to app

XICHENG YANG - Mar 12, 2026, 10:12 PM CDT

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CombinedCode.ino (3.32 kB)

2026/03/12-webpage code reading

XICHENG YANG - Mar 12, 2026, 10:26 PM CDT

Title: webpage code reading

Date: 2026/03/12

Content by: Xicheng Yang

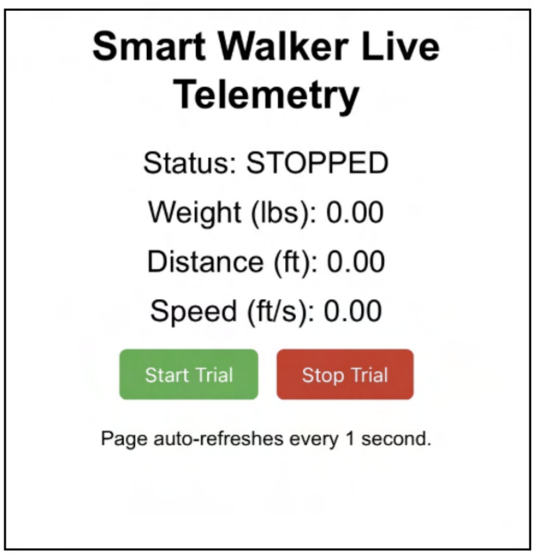
Goals: read the webpage control code from last semester's group

Reference:

source code attached

https://github.com/F4llenDeath/smart-walker

Content:

1. WiFi
    1. AP: Smart_Walker
    2. WiFiServer server(80);
    3. info shown
        1. 

2. sensor loop is already researched in last entry
3. trail logic
    1. if (req.indexOf("GET /start") >= 0)
    2. record and display average weight and speed during trail
        1. trialWeightSum += weight_lbs;
           trialWeightCount++;
        2. if (!isnan(speed_ft_s)) {
              trialSpeedSum += speed_ft_s;
              trialSpeedCount++;
           }
    3. absolute distance change from start to end
4. webpage

    1. refresh every 1s
    2. HTML only

Conclusions/action items:

1. things to keep
    1. trail metrics with average values
    2. we could add more advanced views within the app like curve etc.
2. things to change
    1. webpage hosted by arduino is kind of a brute force solution
    2. the performance are very limited with weak processing capability of arduino
    3. a phone app will help a lot

XICHENG YANG - Mar 12, 2026, 10:13 PM CDT

Download

Webpage.ino (6.45 kB)

2026/03/12-swift vs react vs flutter

XICHENG YANG - Mar 12, 2026, 10:33 PM CDT

Title: swift vs react vs flutter

Date: 2026/03/12

Content by: Xicheng Yang

Goals: find the best tech stack for the smart walker phone app

Reference:

https://doi.org/10.24251/HICSS.2018.718

https://docs.flutter.dev

https://reactnative.dev/docs/getting-started

https://developer.apple.com/documentation/swiftui

Content:

1. Swift (SwiftUI)
    1. native iOS development
    2. best performance and hardware access
    3. strong Apple ecosystem integration
        1. Bluetooth, sensors, and system APIs easiest
    4. development mainly in Xcode
    5. limited to Apple platforms
2. React Native
    1. JavaScript / React based framework
    2. cross platform (iOS + Android)
        1. large community and many libraries
    3. UI built from JS bridge to native components
    4. BLE libraries available but sometimes unstable
    5. debugging can be harder due to bridge layer
3. Flutter
    1. Google framework using Dart
    2. cross platform from single codebase
    3. UI rendered with its own engine
        1. very consistent visual appearance
    4. good performance but slightly larger app size
    5. BLE support exists but ecosystem smaller

Conclusions/action items:

1. for our app
    1. swift likely to be simplest
    2. direct bluetooth access
    3. only drawback: does not support android

3. only drawback: does not support android
    1. but seems our client use iPhone so wont be a big problem

2026/02/19-sensor occlusion robustness testing ideas

XICHENG YANG - Feb 20, 2026, 8:28 PM CST

Title: occlusion robustness testing

Date: 2026/02/19

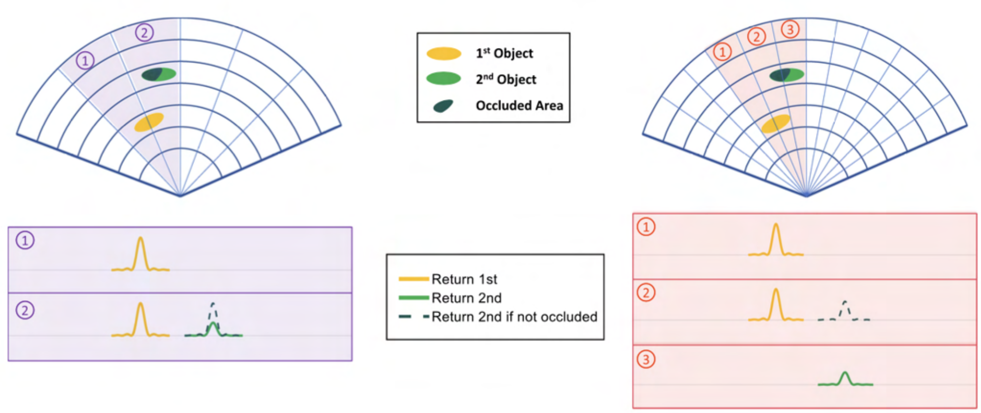
Content by: Xicheng Yang

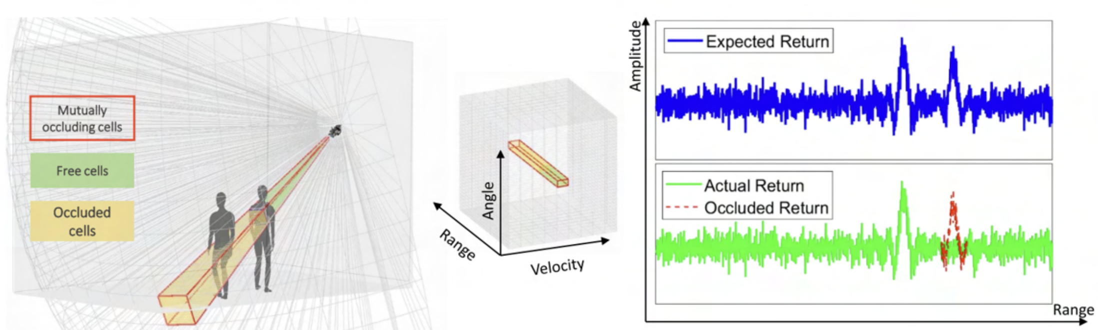
Goals: some ideas of mmWave radar occlusion robustness testing

Reference:

A. Murtada, B. S. M. R. Rao, M. Ahmadi, and U. Schroeder, "Occlusion-Informed Radar Detection for Millimeter-Wave Indoor Sensing," IEEE Open Journal of Signal Processing, vol. 5, pp. 976–990, 2024, doi: https://doi.org/10.1109/ojsp.2024.3444709.

Content:

1. mmWave sensor expected output
    1. 

2. a reference testing setup
    1. 

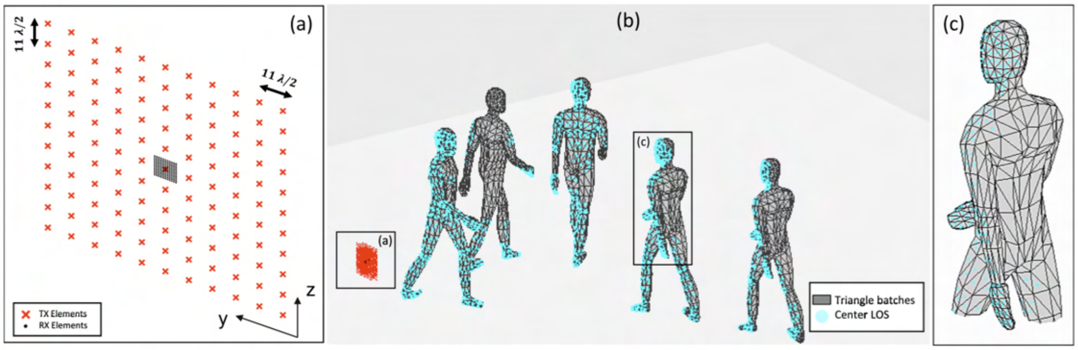


FIGURE 7. Simulation scenario and modeling. (a) Configuration of 121 × 121 TX-RX antennas for the radar sensor. (b) Snapshot of a single time frame of the scenario depicting human targets modeled using triangle batches, highlighting the origin points of triangle batches with LOS. (c) Close-up view of a single human object.

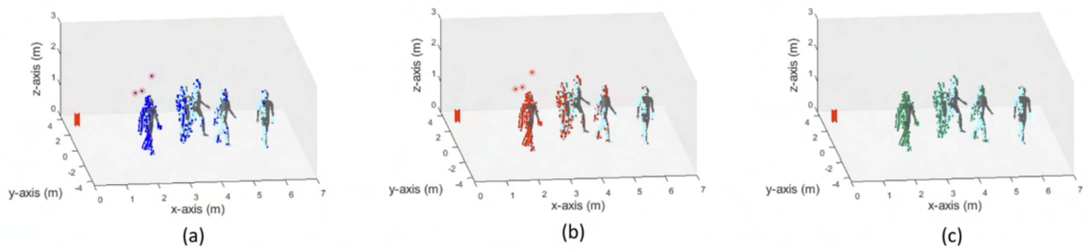
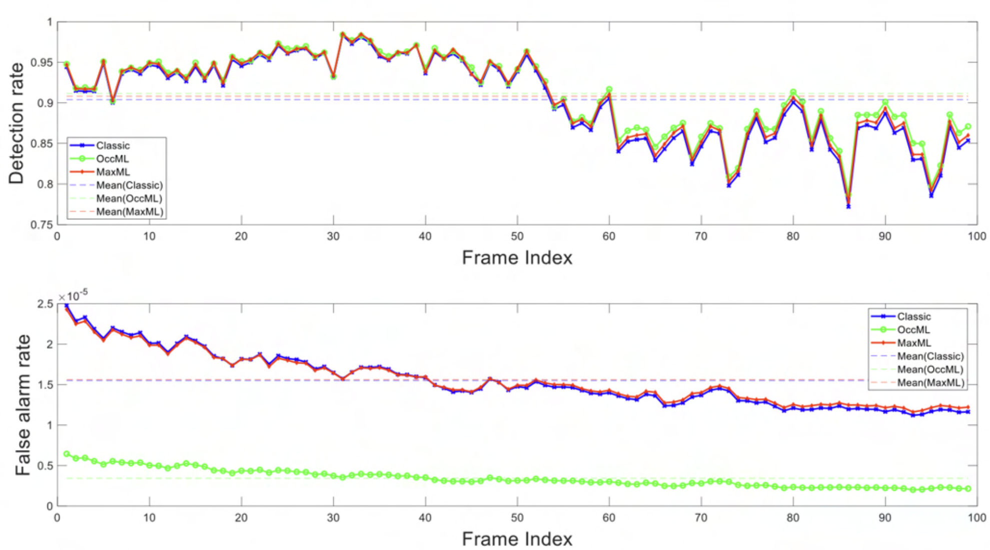


FIGURE 8. Single time frame snapshot of point cloud detection highlighting some of the visible false alarms of Classic and Max-ML detectors not present in the output of Occ-ML detector. (a) Classic detector output (b) Max-ML detector output (c) Occ-ML detector output.

2.
3. fixed radar position
4. target motion paths
    1. fully visible segments
    2. partially occluded segments
    3. full occluded segments

3. metrics
    1. missed detection rate under occlusion
    2. stability of target trajectory across occlusion
    3. detection confidence variation between visible and shadow zones
    4. a reference plot toward false report rate
        1. 

4. possible future testing beyond this one
    1. occlusion transition testing
    2. visible -> occluded -> visible

3. evaluates whether
    1. tracking identity is preserved
    2. system prematurely deletes track during occlusion
    3. re-detection after occlusion is stable
5. some limitations to this testing method
    1. obstacles are static
    2. limited indoor environment complexity
    3. single target

Conclusions/action items:

1. a very promising testing protocol, as our use case is
    1. completely indoor, only measuring against still wall
    2. single target at one time only
    3. there will be both partial occlusion and full occlusion
    4. false negative rate matters
2. only concern:
    1. our proposed obstruction is not still: random people walks in front of the walker
    2. could look into this while composing the final testing protocol

---

XICHENG YANG - Feb 20, 2026, 8:29 PM CST


Occlusion-Informed Radar Detection for Millimeter-Wave Indoor Sensing

AHMED MURTADA (Member, IEEE), BHAVANI SHANKAR MYSORE RAMA RAO (Senior Member, IEEE), MOEIN AHMADI (Member, IEEE), AND UDO SCHROEDER

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Occlusion-Informed_Radar_Detection_for_Millimeter-Wave_Indoor_Sensing.pdf (4.11 MB)

2026/02/26-load cell testing

XICHENG YANG - Feb 26, 2026, 9:31 PM CST

Title: load cell testing

Date: 2026/02/26

Content by: Xicheng Yang

Goals: some ideas of load cell testing

Reference:

Li, X., & El-Sheimy, N. (2010). Calibration and performance analysis of load cells for structural monitoring applications. Measurement, 43(10), 1415–1424. https://doi.org/10.1016/j.measurement.2010.07.010

Content:

1. load cell testing outcome done by last year's group

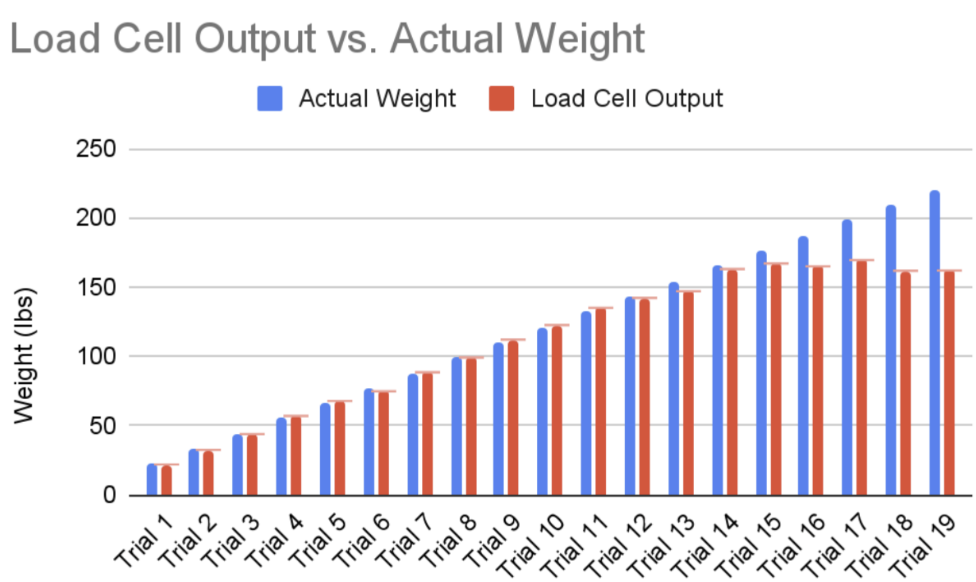
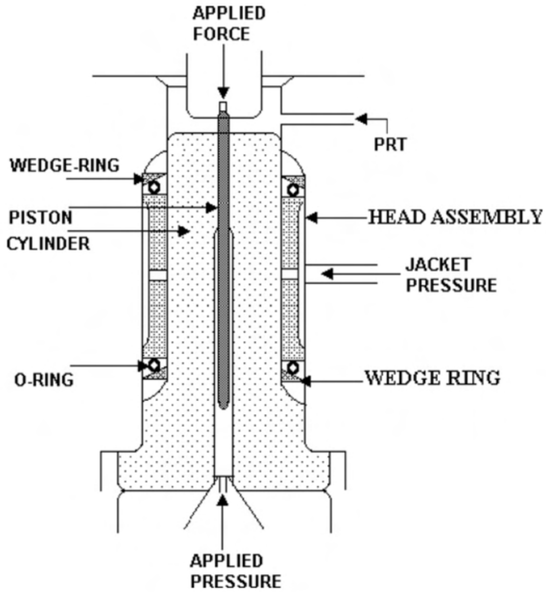


Figure 22: *Relationship between actual weight and load cell recorded weight, the blue bars represent the known weight placed on the load cells, the red bars are the corresponding readings given by the load cells, and the vertical error bars indicate the constant ± 0.056 lb potential error associated with the sensors.*

   1. \
   2. tested trails: 22.05 lb, 33.07 lb, 44.09 lb, 55.12 lb, 66.14 lb, 77.16 lb, 88.18 lb, 99.21 lb, 110.23 lb, 121.25 lb, 132.28 lb, 143.3 lb, 154.32 lb, 165.35 lb, 176.37 lb, 187.39 lb, 198.42 lb, 209.44 lb, and 220.46 lb
   3. calibration factor: -18670
   4. result: average error of 5.51%, but only 1.68% error up to 165 lbs
      1. the saturation over 165 lbs could be caused
         1. mechanical strain gauge nonlinearity
         2. ADC resolution limits
         3. amplifier gain saturation
         4. bridge imbalance at higher strain levels

2. a more advanced testing done by other researchers

2. a mort



1.
2. a detailed pressure distribution illustration

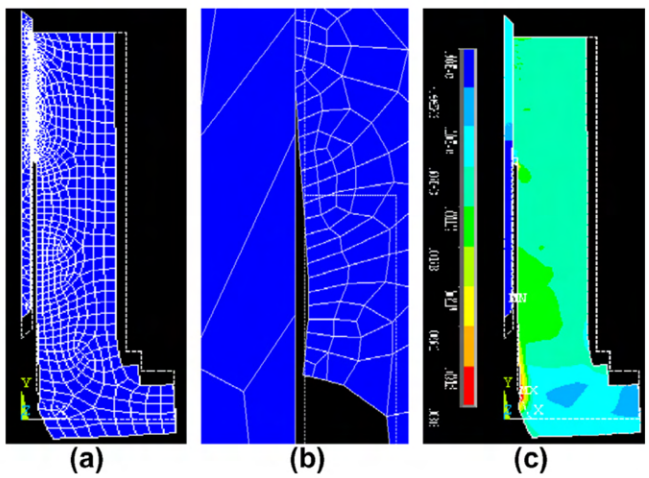


Fig. 3. (a) Meshed deformed structure of p–c assembly, (b) meshing around engagement length and (c) image of the distorted p–c assembly in CCM mode at p = 1.0 GPa and p_j = 0.5 p.

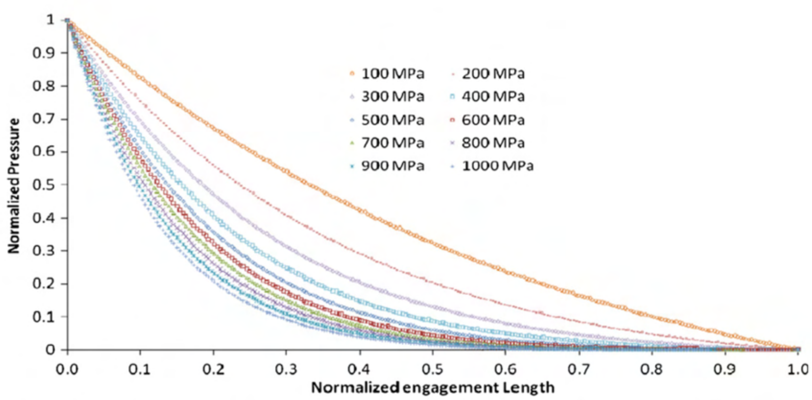


Fig. 4. Normalized pressure distributions in the clearance as a function of normalized length for different applied pressures.

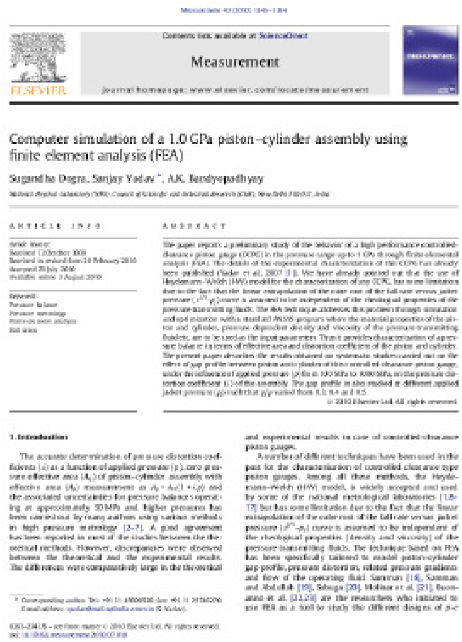
3.
4. most load cells maintain <2% full-scale error within 60–80% of rated capacity, but error increases near saturation thresholds
5.

Conclusions/action items:

1. we could just reuse the last semester's protocol and perform same series of testing on the new cells and end caps
    1. the purpose is unchanged, we just need to know whether they are accurate
    2. only changing parameter will be the calibration factor as the end cap changed

---

XICHENG YANG - Feb 26, 2026, 9:21 PM CST



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1-s2.0-S0263224110001545-main.pdf (1.91 MB)

2026/02/26-wireless transmission testing

XICHENG YANG - Feb 27, 2026, 12:09 PM CST

Title: wireless transmission testing

Date: 2026/02/26

Content by: Xicheng Yang

Goals: some ideas of wireless transmission robustness testing

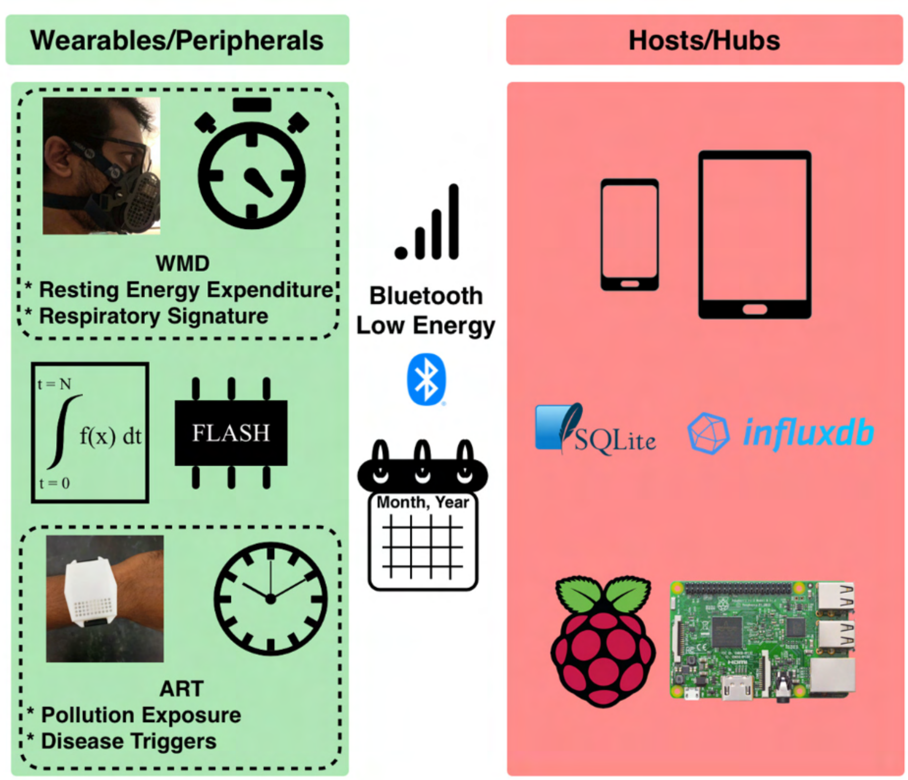
Reference:

Tipparaju, V. V., Mallires, K. R., Wang, D., Tsow, F., Xian, X., & others (2021). Mitigation of data packet loss in Bluetooth Low Energy-based wearable healthcare ecosystem. *Sensors*. (Open-access via PubMed Central).

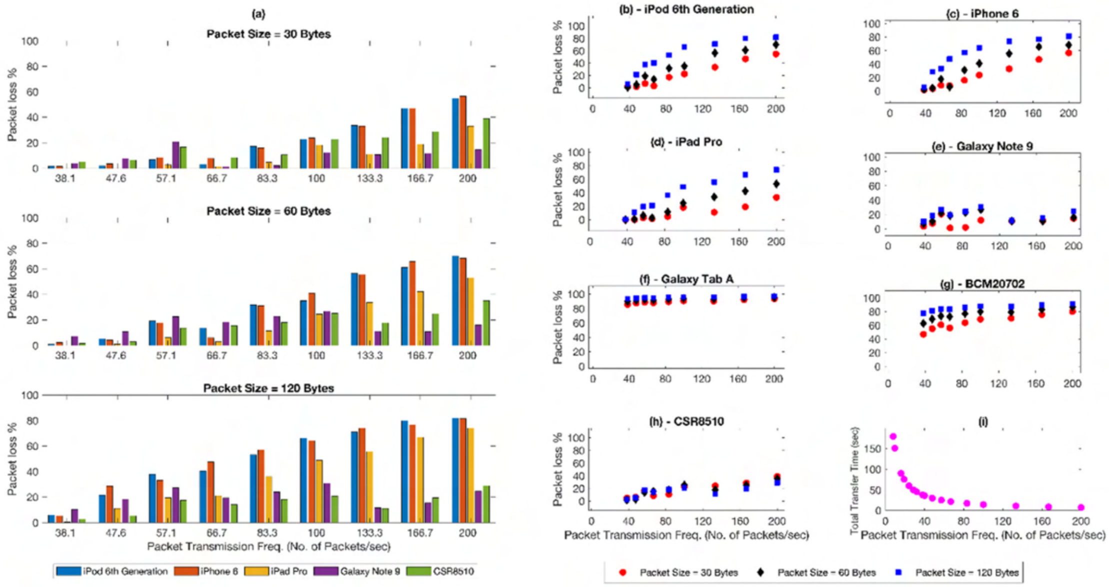
Tosi, J., Taffoni, F., Santacatterina, M., Sannino, R., & Formica, D. (2017). Performance evaluation of Bluetooth Low Energy: A systematic review. *Sensors, 17*, 2898. https://doi.org/10.3390/s17122898

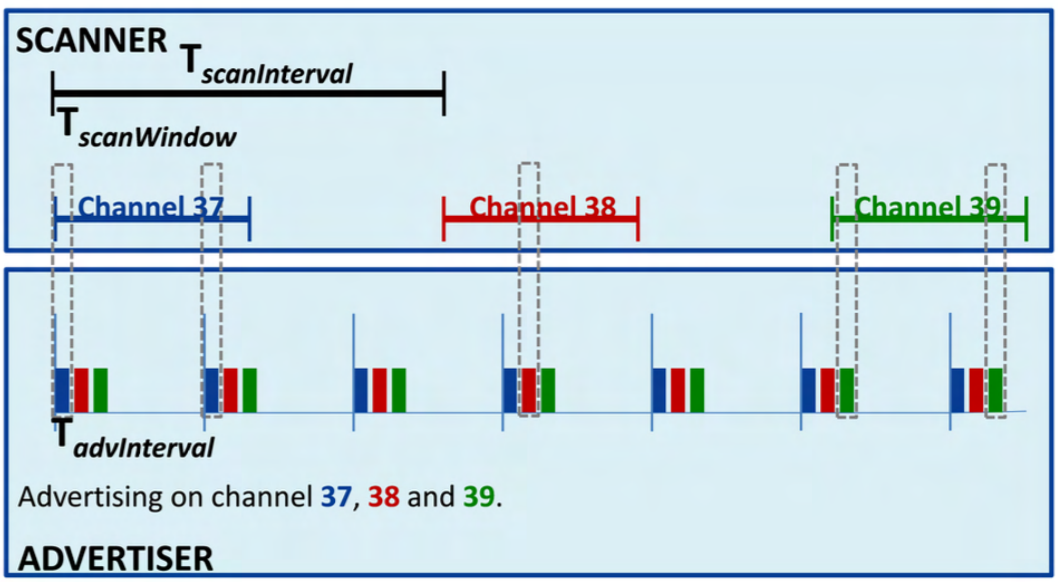
Rajotte, K. J., Wooding, A., McDonald, B. E., Farrell, T. R., Li, J., Huang, X., & Clancy, E. A. (2024). Evaluation of BLE star network for wireless wearable prosthesis/orthosis controller. *Applied Sciences, 14*(22), 10455. https://doi.org/10.3390/app142210455

Content:

1. we are going to enable the bluetooth transmission function on the Arduino uno wifi rev2 while current prototype only has wifi enabled.
    1. 

2. the goal is to quantify the usability of both transmission protocol with a emphasize on the newly supported bluetooth
    1. metrics: latency, packet loss, reconnection robustness etc.

2. 

3. latency and jitter testing
    1. strongly depends on selected connection interval and design choices
    2. 

    3. lower latency leads to higher power consumption and fewer supported connections
4. throughput
    1. or sustained data rate

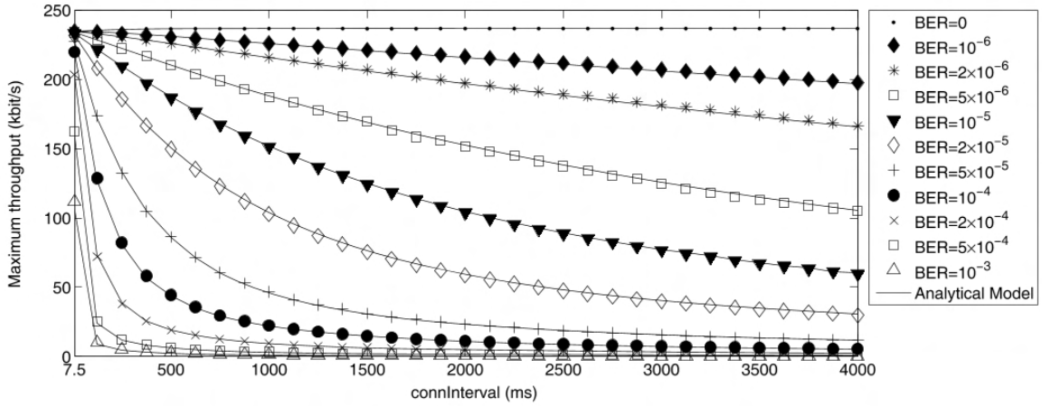


Figure 13. Maximum throughput of a Bluetooth Low Energy link for various *connInterval* (ranging between 7.5 ms and 4000 ms) and BER values (ranged from zero to 10^{-3}): simulation (symbols) vs. analysis (lines). The simulation has been performed using 1,000,000 *connEvents* per each parameter set. Adapted from [65].

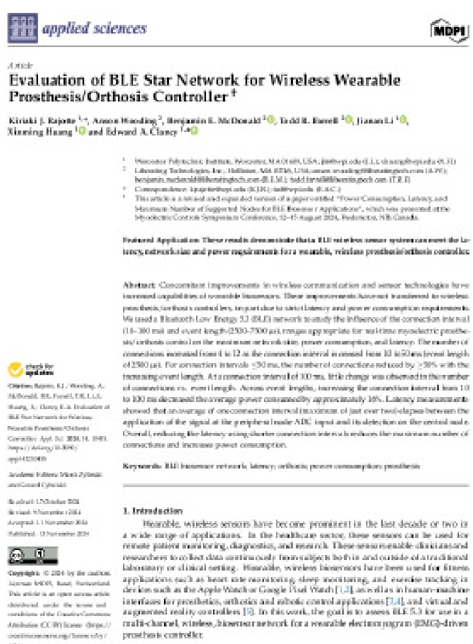
2.

5. a possible test matrix, as included in the preliminary report
    1. distance: 1m, 5m, 10m, 15m, 20m
    2. environments: hallway, around a corner, and through one wall

Conclusions/action items:

1. the testing method of bluetooth is pretty clear and have lots of established testing protocols we could use
2. the problem will be the corporation of two transmission protocols wifi and bluetooth
    1. we need to clarify that whether they function together or one is another's backup.

XICHENG YANG - Feb 26, 2026, 9:38 PM CST


applied sciences
MDPI
Article
Evaluation of BLE Star Network for Wireless Wearable Prosthesis/Orthosis Controller †

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applsci-14-10455-v2.pdf (2.12 MB)

XICHENG YANG - Feb 26, 2026, 9:38 PM CST

sensors

Review

Performance Evaluation of Bluetooth Low Energy: A Systematic Review

Jacopo Tosi [1,2,*], Fabrizio Taffoni [1,2], Marco Santacatterina [3], Roberto Sannino [3] and Domenico Formica [1]

Received: 22 September 2017; Accepted: 8 December 2017; Published: 13 December 2017

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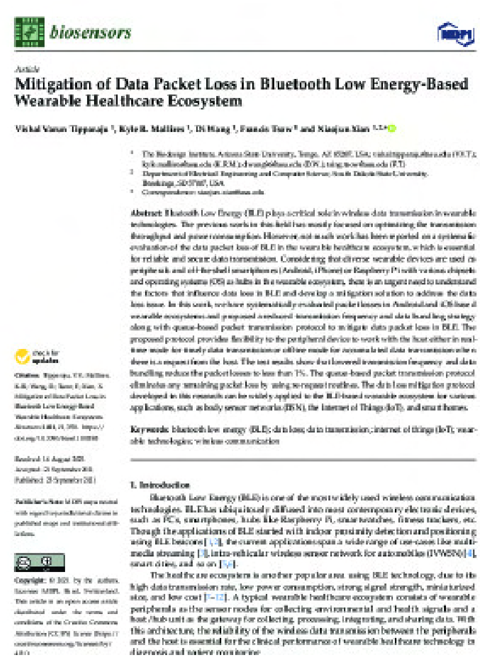
sensors-17-02898.pdf (26.8 MB)

XICHENG YANG - Feb 26, 2026, 9:38 PM CST



biosensors

Article

Mitigation of Data Packet Loss in Bluetooth Low Energy-Based Wearable Healthcare Ecosystem

Vishal Varun Tipparaju [1], Kyle R. Mallires [1], Di Wang [1], Francis Tsow [1] and Xiaojun Xian [1,2,*]

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biosensors-11-00350.pdf (3.85 MB)

2026/03/12-app framework setup

XICHENG YANG - Mar 12, 2026, 10:43 PM CDT

Title: app framework setup

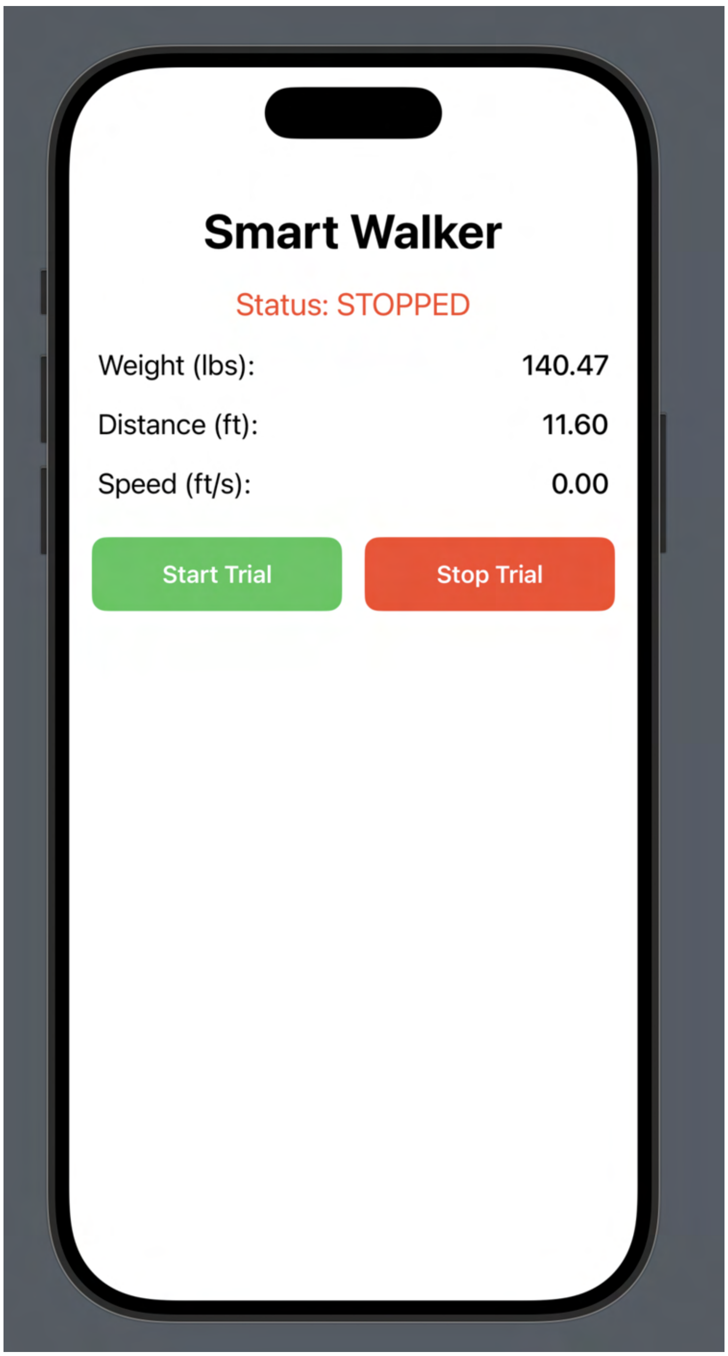
Date: 2026/03/12

Content by: Xicheng Yang

Goals: setup a first version of our app replicating the current website UI

Reference: N/A

Content:



```
//
//  ContentView.swift
//  Smart Walker
//
//  Created by Xicheng Yang on 2026/3/12.
//

import SwiftUI

struct ContentView: View {
    @State private var trialRunning = false
    @State private var weightLbs: Double = 0.0
    @State private var distanceFt: Double = 0.0
    @State private var speedFtS: Double = 0.0

    var body: some View {
        VStack(spacing: 18) {
            Text("Smart Walker")
                .font(.largeTitle)
                .fontWeight(.bold)
                .multilineTextAlignment(.center)
                .padding(.top, 18)

            Text("Status: \(trialRunning ? "RUNNING" : "STOPPED")")
                .font(.title2)
                .foregroundColor(trialRunning ? .green : .red)

            telemetryRow(label: "Weight (lbs)", value: weightLbs, decimals: 2)
            telemetryRow(label: "Distance (ft)", value: distanceFt, decimals: 2)
```

```
        telemetryRow(label: "Speed (ft/s)", value: speedFtS, decimals: 2)

        HStack(spacing: 16) {
            Button(action: startTrial) {
                Text("Start Trial")
                    .font(.headline)
                    .foregroundColor(.white)
                    .frame(maxWidth: .infinity)
                    .padding()
                    .background(Color.green)
                    .cornerRadius(10)
            }

            Button(action: stopTrial) {
                Text("Stop Trial")
                    .font(.headline)
                    .foregroundColor(.white)
                    .frame(maxWidth: .infinity)
                    .padding()
                    .background(Color.red)
                    .cornerRadius(10)
            }
        }
        .padding(.top, 8)
        Spacer()
    }
    .padding()
    .onAppear {
        startMockRefresh()
```

```
        }
    }

    @ViewBuilder
    private func telemetryRow(label: String, value: Double, decimals: Int) -> some View {
        HStack {
            Text(label + ":")
                .font(.title3)
            Spacer()
            Text(String(format: "%.\(decimals)f", value))
                .font(.title3)
                .fontWeight(.medium)
        }
        .padding(.horizontal, 4)
    }

    private func startTrial() {
        trialRunning = true
    }

    private func stopTrial() {
        trialRunning = false
    }

    private func startMockRefresh() {
        Timer.scheduledTimer(withTimeInterval: 1.0, repeats: true) { _ in
            if trialRunning {
                weightLbs = Double.random(in: 120...180)
                distanceFt += Double.random(in: 0.2...1.2)
```

```
                speedFtS = Double.random(in: 1.0...4.0)
            } else {
                speedFtS = 0.0
            }
        }
    }
}

#Preview {
    ContentView()
}
```

Conclusions/action items:

1. full code repo available at https://github.com/F4llenDeath/smart-walker

XICHENG YANG - Mar 12, 2026, 10:42 PM CDT

Download

ContentView.swift (2.85 kB)

2026/03/19-app ver 1.0

XICHENG YANG - Mar 19, 2026, 6:21 PM CDT

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BluetoothManager.swift (9.62 kB)

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ContentView.swift (8.66 kB)

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DataStore.swift (5.71 kB)

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Smart_WalkerApp.swift (450 B)

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TrialDetailView.swift (3.09 kB)

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Patient.swift (999 B)

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Trial.swift (3.67 kB)

XICHENG YANG - Mar 19, 2026, 6:35 PM CDT

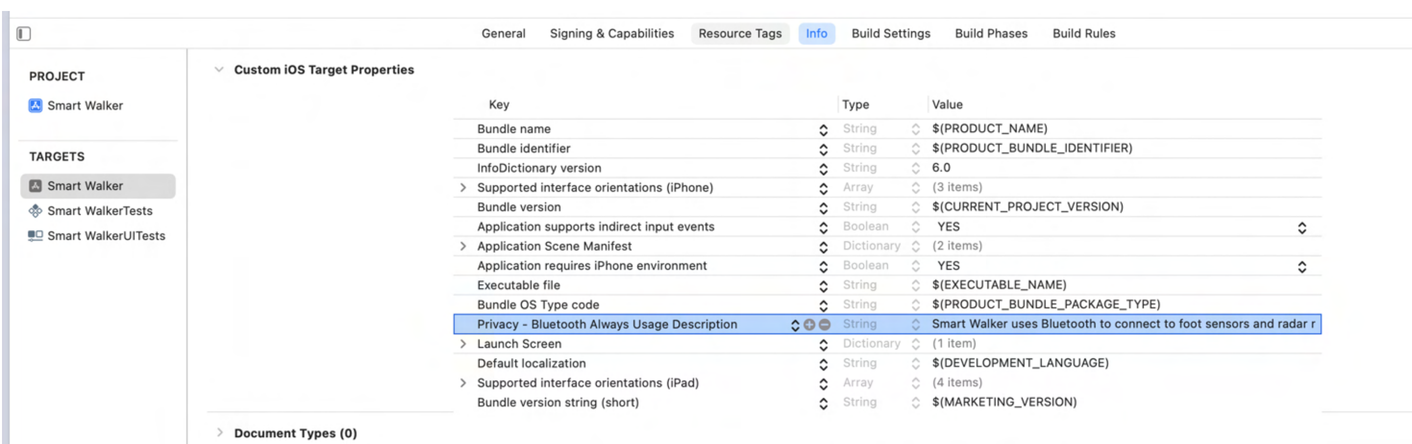
For archive

full repo available at https://github.com/F4llenDeath/smart-walker

XICHENG YANG - Apr 13, 2026, 5:28 PM CDT

update apr 13

remember to enable bluetooth permission request in xcode



2026/04/14-app ver 1.1

XICHENG YANG - Apr 14, 2026, 10:12 PM CDT

what changed:

1. the app now correctly request bluetooth permission on the phone
2. graphing function added in the trial detail page
3. a trial deletion button added
4. a simulation mode for testing

full repo available at https://github.com/F4llenDeath/smart-walker

XICHENG YANG - Apr 14, 2026, 10:13 PM CDT

Download

BluetoothManager.swift (11 kB)

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TrialDetailView.swift (6.68 kB)

XICHENG YANG - Apr 14, 2026, 10:13 PM CDT

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Patient.swift (999 B)

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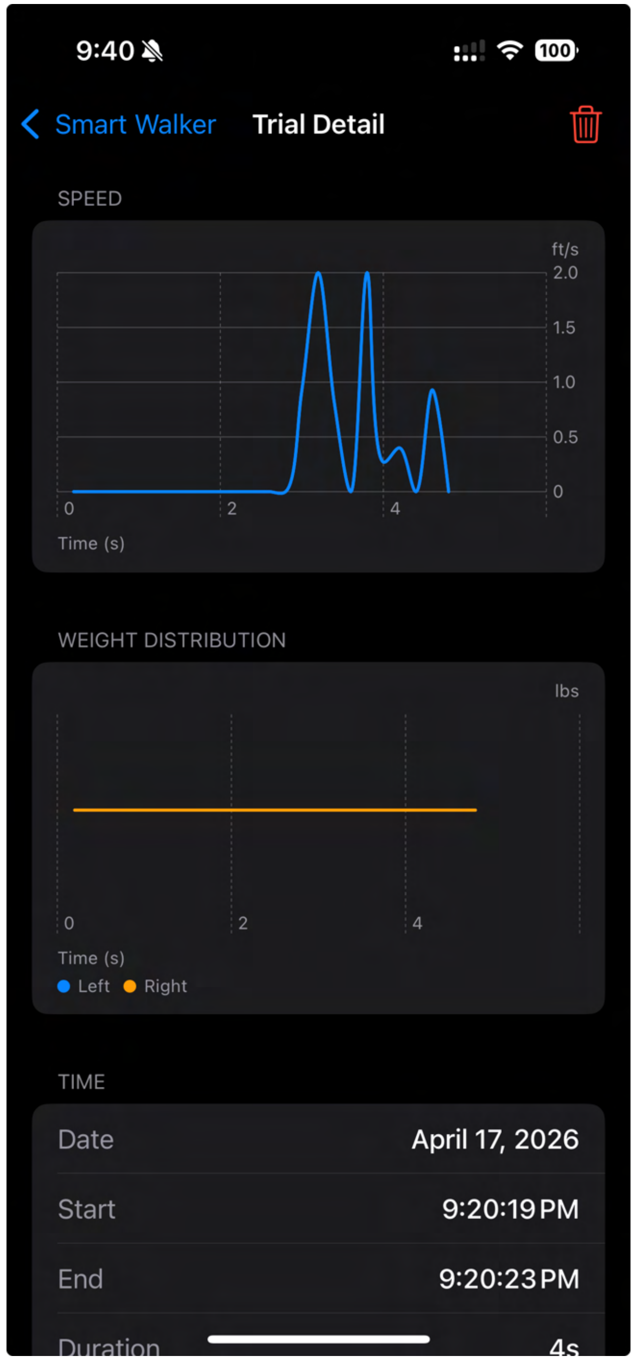
Trial.swift (3.67 kB)

XICHENG YANG - Apr 17, 2026, 9:40 PM CDT

update, some pictures of the new graphing function


6:35
100
Smart Walker
Trial Detail
SPEED
ft/s
4
3
2
1
0
0
2
4
6
Time (s)
WEIGHT DISTRIBUTION
lbs
100
75
50
25
0
0
2
4
6
Time (s)
Left
Right
TIME
Date
April 13, 2026
Start
6:34:51 PM
End
6:34:58 PM
Duration
7s


9:40
100
Smart Walker
Trial Detail
SPEED
ft/s
2.0
1.5
1.0
0.5
0
0
2
4
Time (s)
WEIGHT DISTRIBUTION
lbs
0
2
4
Time (s)
Left
Right
TIME
Date
April 17, 2026
Start
9:20:19 PM
End
9:20:23 PM
Duration
4s

2026/03/19-arduino ver 1.0

XICHENG YANG - Mar 20, 2026, 11:08 AM CDT

For archive

TODO: mmWave radar part

full repo available at https://github.com/F4llenDeath/smart-walker

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swLeftFoot.ino (2.68 kB)

XICHENG YANG - Mar 20, 2026, 11:08 AM CDT

Download

swRightFoot.ino (2.65 kB)

2026/03/24-mmwave radar setup

XICHENG YANG - Mar 24, 2026, 9:52 PM CDT

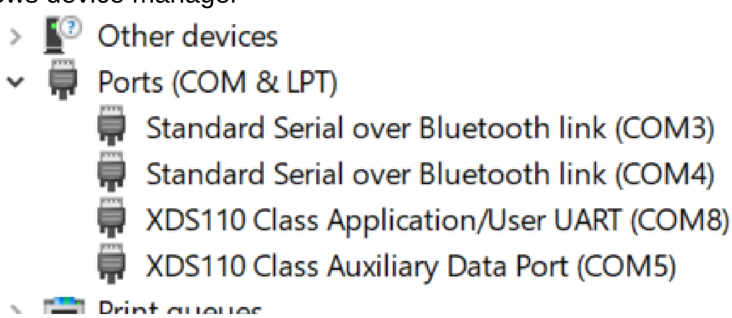
Title: mmwave radar setup

Date: 2026/03/24

Content by: Xicheng Yang

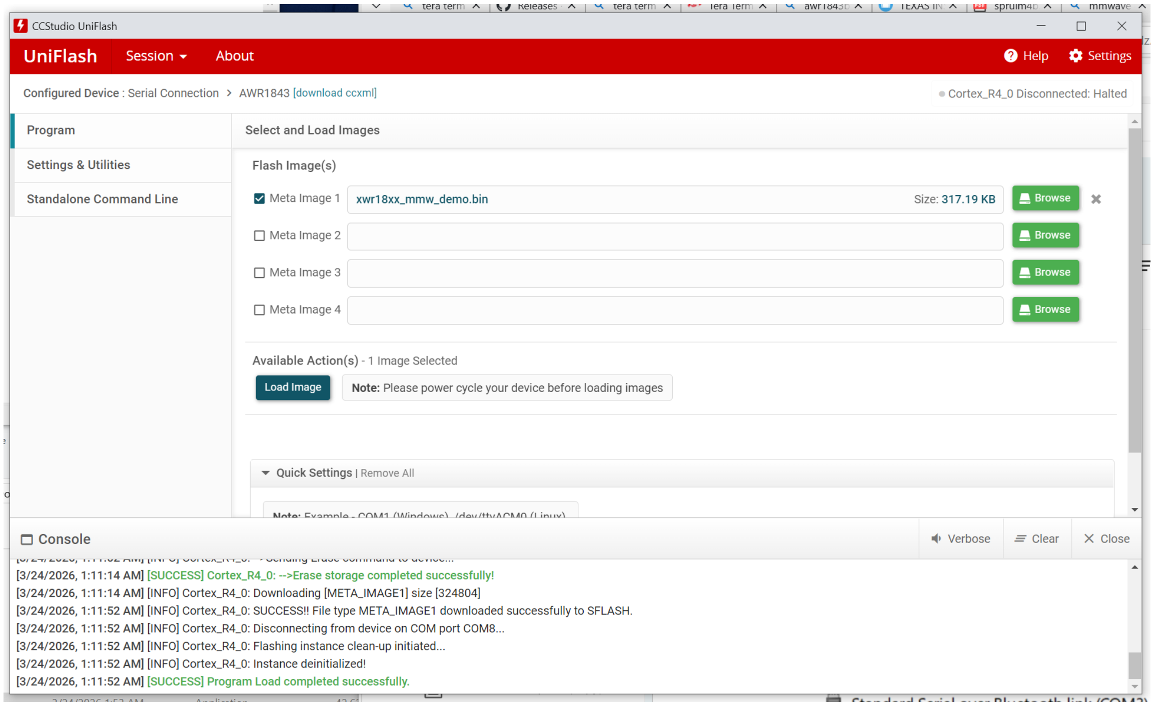
Goals: setup the mmwave radar

Content:

1. hardware
    1. connect board to pc with microusb
    2. power with 5v 2.5A 2.1mm cable
2. port
    1. windows device manager
    2. 

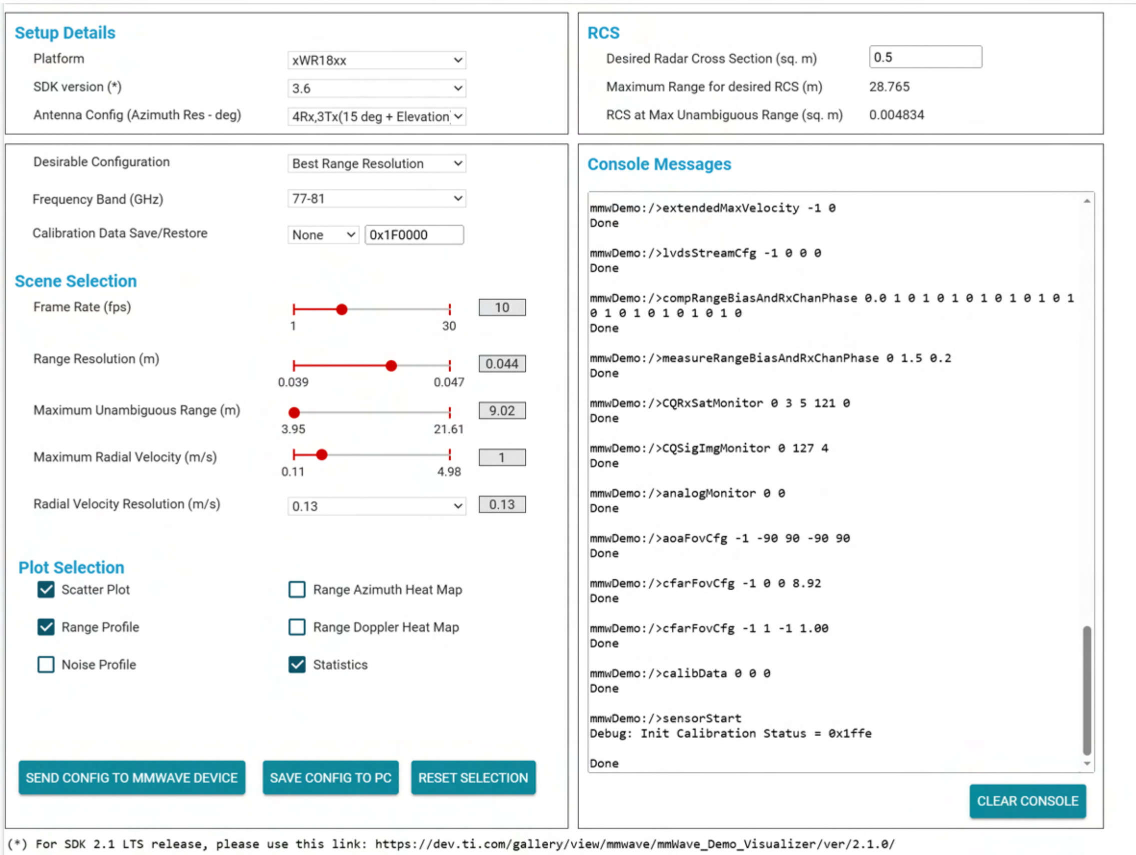
    3. record COM8 and COM5
3. environment setup
    1. [MMWAVE-SDK Software development kit (SDK) | TI.com]
    2. [UNIFLASH Software programming tool | TI.com]
    3. [mmWave Demo Visualizer]
4. firmware flashing
    1. open uniflash
    2. pick the connected board
    3.

SOP2 jumper /switch	SOP1 jumper /switch	SOP0 jumper /switch	Bootloader mode & operation
0	0	1	**Functional Mode** Device Bootloader loads user application from QSPI Serial Flash to internal RAM and switches the control to it
1	0	1	**Flash Programming Mode** Device Bootloader spins in loop to allow flashing of user application to the serial flash.

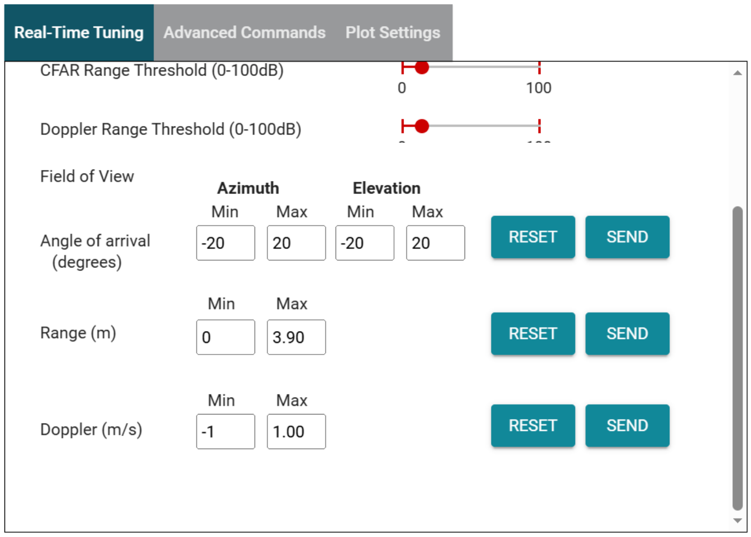
4. 

5. location of meta image in sdk: C:\ti\mmwave_sdk_03_06_02_00-LTS\packages\ti\demo\xwr18xx\mmw

5. TI demo visualizer

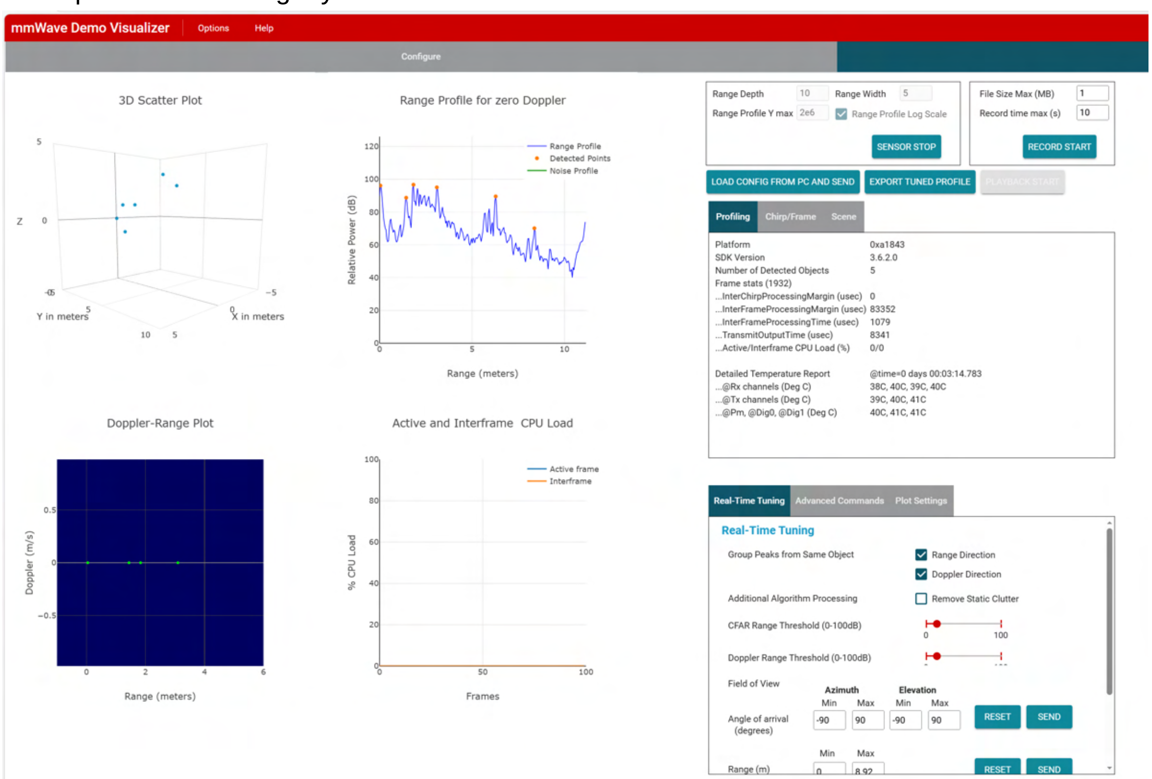
1. 

2. scanning config to be updated
    1. the setup that could yield a cleanest outcome in my room:



2.

3. the output from scanning my room:



4.

Conclusions/action items:

1. problem i am facing right now
    1. how to make the setup profile permanent on the board?
        1. let arduino send the cfg file every time it boot up? but this sounds very unstable.
        2. embed config into the firmware. will be very stable, but i need to learn how to use CCS IDE


MMWAVE SDK User Guide

MMWAVE SDK User Guide

Product Release 3.1.1
Release Date: Jan 18, 2019
Document Version: 1.0

Texas Instruments

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7801.mmwave_sdk_user_guide.pdf (3.52 MB)

2026/03/24-mmwave radar output parsing

XICHENG YANG - Mar 24, 2026, 10:34 PM CDT

Title: mmwave radar output parsing

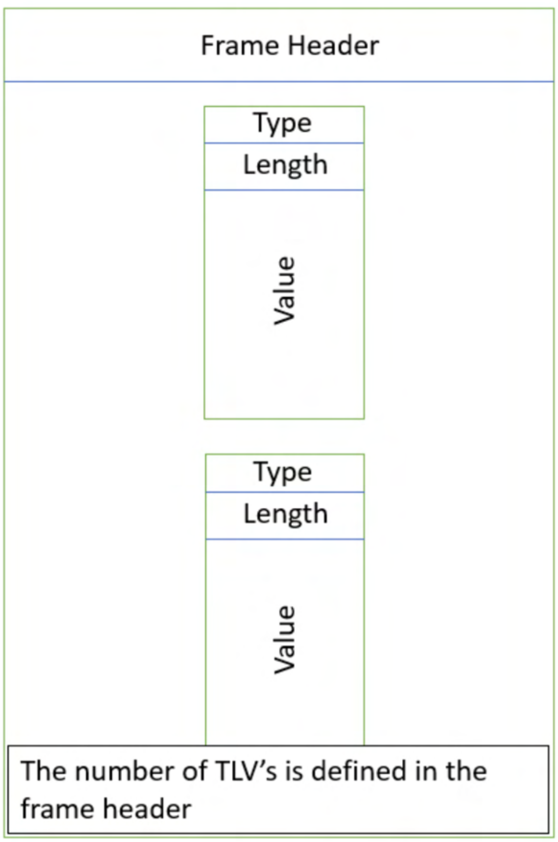
Date: 2026/03/24

Content by: Xicheng Yang

Goals: parse the output of the mmWave radar

Reference: https://dev.ti.com/tirex/explore/node?isTheia=false&node=A__ADnbI7zK9bSRgZqeAxprvQ__radar_toolbox__1AslXXD__2.20.00.05

Content:

1. the general structure
    1. 

2. frame header
    1.

Value	Type	Bytes	Details
Magic Word	uint16_t	8	Output buffer magic word (sync word). It is initialized to {0x0102,0x0304,0x0506,0x0708}
Version	uint32_t	4	SDK Version represented as (MajorNum x 2^24 + MinorNum x 2^16 + BugfixNum x 2^8 + BuildNum)
Total Packet Length	uint32_t	4	Total packet length including frame header length in Bytes
Platform	uint32_t	4	Device type (ex 0xA6843 for IWR6843 devices)
Frame Number	uint32_t	4	Frame number (resets to 0 when device is power cycled or reset. Not when sensor stop/start is issued.)
Time [in CPU Cycles]	uint32_t	4	Time in CPU cycles when the message was created.
Num Detected Obj	uint32_t	4	Number of detected objects (points) for the frame
Num TLVs	uint32_t	4	Number of TLV items for the frame.
Subframe Number	uint32_t	4	0 if advanced subframe mode not enabled, otherwise the sub-frame number in the range 0 to (number of subframes - 1)

3. TLV

3. TLV
    1. we use detected points as payload

        ### Detected Points

Type Identifier	Type Value	Length	Value
1	MMWDEMO_OUTPUT_MSG_DETECTED_POINTS	(Num Detected Obj) x (16 Bytes)	Array of detected points

        Each point is represented by 16 bytes giving position and radial Doppler velocity as shown in the table below

    2.

Value	Type	Bytes
X [m]	float	4
Y [m]	float	4
Z [m]	float	4
doppler [m/s]	float	4

    3. the gui monitor command is guiMonitor -1 1 1 0 0 0 1

Conclusions/action items:

1. implement the parser in arduino ver 1.1

XICHENG YANG - Mar 24, 2026, 10:28 PM CDT

Understanding UART Data Output Format

Table of Contents

Understanding the UART Data Output Format

To understand the data output from the EVM, it is important to understand how the device itself works. The mmWave radar sensor is a Frequency-Modulated Continuous Wave (FMCW) radar sensor that is able to detect the range, velocity, and angle of objects. To operate this device, configurations determining the properties of the chirps transmitted from the radar are sent via configuration commands/files in a Command Line Interface (CLI) to the device via UART.

When the chirp returns after bouncing off an object, it is mixed with the original transmit chirp to determine range, velocity, and angle. The resulting signal is digitized and organized into a Type Length Value structure (TLV) based on the demo being run. This information is then packed into an output structure and sent back to the computer via UART. The current UART output is sent out every frame as a packet containing a frame header and TLV.

Each TLV item in the packet payload contains a datatype and value (payload) containing information describing that type of information. The length of the packet can depend on the

Download

Understanding_UART_Data_Output_Format.html (127 kB)

2026/03/24-arduino ver 1.1

XICHENG YANG - Mar 24, 2026, 10:43 PM CDT

1. some logic of swradar.ino
    1. the scanned angle is +-20 deg in both x and z direction
    2. distance measured by detecting the closest point
2. the radar config file used attached

For archive

full repo available at https://github.com/F4llenDeath/smart-walker

XICHENG YANG - Mar 24, 2026, 11:44 PM CDT

DATA

Download

xwr18xx_profile_2026_03_24T08_16_44_372.cfg (1.26 kB)

XICHENG YANG - Mar 24, 2026, 11:45 PM CDT

INO

Download

swRadar.ino (11.2 kB)

2026/03/26-wall tracking algorithm

XICHENG YANG - Mar 26, 2026, 4:48 PM CDT

Title: wall tracking algorithm

Date: 2026/03/25

Content by: Xicheng Yang

Goals: explore some methods to track the wall to improve occlusion sensing

Reference:

https://stackoverflow.com/questions/63237222/wall-detection-using-pcl-and-ransac

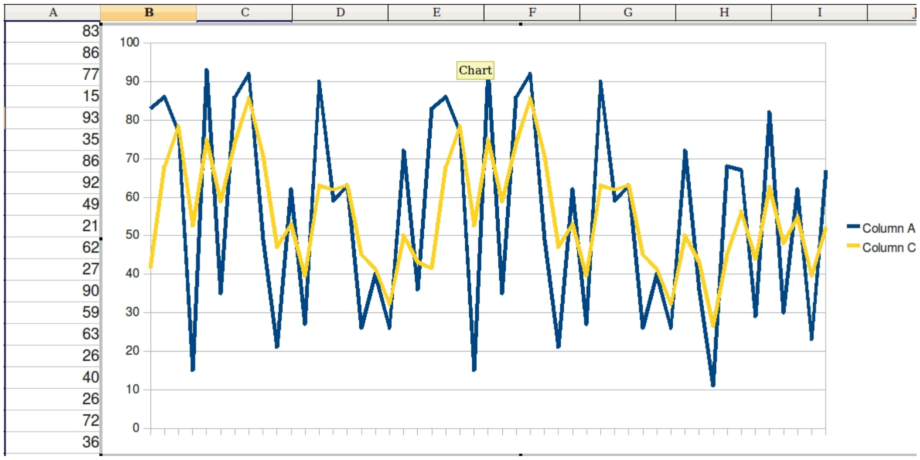
https://www.thinkautonomous.ai/blog/ransac-algorithm/

https://en.wikipedia.org/wiki/Random_sample_consensus

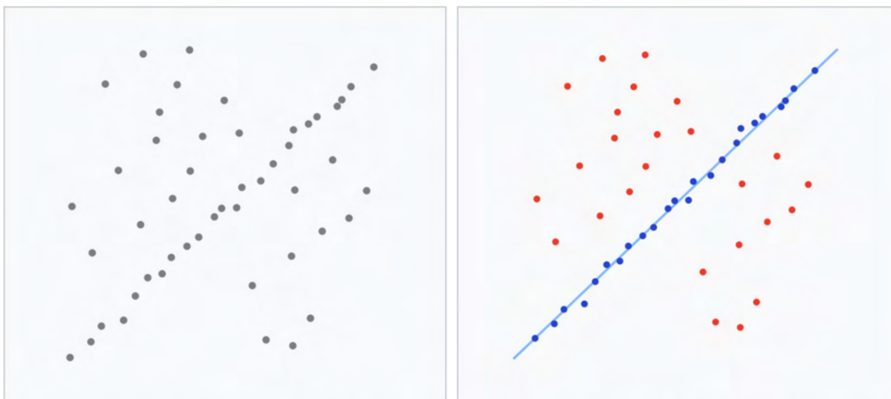
https://en.wikipedia.org/wiki/Alpha_beta_filter

Content:

1. what we currently have to calculate the distance and speed from sensor output
    1. Pick the closest detected point in each radar frame
    2. Use its Doppler velocity as walker speed
    3. Problems: no target selection (any clutter can be "closest")
2. what I want:
    1. Identify which detected point / line of point is the wall, lock onto it, and keep reading its Doppler velocity even when obstructions temporarily appear.
3. a simple wall tracker
    1. for little points input (1-5)
    2. Collect all points per frame (TLV Type 1: x, y, z, velocity) + SNR (TLV Type 7)
    3. Wall selection: highest SNR point within predicted range window
        1. Prediction gate: if wall already tracked, reject candidates where |range − predicted_range| > tolerance (e.g., 1.0m). This is what rejects obstructions.
    4. smooth range and range-rate, possibly Alpha-beta filter
        1. Range tracking is only for maintaining the prediction gate (knowing where the wall should be next frame), NOT for distance measurement.

2. 

4. RANSEC

1. 

A data set with many outliers for which a line has to be fitted.

Fitted line with RANSAC; outliers have no influence on the result.

2. for a denser point cloud like input, like >5 points per frame
3. Fit y = d among filtered points
4. Pick the d with the most inlier points = wall range
5. Average inlier Doppler velocities = wall speed (more robust than single-point)
6. but this needs a wide fov (like +- 50 degrees)

Conclusions/action items:

1. difficulties facing right now: the mmWave radar output, as attached in the radar setup entry, the number of points are very limited
   1. the wall is only displayed as one strong point instead of a series of aligned points
   2. so the first one might be a more feasible upgrade.

XICHENG YANG - Mar 26, 2026, 4:54 PM CDT

RANSEC pseudocode provided by wikipedia

```
Given:
    data – A set of observations.
    model – A model to explain the observed data points.
    n – The minimum number of data points required to estimate the model parameters.
    k – The maximum number of iterations allowed in the algorithm.
    t – A threshold value to determine data points that are fit well by the model 
(inlier).
```

```
    d – The number of close data points (inliers) required to assert that the model
fits well to the data.

Return:
    bestFit – The model parameters which may best fit the data (or null if no good
model is found).


iterations = 0
bestFit = null
bestErr = something really large // This parameter is used to sharpen the model
parameters to the best data fitting as iterations go on.

while iterations < k do
    maybeInliers := n randomly selected values from data
    maybeModel := model parameters fitted to maybeInliers
    confirmedInliers := empty set
    for every point in data do
        if point fits maybeModel with an error smaller than t then
             add point to confirmedInliers
        end if
    end for
    if the number of elements in confirmedInliers is > d then
        // This implies that we may have found a good model.
        // Now test how good it is.
        betterModel := model parameters fitted to all the points in confirmedInliers
        thisErr := a measure of how well betterModel fits these points
        if thisErr < bestErr then
            bestFit := betterModel
            bestErr := thisErr
        end if
    end if
    increment iterations
end while

return bestFit
```

2026/03/27-radar config

XICHENG YANG - Mar 27, 2026, 1:22 AM CDT

Title: radar config

Date: 2026/03/27

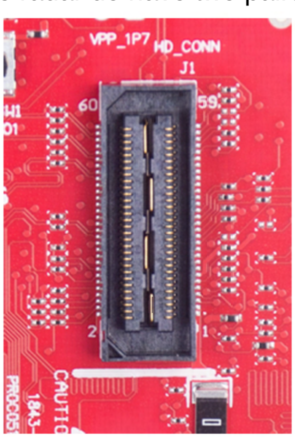
Content by: Xicheng Yang

Goals: find out how to make the mmwave sensor auto load the custom config file

Reference:

[Hard Coded Config User Guide]

Content:

1. how to send the config file to the mmwave radar and make the radar work according to the config every time it power up.
    1. two solutions:
    2. send the config each time from arduino
    3. modify the radar firmware to hard code the config on board
2. why we need a custom config file
    1. there is too much noise using the demo default config
        1. narrowed the sensing angle improves
        2. if someone is really good at algorithm maybe we could just use default demo
    2. the default config is also not built in, needs transfer from the official visualizer each time the board reboot
    3. maybe make the board dont reboot? is there a sleep mode available? more research needed.
3. option 1, stock demo, send .cfg file over cli uart each time.
    1. this is the option currently used in arduino ver 1.1 software
    2. problems:
        1. this method needs two uart channels:
            1. the baud rate required for cli instruction sending and radar reading sending is different
            2. so they need separate tx channels from the radar board
        2. the radar do have two pairs of uart pins, but on of them is on the J1
        3. 

Pin Number	Description	Pin Number	Description
43	TRACE_DATA12	44	LVDS_CLKP

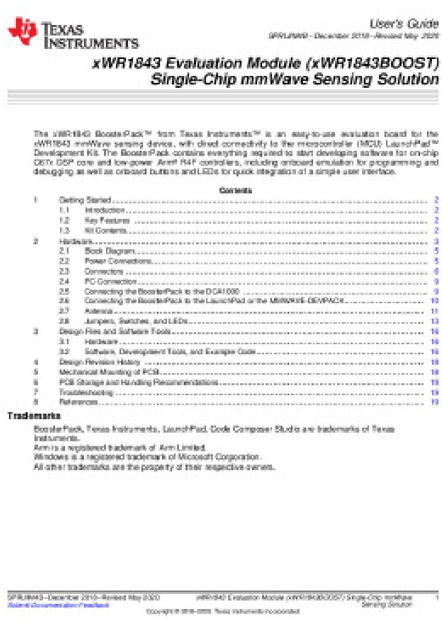
45	TRACE_DATA13	46	LVDS_CLKM
47	TRACE_DATA14	48	GND
49	TRACE_DATA15	50	LVDS_1P
51	I2C_SDA	52	LVDS_1M
53	I2C_SCL	54	GND
55	RS232RX (Rx into AWR device)	56	LVDS_0P
57	RS232TX (Tx from AWR device)	58	LVDS_0M
59	nRESET	60	GND

4. option 2, ha[illegible]
    1. ti did p[illegible]d stable then sending the cfg file each time.
    2. but the guide on xwr68xx series instead of 18xx series we have
    3. need more investigation if this also applied to our model
    4. possible difficulties:
        1. i dont know how to pack the modified code into a .bin bineray file
        2. if i fuck up there is risk of breaking the whole board and its very expensive
    5. the guide link here: [Hard Coded Config User Guide]

Conclusions/action items:

1. so, there are four problems right now, solving any one could solve the problem
    1. a well design algorithm that could accurately recognize wall from huge amount of noise in default 90 deg scan angle
    2. a sleep mode on board that presist imported config file
    3. connect the J1 pin 57 to arduino
    4. hard code config file

XICHENG YANG - Mar 27, 2026, 1:04 AM CDT


User's Guide

xWR1843 Evaluation Module (xWR1843BOOST) Single-Chip mmWave Sensing Solution

Contents

Trademarks

[Download]

spruim4b.pdf (6.99 MB)

XICHENG YANG - Apr 13, 2026, 1:38 PM CDT

update 4.13:

finally managed to build a .bin file with hardcoded config

attached here

XICHENG YANG - Apr 13, 2026, 1:38 PM CDT

Download

out_of_box_1843_isk.bin (323 kB)

2026/04/13-TI SDK build

XICHENG YANG - Apr 13, 2026, 3:00 PM CDT

Title: TI sdk build

Date: 2026/04/13

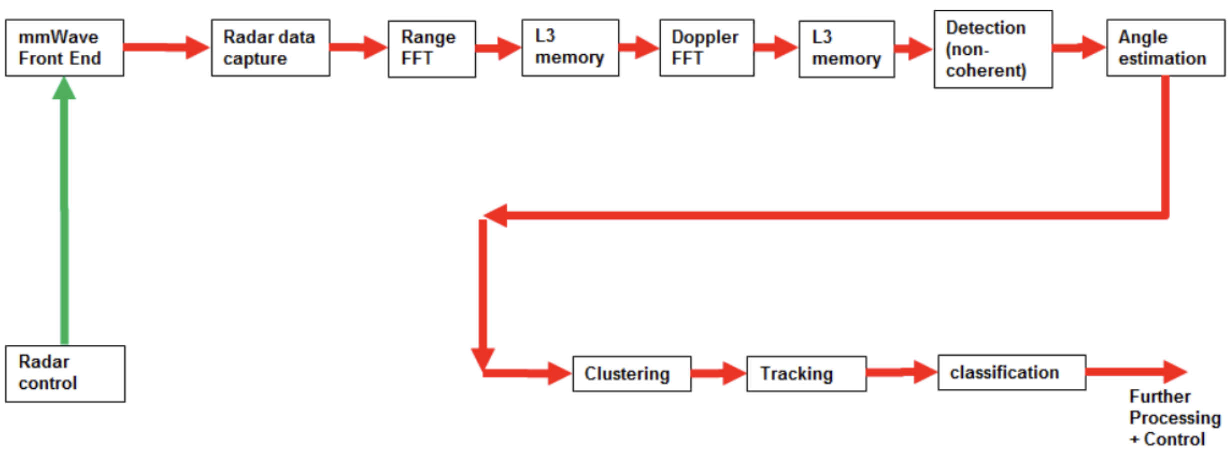
Content by: Xicheng Yang

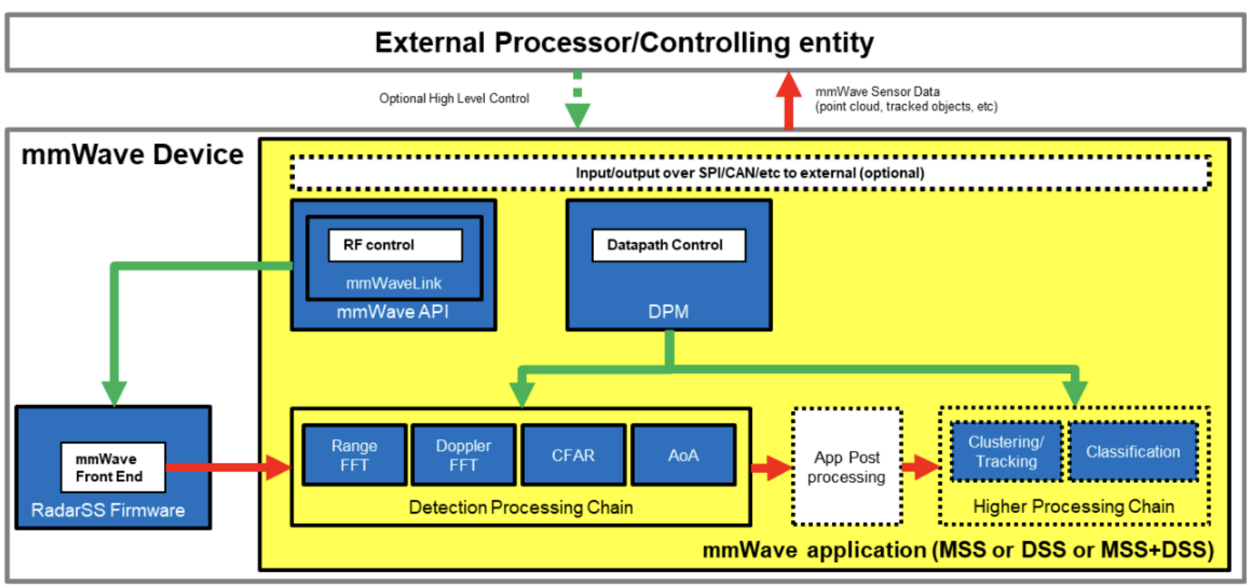
Goals: build a .bin firmware file what have hardcoded config

Reference:

[Hard Coded Config User Guide]

Content:

1. 

2. 

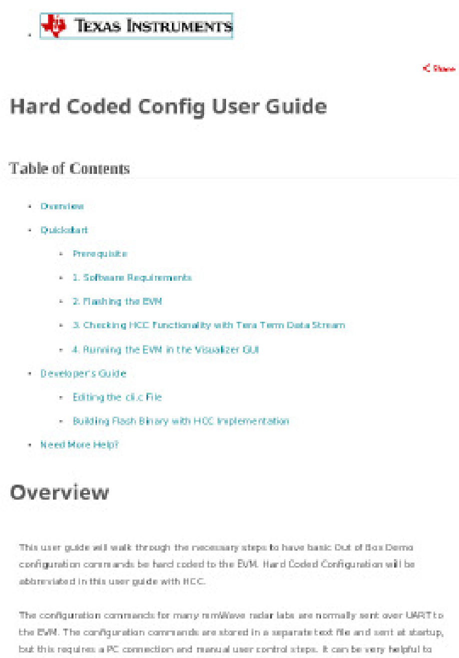
3. cli.c file
   1. location: `<MMWAVE_SDK3_INSTALL_DIR>\packages\ti\utils\cli\src`
   2. add the hard coded config
   3. modified cli.c attached

    4. replace the default cli.c in sdk folder with the modified one
4. build the dss and mss project
    1. just right click -> build project in the css studio
    2. project name should be all lowered and have no spaces
5. flash the generated out_of_box_1843_isk.bin in the mss project folder
    1. remember to power off and on after turning sop2 to 1 mode.

Conclusions/action items:

1. at apr 13th, the arduino still could not receive any data input from the radar
2. I hate this thing

XICHENG YANG - Apr 13, 2026, 2:55 PM CDT



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Share

Hard Coded Config User Guide

Table of Contents

- Overview
- Quickstart
    - Prerequisite
    - 1. Software Requirements
    - 2. Flashing the EVM
    - 3. Checking HCC Functionality with Tera Term Data Stream
    - 4. Running the EVM in the Visualizer GUI
- Developer's Guide
    - Editing the cli.c File
    - Building Flash Binary with HCC Implementation
- Need More Help?

Overview

This user guide will walk through the necessary steps to have basic Out of Box Demo configuration commands be hard coded to the EVM. Hard Coded Configuration will be abbreviated in this user guide with HCC.

The configuration commands for many mmWave radar labs are normally sent over UART to the EVM. The configuration commands are stored in a separate text file and sent at startup, but this requires a PC connection and manual user control steps. It can be very helpful to

Download

hard_coded_config_user_guide.html (1.05 MB)

2026/04/13-arduino ver 1.2

XICHENG YANG - Apr 13, 2026, 3:02 PM CDT

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swRadar.ino (8.34 kB)

XICHENG YANG - Apr 13, 2026, 3:03 PM CDT

new swradar.ino with the configuration file transmitting functions removed.

pin change to gpio 44 for rx

2026/04/14-use Raspberry pi as sensor control board

XICHENG YANG - Apr 14, 2026, 10:09 PM CDT

Title: use Raspberry pi as sensor control board

Date: 2026/04/14

Content by: Xicheng Yang

Goals: explore the feasibility of using a raspberry pi as the awr1843boost control board

Reference:

1. https://github.com/ibaiGorordo/AWR1843-Read-Data-Python-MMWAVE-SDK-3-
2. https://www.raspberrypi.com/products/raspberry-pi-zero-2-w/

Content:

1. the current dead end I reached
    1. problem: how to send and keep the configuration file in the sensor and let sensor's output reach the phone app
    2. solution 1: let arduino esp32 send the config file to the sensor each time sensor starts
        1. but this method needs two pair of uart channels, one pair to send config file another to send the radar output
        2. the second pair of uart is in the form of J1 60 hd connector as stated in former entries
        3. this port could only be connected by ti custom control board which are very expensive
            1. DCA1000EVM, $699
    3. solution 2: use the out of box demo firmware provided by ti
        1. this firmware is designed to have a pc or laptop connected to the sensor through usb while measuring
        2. we cant have a laptop connected every time patient want to use the walker
    4. solution 3: flash a customized firmware with config file hard coded into the control board
        1. ideally, arduino does not need to send the config any more so only one pair of uart channel will work
        2. but there is no guide of how to hard code xwr118xx series boards
        3. the only guide available by ti, included in former entries, is for xwr68xx series
        4. follow the steps on this guide cause right light of INERR shining on the board
            1. means initialization error
            2. the firmware is broken
    5. solution 4: fly wire and use level shifter to force connect the J1 pins to the arduino
        1. too risky, very high possibility break the whole sensor board which worth around $250
2. new ideas come up
    1. I could use the raspberry pi board as the pc in the solution 2.
        1. raspberry pi is a mini fully functional pc
        2. I can just run the oob demo firmware on the sensor and keep it connected to the pi board
        3. connect through usb, no more uart hassles
    2. have anyone done this before?
        1. luckily yes!

2. https://github.com/ibaiGorordo/AWR1843-Read-Data-Python-MMWAVE-SDK-3-
3. this guy did the exact thing and he open sourced his code
    1. he even have pre-built port assignment to connect to raspberry pi
4. hallelujah! open source!

Conclusions/action items:

1. buy a raspberry pi zero 2 w https://www.raspberrypi.com/products/raspberry-pi-zero-2-w/
    1. this thing is small
    2. low power consumption
    3. have micro usb port, exact same as the one on the sensor, easy connection
    4. have ble support, no esp32 needed anymore
2. I am finally starting to do something ti engineers want their customers to do

2026/04/14-controller ver 1.3

XICHENG YANG - Apr 14, 2026, 11:55 PM CDT

no longer swradar.ino, replaced with swradar.py, which use a raspberry pi as a control board

it send config to oob demo firmware, interpret input, and forecast out through ble

testing still needed, hopefully it will work

XICHENG YANG - Apr 14, 2026, 11:55 PM CDT

Download

AWR1843config.cfg (1.44 kB)

XICHENG YANG - Apr 14, 2026, 11:55 PM CDT

```
# Radar parsing code based on AWR1843-Read-Data-Python by Ibai Gorordo
# Original: https://github.com/ibaiGorordo/AWR1843-Read-Data-Python-MMWAVE-SDK-3-
# Licensed under MIT License
# Modified for Smart Walker: replaced plotting with BLE server output

import serial
import time
import math
import asyncio
import threading
import numpy as np
from bless import BlessServer, BlessGATTCharacteristic,
GATTCharacteristicProperties, GATTAttributePermissions

# Change the configuration file name
configFileName = 'AWR1843config.cfg'

CLIport = {}
Dataport = {}
byteBuffer = np.zeros(2**15,dtype = 'uint8')
byteBufferLength = 0;


# ------------------------------------------------------------------

# Function to configure the serial ports and send the data from
# the configuration file to the radar
def serialConfig(configFileName):

    global CLIport
    global Dataport
    # Open the serial ports for the configuration and the data ports

    # Raspberry pi
    CLIport = serial.Serial('/dev/ttyACM0', 115200)
    Dataport = serial.Serial('/dev/ttyACM1', 921600)

    # Windows
    #CLIport = serial.Serial('COM8', 115200)
    #Dataport = serial.Serial('COM9', 921600)

    # Read the configuration file and send it to the board
    config = [line.rstrip('\r\n') for line in open(configFileName)]
    for i in config:
        CLIport.write((i+'\n').encode())
        print(i)
        time.sleep(0.01)

    return CLIport, Dataport

# ------------------------------------------------------------------

# Function to parse the data inside the configuration file
def parseConfigFile(configFileName):
    configParameters = {} # Initialize an empty dictionary to store the
configuration parameters

    # Read the configuration file and send it to the board
    config = [line.rstrip('\r\n') for line in open(configFileName)]
    for i in config:

        # Split the line
```

Download

swRadar.py (15.4 kB)

2026/04/17-pi setup

XICHENG YANG - Apr 17, 2026, 9:31 PM CDT

Title: pi setup

Date: 2026/04/17

Content by: Xicheng Yang

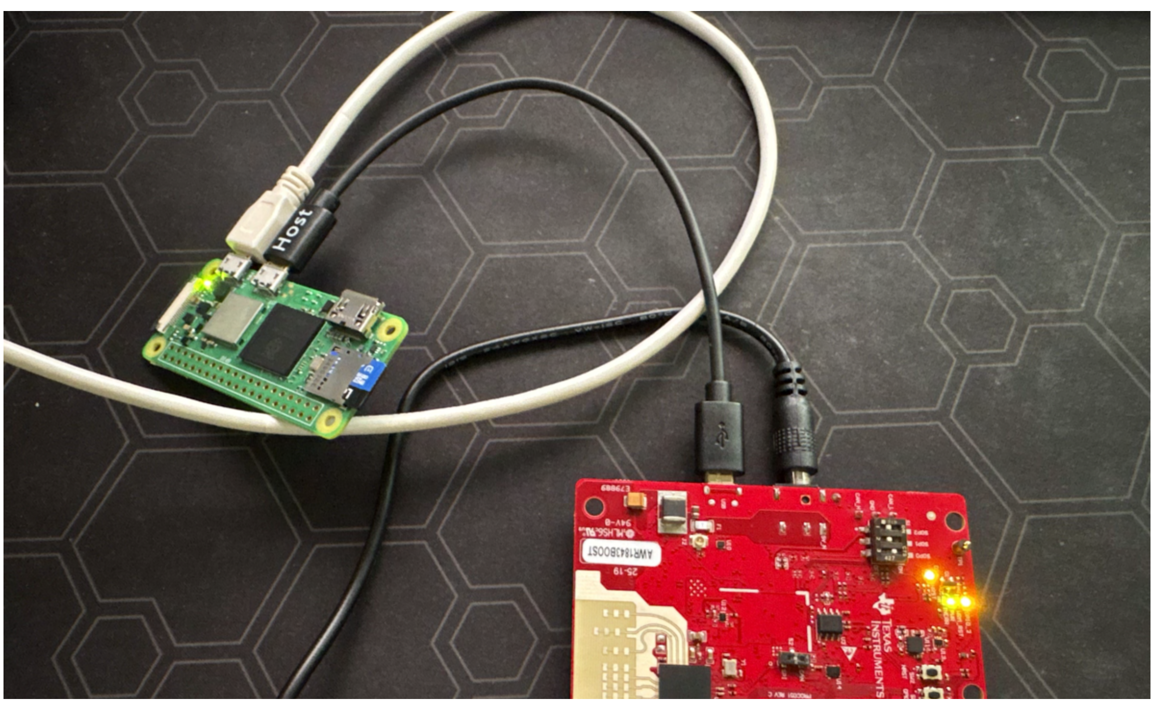
Goals: setup the raspberry pi zero 2 W to work with sensor

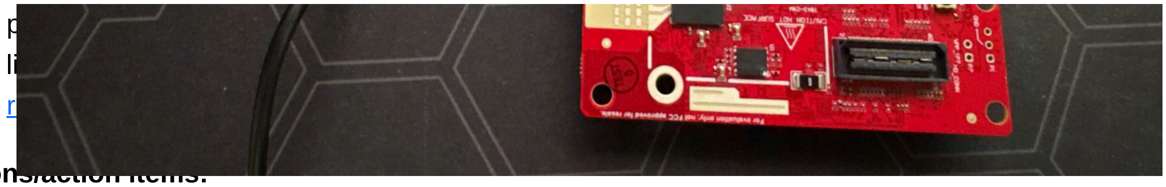
Reference:

1. https://www.raspberrypi.com/documentation/computers/getting-started.html
2. https://networkmanager.dev/docs/api/latest/nmcli.html

Content:

1. install the os
    1. included in the link above
        1. https://www.raspberrypi.com/documentation/computers/getting-started.html
    2. something specific for this project
        1. used lite version of os for being headless
        2. hostname: pi02w-sw
        3. username: smartwalker
        4. password: bmedesign2026
        5. ssh smartwalker@pi02w-sw.local
2. wifi setups
    1. include a wifi config in the os when setting up
    2. add more about nmcli
    3. https://networkmanager.dev/docs/api/latest/nmcli.html
3. wiring





2. p
3. li
   r
   1.

Conclusions/action items:

1. nothing

2026/04/17-system service setup

XICHENG YANG - Apr 17, 2026, 9:38 PM CDT

Title: system service setup

Date: 2026/04/17

Content by: Xicheng Yang

Goals: make the swradar.py into a system service in pi to make it auto run every time pi boots

Reference:

1. https://blog.usedbytes.com/2019/11/run-at-startup-without-rc.local/

Content:

1. put this in /etc/systemd/system/swradar.service
    1. [Unit]

       Description=Smart Walker Radar BLE Bridge

       After=bluetooth.service dev-ttyACM0.device dev-ttyACM1.device multi-user.target

       Wants=bluetooth.service

       BindsTo=dev-ttyACM0.device dev-ttyACM1.device

       [Service]

       Type=simple

       User=root

       WorkingDirectory=/home/smartwalker

       ExecStartPre=/bin/sleep 10

       ExecStart=/usr/bin/python3 /home/smartwalker/swRadar.py

       Restart=on-failure

       RestartSec=5

       [Install]

       WantedBy=multi-user.target
2. all commands used to start and test service
    1. # Service

sudo systemctl enable --now swradar.service   # enable + start

sudo systemctl restart swradar.service   # restart after code change

sudo systemctl status swradar.service   # quick health check

Logs

sudo journalctl -u swradar.service -b --no-pager   # full log this boot

sudo journalctl -u swradar.service -f   # live tail

sudo journalctl -u swradar.service -b | head -80   # startup handshake

3. some update on swradar.py to solve the problem of 1-3 patches leftover when rebooting the pi, included in the arduino ver 1.3

Conclusions/action items:

1. pi and sensor now can just be controlled by their power source, no need to add any switches on them.

XICHENG YANG - Apr 17, 2026, 9:39 PM CDT

```
# Radar parsing code based on AWR1843-Read-Data-Python by Ibai Gorordo
# Original: https://github.com/ibaiGorordo/AWR1642-Read-Data-Python-MMWAVE-SDK-3-
# Licensed under MIT License
# Modified for Smart Walker: replaced plotting with BLE server output

import serial
import time
import math
import asyncio
import threading
import numpy as np
from bless import BlessServer, BlessGATTCharacteristic,
GATTCharacteristicProperties, GATTAttributePermissions

# Change the configuration file name
configFileName = 'AWR1843config.cfg'

CLIport = {}
Dataport = {}
byteBuffer = np.zeros(2**15,dtype = 'uint8')
byteBufferLength = 0;


# ------------------------------------------------------------------

# Function to configure the serial ports and send the data from
# the configuration file to the radar
def serialConfig(configFileName):

    global CLIport
    global Dataport

    # Raspberry pi
    CLIport  = serial.Serial('/dev/ttyACM0', 115200, timeout=0.1)
    Dataport = serial.Serial('/dev/ttyACM1', 921600, timeout=0.1)

    # Windows
    #CLIport = serial.Serial('COM3', 115200)
    #Dataport = serial.Serial('COM4', 921600)

    # Halt any previous session, drain stale CLI/data, then reconfigure.
    CLIport.write(b'sensorStop\n')
    _drain_until_quiet(CLIport, quiet_ms=300, max_wait_s=2.0)
    _drain_all(Dataport)

    with open(configFileName) as f:
        config = [line.rstrip('\r\n') for line in f]

    for line in config:
        stripped = line.strip()
        if not stripped or stripped.startswith('%'):
            print(line)
            continue

        CLIport.reset_input_buffer()
        CLIport.write((line + '\n').encode())
        print(line)

        if not _wait_for_ack(CLIport, timeout_s=1.2):
            print(f"[Radar] WARNING: no ack for '{line}'")

    return CLIport, Dataport
```

[Download](#)

swRadar.py (16.9 kB)

general training

XICHENG YANG - Mar 22, 2026, 9:17 PM CDT

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

This certifies that Xicheng Yang has completed training for the following course(s):

Expand All | Collapse All

Course	Assignment	Completion	Expiration
2024-2025 HIPAA Privacy & Security Training	2024-2025 HIPAA Privacy & Security Training	9/14/2025	
Biosafety 102: Bloodborne Pathogens for Laboratory and Research	Biosafety 102: Bloodborne Pathogens Safety in Research Quiz 2025	9/10/2025	9/10/2026
Biosafety 105: Biosafety Cabinet Use	Biosafety 105: Biosafety Cabinet Use Quiz	9/14/2025	No Expiration
Biosafety 106: Autoclave Use	Biosafety 106: Autoclave Use: Safety and Efficacy - Verification Quiz	9/14/2025	No Expiration
Biosafety 107: Centrifuge Safety	Biosafety 107: Centrifuge Safety Verification Quiz	3/20/2026	No Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	1/27/2025	1/27/2030
Chemical Safety: Cryogen Safety Training	Part 1 Final Quiz	3/9/2024	3/9/2029
Chemical Safety: Cryogen Safety Training	Part 2 Final Quiz	3/10/2024	3/10/2029
Chemical Safety: Fume Hood Safety Training	Fume Hood Final Quiz	3/10/2024	3/10/2029
Chemical Safety: Personal Protective Equipment	PPE Final Quiz	3/10/2024	3/10/2029
Chemical Safety: Sharps Training for Chemical Manipulations	Sharps Final Quiz	3/10/2024	
Chemical Safety: The OSHA Lab Standard	Final Quiz	3/9/2024	
Disposing of Hazardous Chemicals	Final Quiz	3/10/2024	3/10/2029
Radiation Safety 107: Laser Safety 2024-2025	Laser Safety 2024-2025	9/16/2025	
Responsible and Ethical Conduct of Research (RECR)	RCR Certification	3/20/2026	No Expiration
UW IRB Member/Staff	Basic/Refresher Course - Human Subjects Research	9/14/2025	

Data Last Imported: 03/22/2026 08:55 PM

Download

Screenshot_2026-03-22_at_9.16.05_PM.png (496 kB)

2026/01/28-Lecture 1

XICHENG YANG - Jan 28, 2026, 1:52 PM CST

Title: Library 1

Date: 2025/01/28

Content by: Xicheng Yang

Content:

1. Chatbots are not reliable search tools
2. Evaluate sources
    1. Relevance
    2. Authority
    3. Quality
    4. Currency
3. Ways to get a paper
    1. database - title - abstract - content
    2. Download pdf from database
    3. find at UW
    4. request library
        1. Ask a librarian service
4. Citation manager
    1. Zotero
    2. Can edit all info
        1. Title, abstract etc.
    3. Insert citation to word files
        1. Should go over manually
        2. Check the auto format
5. Technical reports
    1. Using federal funds
    2. Timely update of the research
    3. databases
        1. DTIC
        2. NTRL
        3. OSTL
    4.

2026/02/04-Lecture 2

XICHENG YANG - Feb 04, 2026, 1:26 PM CST

Title: Job Search

Date: 2025/02/04

Content by: Xicheng Yang

Content:

1. resume and cover letter peer review
    1. Read
    2. Rubric

2026/02/11-Lecture 3

XICHENG YANG - Feb 11, 2026, 2:02 PM CST

Title: presentation

Date: 2025/02/11

Content by: Xicheng Yang

Content:

1. presentation
    1. font consistent
    2. effective figures
        1. caption
        2. units
        3. cite
        4. consistent axis scales
    3. remove messy background
    4. avoid being technical
2. interview
    1. bring portfolio
    2. both technical skills and soft skills
    3. reflect on weaknesses and challenges
    4. improve skill through practice

2026/02/18-Lecture 4

XICHENG YANG - Feb 18, 2026, 1:33 PM CST

Title: presentation peer review

Date: 2025/02/18

Content by: Xicheng Yang

Content:

1. Professional review
2. Refer to bme design resources
3.

2026/02/25-Lecture 5

XICHENG YANG - Feb 25, 2026, 1:49 PM CST

Title: diversity and inclusion

Date: 2025/02/25

Content by: Xicheng Yang

Content:

1. Diversity in engineering design
    1. Wide range of ideas
    2. Different educational backgrounds
    3. Test designs with multiple demographics
    4. Accommodations
    5. Ethnicity
    6. Socioeconomic status
2. Universal design
    1. Use by all people
    2. Design broadly and inclusively
    3. 7 principles
        1. Equitable use
        2. Flexibility in use
        3. Simple and intuitive use
        4. Perceptible information
        5. Tolerance for error
        6. Low physical effort
        7. Size and space for approach and use
3. Biomedical engineering code of ethics

2026/03/04-Lecture 6

XICHENG YANG - Mar 04, 2026, 1:56 PM CST

Title: library 2

Date: 2025/03/04

Content by: Xicheng Yang

Content:

1. Standard
    1. astm
    2. Iso
    3. Ieee
2. Market/industry source
    1. Business databases
    2. Company resaerch
    3. Industry research
3. Patents and prior art
    1. Review
        1. Patent search on disclosed ones
    2. Searching
        1. Hypothetical
        2. Lens.org
    3. Patent examine evaluate
        1. Usefulness
        2. Novelty
        3. Non-obviousness
    4. Evaluation
        1. Independent claims
        2. Dependent claims
            1. Refer to a previous claim
            2. Future limit the claim

2026/03/06-Tong's lecture

XICHENG YANG - Mar 11, 2026, 3:23 PM CDT

Title: Tong's lecture

Date: 2025/03/06

Content by: Xicheng Yang

Content:

1. experience
    1. south dakota
    2. asu
    3. u Michigan
    4. Wisconsin
    5. brl X
    6. NIT, Gore X
    7. neuronexus -> NEL
    8. brain sync
    9. neuraworx
    10. neuro one> zimmer
2. epilepsy surgery
    1. seizure implant
3. tweeting by thinking
4. brain sync
    1. stroke rehabilitation
    2.

2026/03/11-Lecture 7

XICHENG YANG - Mar 11, 2026, 3:34 PM CDT

Title: protocol

Date: 2025/03/11

Content by: Xicheng Yang

Content:

1. 1. Protocol development
    1. Planning
        1. Fabrication plan
        2. testing plan
    2. Execution
        1. Fabrication procedure
        2. Experiments
2. Rapid prototyping
    1. Low fidelity prototypes
    2. Early testing
    3. Documentation
3. Protocol components
    1. Materials
    2. Equipment list
    3. Step-by-step methods
    4. Testing documentation

2026/03/18-Lecture 8

XICHENG YANG - Mar 18, 2026, 1:43 PM CDT

Title: brevity in communication

Date: 2025/03/18

Content by: Xicheng Yang

Content:

1. Structure
    1. Attention grabber
    2. Intro
    3. Value proposition
    4. Benefits
    5. Call to action
2. Tong award
    1. Info available in design resources
    2. Project builder -> award selection
    3. Due the end of spring break
3. Dos and donts
    1. Do maintain eye contact
    2. Keep it concise
    3. Tailor to different audiences
    4. Don’t overwhelm
    5. Don’t forget to listen
4. Executive summary
    1. One page document
5. Abstract
    1. A clear summary
    2. Structure
        1. Background
        2. Objective
        3. Methods
        4. Results and analysis
        5. Discussion
6. Technical reports
    1. Eliminate extraneous text
    2. Avoid conversational text
    3. Spell out acronyms
    4. Remove redundancies
    5. Do not include raw data
    6. Proofread thoroughly

2026/03/25-Lecture 9

XICHENG YANG - Mar 25, 2026, 2:04 PM CDT

Title: ethic in engineering

Date: 2025/03/25

Content by: Xicheng Yang

Content:

1. In class activity attached in this entry
2. EVT case
    1. Resulted in a $92.4 criminal penalty
    2. Weakened guidant and acquired by Boston scientific
3.

XICHENG YANG - Mar 25, 2026, 2:00 PM CDT

1. **The Guidant VPs:** Most of the VP's at Guidant are very much against reporting the data to the FDA. (a) How might they continue to justify their case? (b) What would be the moral foundations of their perspective?

(a) They might argue that if they reported data to the public or FDA, there could be panic amongst users and other people affected. They could argue that the harm had already been done, so additional warning cannot help the situation.

(b) Utilitarianism, because they could argue that they were disclosing information in the best interest of the public and protecting them from mass hysteria. In addition, an issue like this could cause a great impact to the rest of the medical device industry.

2. **Patients and doctors:** Think about the position of those directly impacted: primarily patients who might be candidates for this surgery, and the doctors who use the device: (a) what arguments would those people want to ensure are considered by both the VPs and the design engineers about whether to report or not report the complications data? (b) What might be the ethical foundations of their perspective?

(a) the transparency of risks of implantation, the safety of patients, the public trust in the medical and health care system etc.

(b) VP and design engineers want to act at patients' interest, which their product could have maximized benefits for their customers. Patients need fair treatment and full risk disclosure before implantation, and they have right to be fully informed before making decisions.

3. **The design engineers:** (a) What else can they say or do? (b) What arguments can they try to make, and to whom?

    a) The design engineers can formally document their concerns in writing to create an internal paper trail that shows their objection on record. They can present the quantitative failure mode data to leadership, framing disclosure not just as an ethical obligation but a legal one.

    b) To the VPs, the engineers can argue that a cover-up carries far greater long-term legal and reputational liability than the defects themselves, especially keeping in mind historical cases that show how concealment often leads to worse outcomes than transparency. Legal and compliance teams should cite specific FDA reporting obligations. If all internal channels are exhausted, engineers have both the right and professional duty to escalate externally, including reporting it to the FDA.

4. **The design engineers:** What options do they have? Generate a list of possible options (a minimum of 3 from the perspective of the design engineers), describe how each stakeholder is affected, then analyze them using the BMES Code of Ethics (https://www.bmes.org/2025bmesconference/codeofconduct) and a couple of tests from the ethical decision-making system. Explain in detail the best option you would consider trying to act on.

(1) Comply: Patients will remain uninformed and at risk, doctors cannot provide accurate counsel, and engineers become complicit in concealment. This option violates the BMES code of ethics, which prioritizes public safety over employer loyalty. It fails the transparency tests (No engineer would like to see this go public), and the reversibility test (since a patient death from a preventable failure cannot be undone).

[Download](#)

BME_301_-_Ethics_Lecture.pdf (70.7 kB)

2026/04/08-Lecture 10

XICHENG YANG - Apr 08, 2026, 1:36 PM CDT

Title: Engineering judgment

Date: 2025/04/08

Content by: Xicheng Yang

Content:

1. Sun earth
   1. Sphere volumn Eqn is using r^3
   2. So should be about 1392684^3/12742^3 = 1,305,704.667
2. Back of an envelope calculations
3. Abet outcome 6
4. Learn about eng judgment
   1. Engineering problems
   2. Open ended problems
   3. Teamwork
   4. Critical thinking
   5. Communication
   6. Handling uncertainty
   7. Intuition
   8. Ask questions
   9. Embrace life
5. Three domains
   1. Attitudes
   2. Behaviors
   3. Cognitive

2026/04/15-Lecture 11

XICHENG YANG - Apr 15, 2026, 1:44 PM CDT

Title: poster presentation

Date: 2025/04/15

Content by: Xicheng Yang

Content:

1. good and bad poster
2. flow chart
    1. clear step with obvious flow
    2. keep simple
    3. grouping
    4. include decisions
3. final detail
    1. handouts
    2. have other people proofread
    3.

2026/04/23-Lecture 12

XICHENG YANG - Apr 29, 2026, 12:25 AM CDT

Title: poster peer review

Date: 2025/04/23

Content by: Xicheng Yang

Content:

1. this lecture was all about poster peer review
2. I forgot to create a note entry in class since there is nothing to taking note for.

2014/11/03-Template (copy)

XICHENG YANG - Jan 26, 2026, 3:52 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items:

Sensor Initial research

NICOLAS MALDONADO - Feb 12, 2026, 4:55 PM CST

Title: Sensor Initial Research

Date: 02/12/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: General, initial-research style report on each sensing concept

Content:

UWB + Wi-GIM Network: This approach combines Ultra-Wideband (UWB) radio for precise spatial localization with a wireless inertial measurement network (Wi-GIM) made up of IMU nodes (accelerometer + gyroscope). UWB anchors establish absolute position using time-of-flight ranging, while the IMUs provide continuous motion tracking between UWB updates. The result is a hybrid system that fuses radio-based positioning with inertial sensing.

Pros:

- Extremely high positional accuracy
- Works in darkness and through most obstructions
- Absolute position (not just relative motion)
- Mature sensor fusion techniques available
- Excellent for multi-node tracking

Cons:

- Requires infrastructure (anchors)
- Higher system complexity
- More power hungry
- More expensive
- Calibration and setup overhead

Special Features:

- True indoor positioning (no GPS needed)
- Multi-device tracking simultaneously
- Strong ecosystem for motion capture and robotics
- Sensor fusion enables drift correction

Gyroscope + Accelerometer: This is a purely inertial system, using accelerometers to measure linear acceleration and gyroscopes to measure angular velocity. Position and orientation are estimated by integrating these signals over time.

Pros:

- Tiny form factor
- Low power

- Low cost
- Simple hardware integration
- Excellent short-term motion tracking

Cons:

- No absolute position
- Drift accumulates over time
- Requires external reference to correct errors
- Cannot detect objects or environment

Special Features:

- High sampling rates
- Widely supported in embedded ecosystems
- Easy sensor fusion with magnetometers, UWB, or radar
- Industry standard for wearable motion tracking

mmWave Radar: Millimeter-wave radar actively emits RF signals and analyzes reflections to detect objects, motion, and even fine physiological movements. Modern mmWave chips can generate depth maps, track multiple targets, and measure micro-motions like breathing.

Pros:

- Works in darkness and through many materials
- Can detect people and objects without wearables
- Measures micro-motion (respiration, gestures)
- No external infrastructure required
- Strong for occupancy and presence detection

Cons:

- Lower absolute positioning accuracy than UWB
- More complex signal processing
- Higher power draw than IMUs
- RF design constraints

Special Features:

- Contactless sensing
- Multi-target tracking
- Gesture recognition
- Vital-sign detection
- Environmental awareness (not just self-motion)

Conclusions/action items:

- UWB + Wi-GIM: is the precision powerhouse: best for accurate indoor positioning but costly and complex.
- Gyro + Accelerometer: is the minimalist option: cheap, tiny, and efficient, but limited by drift and lack of environmental awareness.
- mmWave Radar: is the context sensor: excels at detecting people and motion through occlusion, with moderate cost and power needs.

mmWave Radar- research

NICOLAS MALDONADO - Mar 05, 2026, 2:29 PM CST

Title: mmWave radar research

Date: 03/04/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: understad the concepts of a mmWave radar to be able to chose the correct one for the project.

Content:

Basic concept

- mmWave (millimeter-wave) radar detects objects by **transmitting high-frequency radio waves and measuring the signals that reflect back**.
- Typical operating frequencies: **~60–77 GHz**.
- The sensor analyzes the returned signal to determine **distance, motion, and position** of objects.

How the radar system works

- **Transmitter**
    - Emits mmWave radio signals into the environment.
- **Reflection**
    - Signals hit objects (person, wall, furniture) and **bounce back toward the sensor**.
- **Receiver**
    - Captures the reflected signal and processes it to determine object properties.

Distance measurement

- Distance is calculated using the **signal travel time**:

  distance=c×t2distance = \frac{c \times t}{2}distance=2c×t

- ccc = speed of light
- ttt = round-trip time of the signal
- The signal travels **to the object and back**, so the distance is divided by 2.

Information radar can provide

- **Distance to an object**
- **Movement or velocity** (via Doppler shift)
- **Relative position** of objects in front of the sensor

Beacon concept

- A **beacon** helps the radar system identify a specific target in a noisy environment.
- **Passive beacon**
  - A reflective object that **strongly reflects radar signals**
  - Examples: metal reflector, reflective tag
- **Active beacon**
  - A device that **transmits its own signal**
  - Allows the radar system to identify a **specific tracked target**

Why this matters for the Smart Walker

- Indoor environments produce many reflections, which can make tracking difficult.
- A beacon could allow the walker to:
  - **Track the user's position relative to the walker**
  - Measure **distance between the user and the walker**
  - Improve reliability of radar detection

Potential applications in the Smart Walker

- Detect **obstacles in front of the walker**
- Monitor **user movement or gait**
- Track whether the **user moves too far away from the walker**
- Improve safety by detecting **instability or abnormal movement**

Key takeaway

- mmWave radar works by **sending radio waves and analyzing reflections**.
- A system typically requires a **transmitter, receiver, and reflected signal from a target**.
- Adding a **beacon (passive or active)** can improve detection by providing a **clear signal to track**, which could help the Smart Walker monitor user position and movement more reliably.

Conclusions/action items:

- The Smart Walker's mmWave system must include a radar module with both a transmitter and receiver to send signals and detect reflections from objects.
- The system should be able to measure distance and motion to determine the position of the user and nearby obstacles.
- Because indoor environments create many reflections, the design should consider using a beacon to provide a clear signal for the radar to track.
- The beacon could be passive (strong reflector) or active (signal transmitter) and could be worn by the user or integrated into the walker.
- Overall, the radar system should prioritize reliable signal transmission, accurate distance measurement, and consistent tracking of the user relative to the walker.

Component Selection - 1| Feb 2, 2026

Title: Component selection - 1

Date: Feb 2, 2026

Content by: Nicolas maldonado

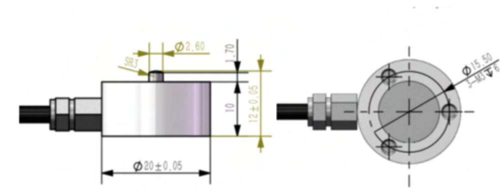
Present: N/A

Goals: To Find compatible load cells that fit well into the project framework

Content:

There are many load cells on themaket with vastly different price ranges. I will try to organize them by price, ranging from $ 50 to $ 1500 each. Ideally, each
150 lbs.

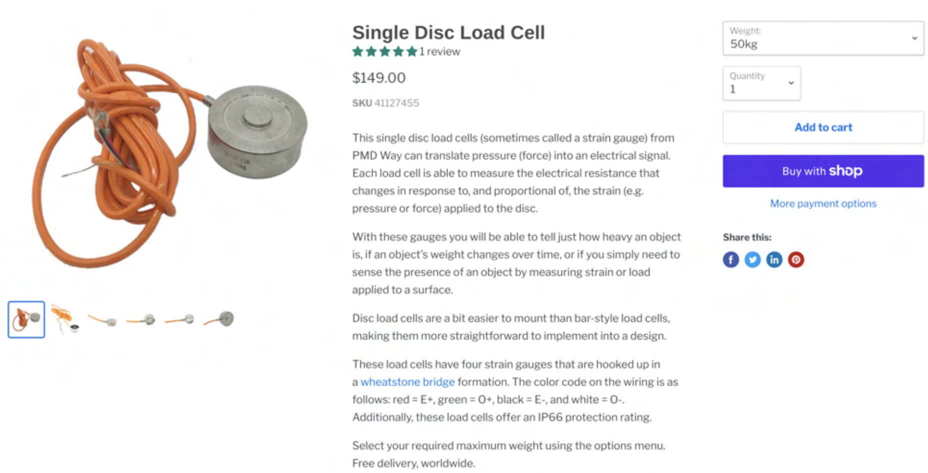
INTRODUCTION:



Technical Specification			
Capacity:	10,20,30,50,100,200,300, 500kg	Material:	Stainless steel
Output Sensitivity:	1.5 ±0.5mV/V	Input resistance:	385 ± 35Ω
Non-linearity:	± 0.3%FS	Output resistance:	350 ± 3Ω
Hysteresis:	± 0.3%FS	Insulation resistance:	≥ 2000MΩ
Repeatability:	± 0.3%FS	Excitation voltage:	5~12Vdc (Recommend 10Vdc)
Creep(30min):	± 0.3%FS	Operating Temp. range:	-20 ~ +60°C
Zero unbalance:	±1.0%FS	Safe overload:	120%FS
Temp Effect on Output:	± 0.3%FS/10°C	Ultimate overload:	150%FS
Temp Effect on Zero:	± 0.3%FS/10°C	Cable :	Φ2, 2m
Response frequency:	>800Hz	Cable ultimate tension:	98N

1. Sparkfun Load cell - https://www.sparkfun.com/load-cell-50kg-disc-tas606.html
a wheatstone configuration, which we had trouble with last semester, so I am hesitant to go that route again; however, it would still work, and it is a cheap p

2. ATO load cell - https://www.ato.com/flat-load-cell?affiliate=shopping&gad_source=1&gad_campaignid=22443499129&gbraid=0AAAAAoOej0aNaMX4cuzdb1jdLOgx3yd7Q&gclid=CjwKCAiAs4HMBhBJEiwAm5jDq1vOMQmvq_a2hoCFhwQAvD_BwE



Technical Parameters:

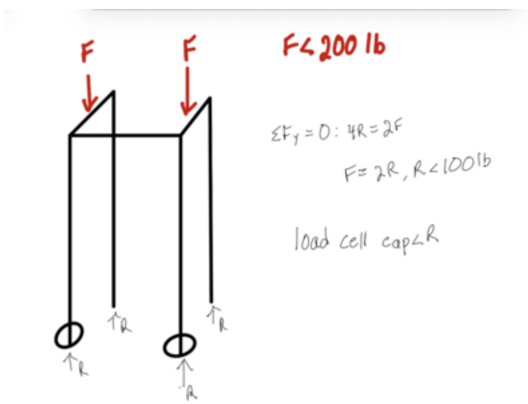
Parameter	Unit	Technical Specifications	Parameter	Unit	Technical Specifications
Sensitivity	mV/V	1.0-2.0	Protect grade		IP67
Comprehensive error	≤%F·S	±0.2%	Operating temperature range	℃	-30℃~+70℃
Creep	≤%F·S	±0.5%	Input resistance	Ω	400±10Ω
Zero balance	≤%F·S	±1%	Output Resistance	Ω	350±10Ω
Zero temperature effect	≤%F·S/10	±0.5%	Safe Overload	≤%F·S	150% F·S
Output temperature effects	≤%F·S℃	±0.05%	Insulation resistance	MΩ	≥2000MΩ
Excitation voltage	V	5V-15V	Maximum excitation voltage	V	15

Slightly expensive, but the specifications will do for the project details.

4.

Conclusions/action items:

NICOLAS MALDONADO - Feb 02, 2026, 11:21 AM CST



Download

Untitled_Draft_.png (133 kB)

Integrating Design into existing end caps

NICOLAS MALDONADO - Feb 03, 2026, 7:22 PM CST

Title: Integrating design into existing end caps

Date: Feb 3, 2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Thinking about if putting a design into existing end caps would be possible to have an easily integrated design.

Content:

The average load cell diameter is>1 in, and the walker end caps I found online have a diameter of 1 in. I will measure the inner diameter of the walker end caps we have tomorrow and check for compatibility. If they are compatible and a 3D-printed insert can be created that fits any walker end cap, it would allow a user to replace the end caps when they wear out without having to mess with internal components, making maintenance significantly easier.

Conclusions/action items:

Measure the inner diameter of the walker end caps we have, and compare them to various load cells, making sure there would be enough clearance for a 3D printed insert.

Measurements of Existing end cap

NICOLAS MALDONADO - Feb 05, 2026, 1:10 PM CST

Title: Measurement of existing end caps

Date: Feb 5, 2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Measuring and comparing end caps with load cell dimensions

Content:

Diameter of smallest inner wall: 1.1in

Diameter of insert: 1in

Diameter of load cell: >1in

I will model a possible insert for the load cell to be "housed" within the existing end cap.

Conclusions/action items:

Model the possible load cells and end cap, and try to integrate a design within existing end cap

NICOLAS MALDONADO - Feb 05, 2026, 1:07 PM CST

Download

Photo_25.pdf (78.2 MB)

Designing the integrated load cell

NICOLAS MALDONADO - Feb 12, 2026, 4:46 PM CST

Title:

Date:

Content by: Nicolas Maldonado

Present: N/A

Goals: Create the most compact reasonable assembly that securely holds a compression load cell inside an existing walker end cap

Content:

1. Walker end cap (existing)

Most standard walkers use legs with a 1.0 inch (25.4 mm) tube diameter. Replacement end caps are designed around this size.
https://horizonmedicalequipment.net/products/walker-tip-replacement-glide-caps-1-inch-diameter-set-of-2

Retail listings also show overall envelope dimensions near 1 inch, but internal cavity geometry varies by manufacturer.
https://www.walmart.com/ip/Drive-Medical-Utility-Walker-Replacement-Tips-1-Pair/22124250

the critical dimension is NOT the outside of the rubber tip, but the internal cavity where your insert sits. This must be measured directly with calipers.

2. Load cell (button / puck style examples from DigiKey)

Typical miniature compression load cells have these sizes:

CDFM3 Miniature Button Load Cell
Diameter: 30 mm
Height: 12 mm
https://mm.digikey.com/Volume0/opasdata/d220001/medias/docus/6357/Miniature%20Button%20Load%20Cell%20Cdfm3%20Datasheet.pdf

Smaller options (if space becomes critical): REB5: diameter under 13 mm, height as low as 7 mm

https://www.digikey.com/en/product-highlight/l/loadstar/reb5-miniature-button-force-sensors

Dish insert dimensions:

Inner pocket diameter (to hold load cell): $D_{pocket} = D_{LC} + 0.30$ to 0.50 mm

This gives 0.15–0.25 mm radial clearance for easy insertion after printing. Pocket depth: $H_{pocket} = 0.60$ to $0.80 \times H_{LC}$ This captures most of the load cell while leaving the top exposed for axial loading.

Bottom thickness under pocket: PLA or PETG: 1.5 to 2.0 mm TPU: 2.0 to 2.5 mm (This is the minimum needed for strength in compression.)

Side wall thickness: 1.8 to 2.5 mm

Outer diameter of insert: $D_{outer} = D_{CAP} - 0.30$ to 0.60 mm. This allows slip-fit seating into the rubber end cap without forcing.

Cable relief notch: Width = cable diameter + 0.5 to 1.0 mm Depth = 1.5 to 3.0 mm. This prevents pinching and allows the wire to route upward inside the walker leg.

Conclusions/action items:

- Load cell diameter (D_LC)
- Load cell height (H_LC)
- End cap cavity diameter (D_CAP)
- End cap cavity depth (H_CAP)

Initial CAD designs

NICOLAS MALDONADO - Mar 05, 2026, 2:10 PM CST

Title: Initial CAD designs

Date: 03/03/2026

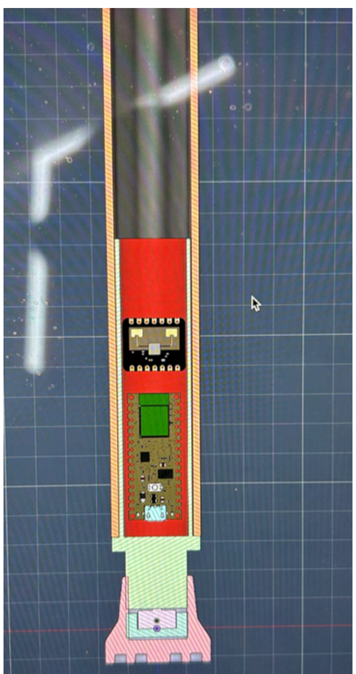
Content by: Nicolas Maldonado

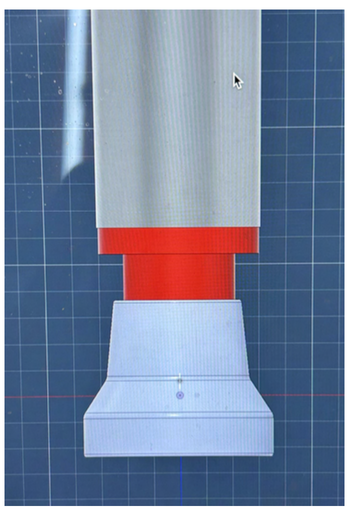
Present: N/A

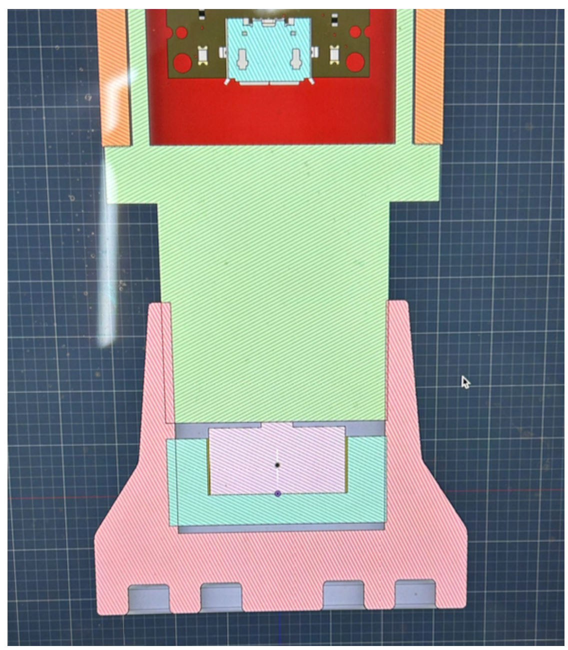
Goals: Design a CAD model of the design

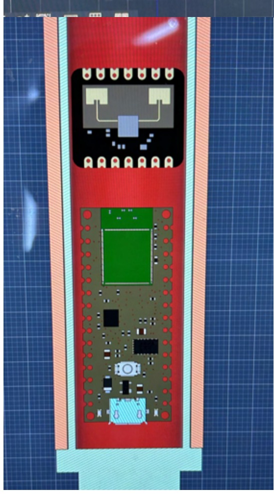
Content:

Initial designs: Initial design was a fit test, the top part fit well into the walker let, but the bottom was too small due to endcap dimensional error. An endcap redesign is necessary.

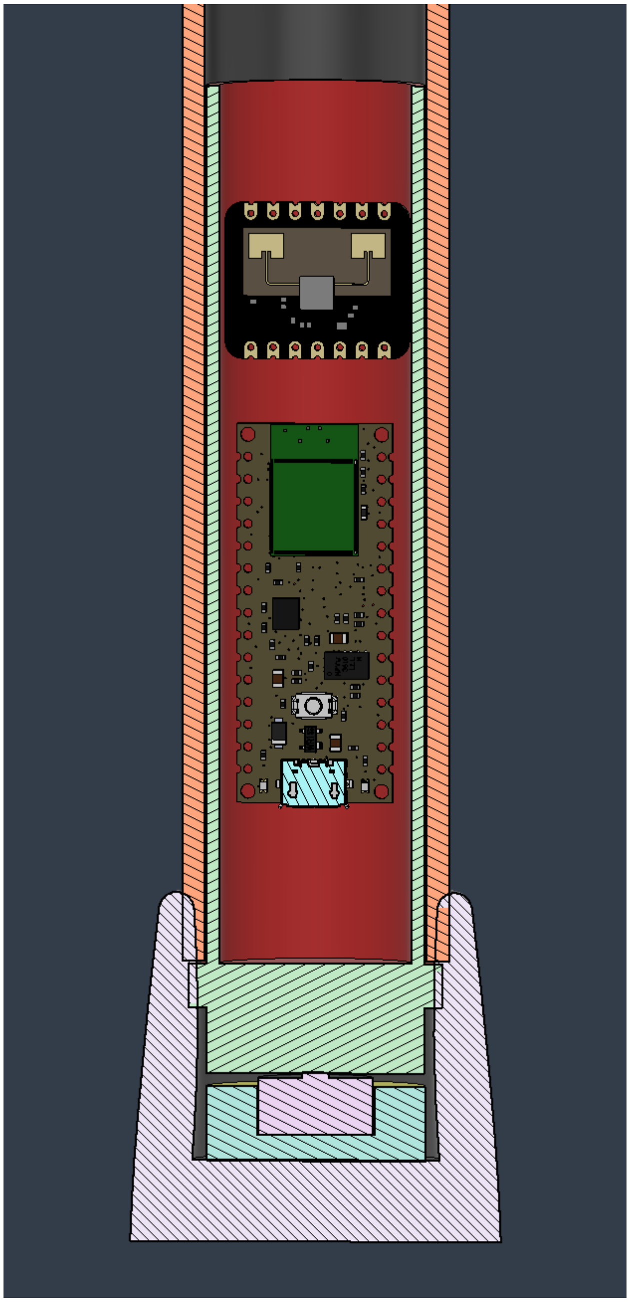








Redesign:



I redesigned the endcap and modified the "plunger" to fit inside it. We need to make sure that the entire design can safely fit inside the endcap to ensure patient safety.

Conclusions/action items:

Component Housing CAD

NICOLAS MALDONADO - Mar 10, 2026, 7:02 PM CDT

Title: Component Housing CAD

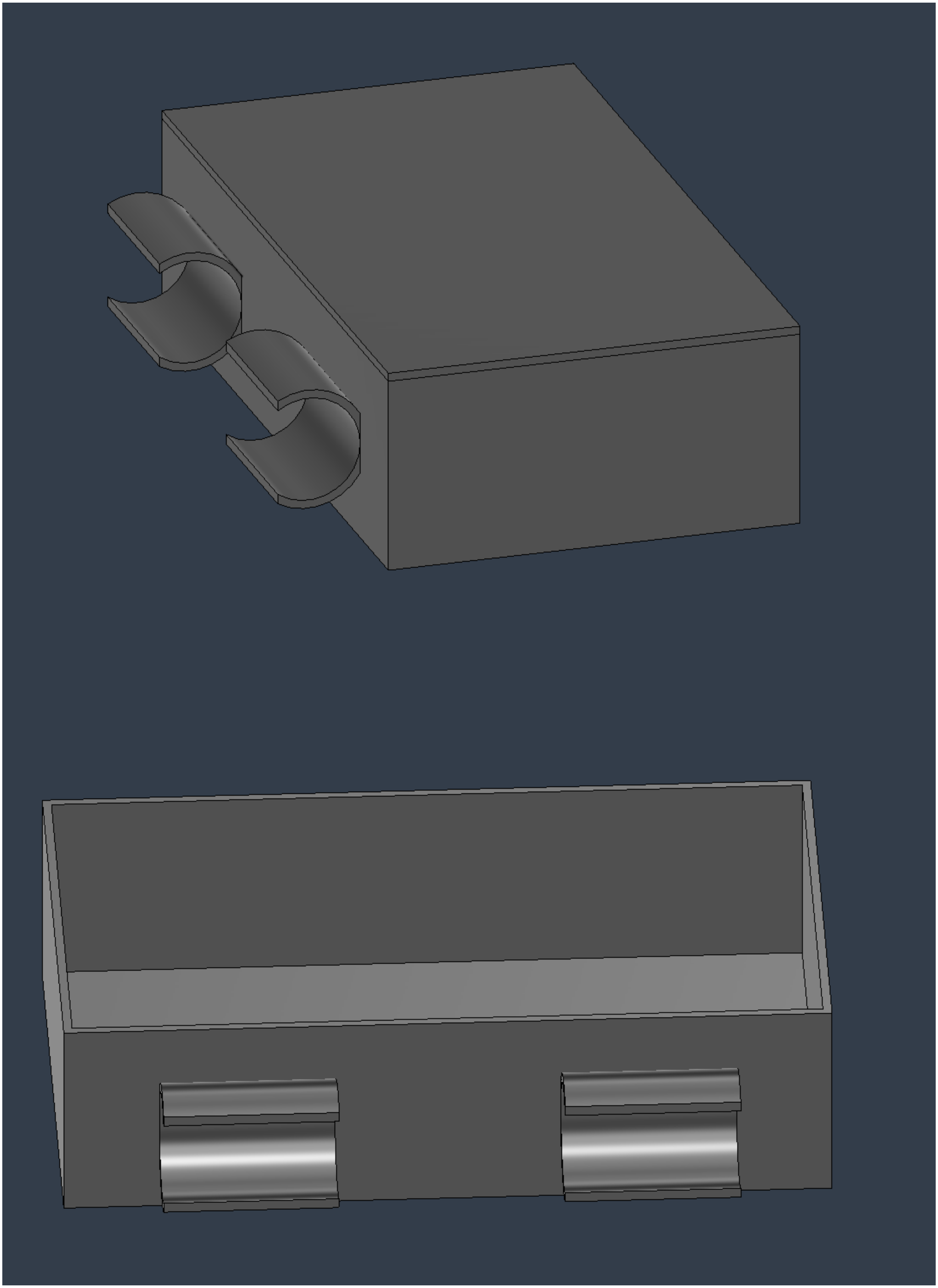
Date: Mar 10, 2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Design a component housing that clips onto the walker body

Content:



Conclusions/action items:

3D print this design and see how it fits

Load Cell housing adjustments V3

NICOLAS MALDONADO - Mar 11, 2026, 9:51 AM CDT

Title: Load cell housing adjustemtns

Date: Mar 10, 2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Adjust the design to fit all the components comfortably

Content:

We need adjustments for:

The wire coming from the load cell(have a cutout in the load cell dish"

The wire from the load cell needs to go up through the plunger.

The battery and arduino must have a place in the housing with charger cables, space optimization, and impact in mind

Designs:

Conclusion/action items:

Design Adjustments- V3 --> V4

NICOLAS MALDONADO - Mar 12, 2026, 2:27 PM CDT

Title: Design Adjustments

Date: 03/12/26

Content by: Nicolas Maldonado

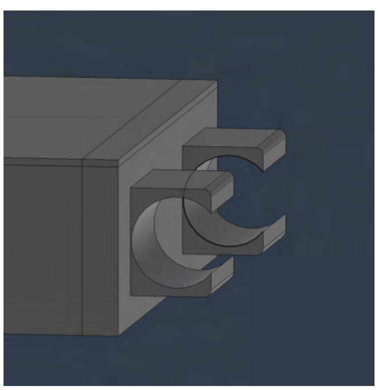
Present: N/A

Goals: make adjustments to design

Content:

mmWave radar design:

The "hands" broke off because the design was too weak at that point. The fix for this is to increase the thickness:



I also decreased the diameter of the hands so that they are a little tighter, and made them a bit taller so it has more of the full circle

Load cell housing:

Plunger(old):

Top diameter: 25mm

Purtruding segment diameter: 29mm

Part touching the load cell height: 3.75mm

Plunger(new):

Top diameter: 25.2mm

Purtruding segment diameter: 28mm

Part touching load cell height: 1mm

Load cell housing:

Put a notch in the holder so that the cable of the load cell can fit.

Edits:

"bottom thickness" 3mm--> 1.5mm

Outer diameter: 27mm --> 26mm

tolerance from load cell: 0.2 --> 0.4

Load cell model:

Added the cable to the model for better fit testing

Conclusions/action items:

I will print these and test them for fit

When components come in, we can measure the actual sizes of the load cells to have holes that the wire can go through to reach the main components.

I have also been thinking about a system that keeps the load cell housing connected to the plunger without causing more force. more thought needed

Also, designing the charger port will also be a next step.

Design Adjustments V4 --> V5

NICOLAS MALDONADO - Mar 19, 2026, 3:27 PM CDT

Title: V4 --> V5

Date: 03/17/26

Content by: Nicolas Maldonado

Goals: Make adjustments to the design

Content:

Plunger:

Load cell housing:

Plunger(old):

Top diameter: 25.2mm --> 25.3

Purtruding segment diameter: 28mm

Part touching load cell height: 1mm

"bottom thickness" 1.5mm

Outer diameter: 26mm

tolerance from load cell: 0.4

Conclusions/action items:

Design Adjustments V5-->V6

NICOLAS MALDONADO - Mar 19, 2026, 3:44 PM CDT

Title: V5-->V6

Date: 03/19/26

Content by: Nicolas Maldonado

Goals: Make adjustments to the design

Content:

Load cell housing:

Cutout for wire Diameter: 3.2mm --> 3.8mm

Plunger:

- outer diameter: 25.3--> 25.4
- Added hole to allow wire to run from the load cell to the housing body
-

Conclusions/action items:

Final Fabrication of Load cell housing

NICOLAS MALDONADO - Apr 28, 2026, 4:58 PM CDT

Title: Fabrication Protocall

Date: 04/22/26

Content by: Nicolas Maldonado

Goals: Outline full fabrication protocall for Load cell housing

Content:

Conclusions/action items:

Training Documentation

NICOLAS MALDONADO - Oct 30, 2025, 4:00 PM CDT

Title: Training Documentation

Date: 10/30/25

Content by: Nicolas Maldonado

Present: N/A

Goals: N/A

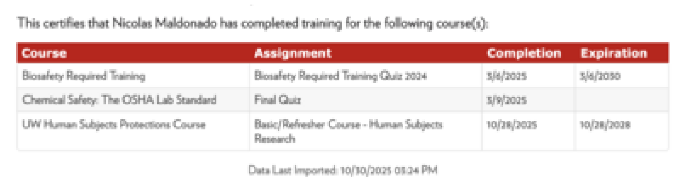
Content:

N/A

Conclusions/action items:

N/A

NICOLAS MALDONADO - Oct 30, 2025, 3:56 PM CDT



This certifies that Nicolas Maldonado has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024	3/6/2025	3/6/2030
Chemical Safety: The OSHA Lab Standard	Final Quiz	3/9/2025	
UW Human Subjects Protections Course	Basic/Refresher Course - Human Subjects Research	10/28/2025	10/28/2028

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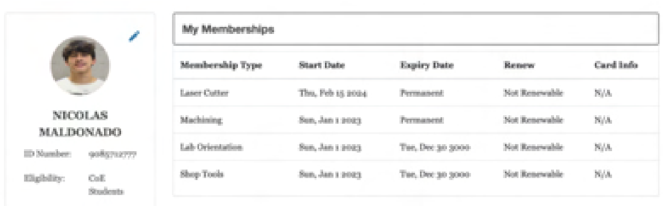
NICOLAS MALDONADO - Oct 30, 2025, 3:56 PM CDT



NICOLAS MALDONADO

ID Number: 9085712777

Eligibility: CoE Students

My Memberships

Membership Type	Start Date	Expiry Date	Renew	Card Info
Laser Cutter	Thu, Feb 15 2024	Permanent	Not Renewable	N/A
Machining	Sun, Jan 1 2023	Permanent	Not Renewable	N/A
Lab Orientation	Sun, Jan 1 2023	Tue, Dec 30 3000	Not Renewable	N/A
Shop Tools	Sun, Jan 1 2023	Tue, Dec 30 3000	Not Renewable	N/A

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Screenshot_2025-10-30_at_3.56.53_PM.png (248 kB)

Lecture 1 - 02/11/2026

NICOLAS MALDONADO - Feb 11, 2026, 12:36 PM CST

Title: Resume workshop

Date: 02/04/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Improve resume and cover letter

Content:

Get in groups of 3

Critique each others resume and cover letter

Apply critique to our resume and cover letter

Conclusions/action items:

Apply revisions to my cover letter and resume

Lecture 2 - 02/11/2026

NICOLAS MALDONADO - Feb 11, 2026, 1:49 PM CST

Title: Presentation tips and job interviews

Date: 02/11/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Learn about interviewing

Content:

Presenting

Make sure there is consistency with bullets, fonts, and flow

Make it easy on the client by simplifying the presentation, and talk through the points

Make sure the order is all consistent when referring to the design matrix

Keep the audience interested, make sure it's not too technical, and create a story throughout the presentation

For the design matrix, go over the highlights, do not overexplain

Do not hang too many bullets

Figures:

for images, figure x, what it is and a citation

For graphs, figure x, what is measured and the data represented

For comparison, demonstrate the key results, conditions, etc.

You can use drawings for the preliminary design. Make sure to remove the background and label each part clearly, and have something for scale

Do not show raw data; make it digestible for the viewer.

Try to tell a story with your figures by showing how your project works. Block diagrams are also useful

Interviewing

Have a portfolio, talk about soft skills

Conclusions/action items:

Lecture 3 -02/18/2026

NICOLAS MALDONADO - Feb 18, 2026, 1:52 PM CST

Title: Presentation peer review

Date: 02/18/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Review and revise preliminary presentation

Content:

I reviwed someones presentation and told them to expand on a couple things

We got feedback as well

Conclusions/action items:

Integrate the suggestions we got on our presentations

Lecture 4 - 02/18/2026

NICOLAS MALDONADO - Feb 25, 2026, 2:08 PM CST

Title: Presentation peer review

Date: 02/18/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Review and revise preliminary presentation

Content:

Lecture 5: Diversity and Inclusion in Design (BME 301)

- Diversity in engineering design encompasses more than just visible characteristics.
- It includes factors such as ethnicity, socioeconomic status, culture, individual experiences, and a range of skill sets.
- Diversity also encompasses less apparent factors, including daily habits and personal perspectives.
- These differences influence user interactions with designs and affect how engineering teams approach problem-solving.

Designing for diversity requires moving beyond the concept of an "average user."

Actual users represent a broad spectrum of abilities, backgrounds, and needs.

Effective engineering design acknowledges this variability from the outset rather than treating it as an afterthought.

Defined by Ron Mace as:

Universal design is the creation of products and environments usable by all people to the greatest extent possible, without the need for adaptation or specialized solutions.

This approach emphasizes broad inclusion rather than relying on special accommodations.

The primary goal is to ensure that products are inherently accessible and functional for the widest possible range of users.

- **The 7 Principles of Universal Design**

- Equitable Use
  - Products should be useful and marketable to individuals with diverse abilities.
  - Equitable use emphasizes safety, privacy, and broad appeal for all users.
- Flexibility in Use
  - Flexibility in use accommodates varying preferences, abilities, and usage rates.
  - It allows for multiple methods of product use.

- Simple and Intuitive Use
  - Products should be easy to understand regardless of a user's experience, language proficiency, or level of concentration.
  - Designs should avoid unnecessary complexity and provide clear, actionable feedback
- Perceptible Information
  - Communicates essential information effectively, even with sensory limitations or environmental distractions
- Tolerance for Error
  - Tolerance for error minimizes hazards and reduces the consequences of user mistakes.
- Low Physical Effort
  - Products should be comfortable to use and cause minimal physical fatigue.
- Size and Space for Approach and Use\
  - Designs must provide sufficient space for reach, manipulation, and use, regardless of body size, posture, or mobility.

Connection to Ethics

- Inclusive design constitutes an ethical responsibility within the field of biomedical engineering
- Engineers are required to consider the following questions:
  - Who benefits from their designs?
  - Who may be unintentionally excluded?
- This approach aligns with the Biomedical Engineering Code of Ethics, which emphasizes a responsibility to public welfare.

Conclusions/action items:

Integrate the suggestions we got for our presentations

Lecture 5 - 02/25/2026

NICOLAS MALDONADO - Apr 08, 2026, 1:35 PM CDT

Title: Patents/standards

Date: 02/25/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Learn about standards and patents

Content:

Standards

- Libraries have databases that include American Society of Testing Materials, American Society of Agricultural and Biological Engineers, and Institute of Electrical and Computer Engineers

- There are freely available online databases.

Market and Industry sources

- Can find information on companies, industries, and consumer trends

- Library research guides: Company research, Industry research, Market research

Specific Recs:

-Dataacle reference solutions

- IBISWorld Industry reports

-ProQuest One Business

Patents and Prior Art

- Patent examiners evaluate applications against prior art, which includes:
 -Inventions Disclosed in US and foreign Patents and patent applications

 - Inventions Disclosed in publications

- Inventions currently for sale to the public

Patents

- almost always, there will be something similar to what you are trying to make

- look for a couple of different examples, not just the one most similar

-Needs novelty : something new that you came up with.

Claims:

-Define legally enforceable aspects. Preamble, transition, and then the

Comparing Patent claims:

-The earlier patent focuses on the basic concept of a bouncing feeder.

-The later patent modifies the design and configuration of the mechanism to achieve a similar effect with a different implementation.

-changing the mechanical configuration

-modifying how the spring or suspension system works

-adding or altering components not described in the earlier claims

Conclusions/action items:

Use standards

Ensure safety and regulatory compliance.

Use market research

Confirm there is real demand for the product.

Search patents

Avoid reinventing existing designs.

Analyze claims

Understand what features are legally protected.

These steps are essential for real-world engineering design and commercialization.

TONG lecture - 03/04/2026

NICOLAS MALDONADO - Apr 08, 2026, 1:35 PM CDT

Title: Tong lecture

Date: 03/04/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Listen to the Tong lecutre

Content:

Dr williams gave a talk on his life

We learned about his early years and his eductation

We learned about his early companies and the ways they failed

And lastly talked about the companies he started in his later years, which were successful

The takeaways

- Keep things simple; sometimes, less is more
- dont be afraid of failure, it may lead to a better situation
- Work with good peole

Conclusions/action items:

Lecture 7 - 03/11/2026

NICOLAS MALDONADO - Mar 11, 2026, 1:55 PM CDT

Title: prototyping

Date: 03/11/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Early prototyping

Content:

Planning general concepts for fab and testing

Detailed material list

Protocalls should be detailed enough for someone else to follow

The more specific the better

- Follow entry guidelines
- specific yet generic protocall
- quantitative data

Writing all protocalls means writing what tools/measurment devices you used and how you used them, include calibration, etc.

Manufacruing

- Keep in mind as we design, that not everything that is able to be 3D printed will be able to be machined at scale
- Use profesionals to tell you what kind of problems that could be forseen, earlier rather than later

Testing Plan

- Think about statistics before starting
- think about control
- do you hvae to design something to ensure precision and accuracy
- reference and discuss the PDS criterion being tested
- testing plan should match fabrication plan

Conclusions/action items:

Lecture 8 - 03/18/26

NICOLAS MALDONADO - Mar 18, 2026, 1:43 PM CDT

Title: Speaking

Date: 03/18/26

Content by: Nicolas Maldonado

Goals: Talking about speaking

Content:

Elevator Pitches (oral, 1–5 min): Structure: hook → intro → value proposition → benefits → call to action. Tailor to audience, practice until natural, avoid jargon, stay authentic. Don't sound robotic or overwhelm with details.

- Show & tell (1 min): lead with what you need help with, show current work, end with a specific question
- Tong award (5 min): intro → problem gap → prototype demo → market potential → open Q&A

Executive Summary (written, 1 page): Essentially a written elevator pitch. Structure: intro → problem → solution → benefits → recommendations/future work. Says more with less — audience-tailored, jargon-free, polished.

Abstract (150–300 words): For reports/papers. Structure: background → objective → methods → results → conclusion. Helps readers decide whether to read the full paper. Write it last.

Technical Reports — Writing Concisely

- Cut redundant pairs (end result, basic fundamentals)
- No conversational filler (basically, pretty much)
- Spell out acronyms on first use
- No raw data
- Proofread the whole document

Conclusions/action items:

Lecture 9 - 03/25/26

NICOLAS MALDONADO - Apr 08, 2026, 1:33 PM CDT

Title: Ethics

Date: 03/25/26

Content by: Nicolas Maldonado

Goals: Understand ethics

Content:

Where Ethics Come From

- Ethics are shaped by religion, personal experience, peers, and family
- Ethical problem-solving mirrors the engineering design process:
  - Recognize when a situation has ethical dimensions
  - Identify stakeholders and their needs
  - Generate possible actions
  - Analyze each option, weighing short- and long-term harms

Guidant Case Study

1. The VPs' Perspective

- Opposed reporting to the FDA, arguing disclosure would cause public panic without helping already-affected patients
- Reasoning is utilitarian — withholding information protects public stability and shields the broader medical device industry

2. Patients and Doctors

- Demanded full transparency about device risks and informed consent before implantation
- Their position rests on patient autonomy and the right to make fully informed decisions (principlism + deontological ethics)

3. Design Engineers — What They Can Do

- Document concerns in writing to establish a formal internal record
- Present failure data to leadership framed as both an ethical and legal obligation
- Engage legal/compliance teams around specific FDA reporting requirements
- If internal channels fail, escalating directly to the FDA is both a right and a professional duty

4. Design Engineers — Options Analysis

- **Comply with VPs:** Patients stay uninformed, engineers become complicit — fails the transparency and reversibility tests, violates the BMES Code of Ethics
- **Internal Escalation:** Gives the company a chance to self-correct but delays patient protections and may still leave patients at avoidable risk

- **Report to the FDA (best option):** Documented test data supports the report, protects patients from future harm, and fulfills professional and legal obligations

Conclusion:

- Two ethical dimensions in the device design:
  - Load cell wires disconnecting during use
  - Enclosure lid detaching when repositioning components
- Action plan:
  - Compile a clear list of known hazards
  - Create a poster or pamphlet for therapists to display and review before each session
- Key takeaway: ethical responsibility extends beyond design — risks must be proactively communicated to clinicians and patients in real-world use

Lecture 10 - 04/08/26

NICOLAS MALDONADO - Apr 08, 2026, 1:38 PM CDT

Title: Engineering judgment

Date: 04/08/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Understand engineering judgment

Content:

Conclusions/action items:

Lecture 11 - 04/15/26

NICOLAS MALDONADO - Apr 28, 2026, 4:53 PM CDT

Title: Poster

Date: 04/15/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Knowing the expectations of a good final poster

Content:

Good Poster

- Polished formatting with cohesive color scheme
- Data presented visually (no raw tables or numbers)
- Concise text with minimal hanging bullets and blank space
- Analysis integrated into figures and captions

Bad Poster

- Poor or inconsistent formatting
- No visuals or images
- Missing citations
- Data analysis written out in prose instead of shown graphically

Conclusions/action items:

Lecture 12 - 04/22/26

NICOLAS MALDONADO - Apr 28, 2026, 4:54 PM CDT

Title: Poster 2

Date: 04/22/2026

Content by: Nicolas Maldonado

Present: N/A

Goals: Poster feedback

Content:

Analysis done on face-to-face --> forgot to print out the poster.

Conclusions/action items:

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

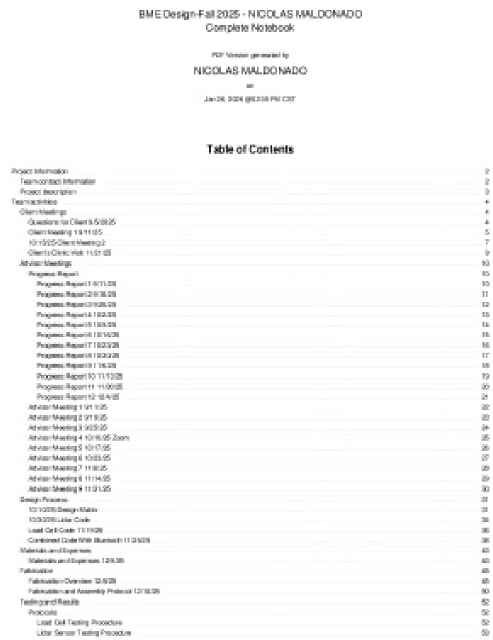
Goals:

Content:

Conclusions/action items:

BME Design-Fall 2025-notebook

NICOLAS MALDONADO - Jan 26, 2026, 2:48 PM CST



BME Design-Fall 2025 - NICOLAS MALDONADO
Complete Notebook

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Jan 26, 2026 @02:38 PM CST

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