BME Design-Spring 2025 - NOLAN BLOMWILLIS Complete Notebook

PDF Version generated by

James Waldenberger

on

Apr 30, 2025 @10:40 PM CDT

Table of Contents

Project Information	
Team contact Information	
Project description	
Team activities	
Client Meetings	
2025/1/24-1st Client Meeting	
2025/1/31-2nd Client Meeting	
2025/2/06-3rd client meeting	
2025/3/10-4th client meeting	
2025/4/21 WARF Meeting	
Advisor Meetings	
2025/1/24 - 1st Advisor Meeting	
2025/1/31 - 2nd Advisor Meeting	
2025/2/14-3rd advisor meeting	
2025/2/24-4th advisor meeting	
2025/2/28-5th advisor meeting	
2025/3/7- 6th advisor meeting	
2025/3/14- 7th advisor meeting	
2025/3/21- 8th advisor meeting	
2025/4/4 9th Advisor Meeting	
2025/4/11-10th advisor meeting	
2025/4/18-11th advisor meeting	
Design Process	
Block Diagrams	
Materials and Expenses	
Expenses Sheet	
Fabrication	
Fabrication Protocol	
Calibration Protocol & Equation	
Testing and Results	
Preliminary Tests/Results	
IR Strip Testing	
IR Wheel Pre-Fab Testing	
IR Strip Testing Data & Analysis	
Protocols	
Force Plate Testing Protocol	
Distance & Velocity Measurement Testing Protocol	
Experimentation/Results	
Force Plate Testing Data & Analysis	
Distance & Velocity Measurement Data & Analysis	
Project Files	
WARF Innovation Disclosure	
Executive Summary	
Product Design Specifications	
Preliminary Presentation	
Poster	48

Final Report	50
Nolan BlomWillis	
Research Notes	
Biology and Physiology	
2025/1/29-Walker Research	
Competing Designs	
2025/1/29-Competing designs	52
Prototype Work	
2025/1/30-Drill walker holes	53
2025/2/14-First iteration of wiring and load cell holders	54
2025/2/23-Load cell holder fabrication	55
2025/2/28-Load Cell Holder Fabrication	56
2025/3/4 - Load Cell Holder Design Meeting With Owen	58
2025/3/4 IR Testing	
2025/3/20-Load Cell Holder Iteration	
2025/4/18-Load cell holder calibration testing protocol	
Eva Schiltz	
Research Notes	
Standards	
2025/4/19- Walking Aid Standard	
Biology and Physiology	
2025/4/11- Neurorehabilitation Research	
2025/4/29 - Resources for introduction	
Competing Designs	
2025/4/12- Distance Measuring Walker Patent	
Design Ideas	
2025/1/30- Load Cell Holder Initial Testing	
2025/2/14 - Adjusted Solidworks Design	
2025/02/21- Load Cell Holder Final Print	
2025/02/28- Initial Load Cell Holder Assembly	
2025/03/07- Jesse Adjusted Load Cell Holder	
2025/3/14 - Plan for Load Cell Holders with New Budget	
2025/4/4 - Final Load Cell Holders and Fabrication	
2025/4/11- Walker Fabrication	
2025/4/22 - Walker Speed and Distance Testing	
2025/4/25 - Load Cell Holder Testing	
Jacob Parsons	
Research Notes	
Biology and Physiology	
2025/04/27 - Bio & Physiology	
Competing Designs	
2025/04/27 - Competing Designs	
Components	
2024/02/2 - Other speed measuring devices	
2024/02/12 - Wheel + Leg Dimensions	
Prototype Work	
2025/01/29 - adxl345 accelerometer work	
2025/02/5 - Hall Effect Beginning	
2025/02/6 - IR Sensor Beginning	
2025/02/12 - IR Strip Testing 2025/02/17 - IR Wheel Measurements for Fabrication	
2025/02/17 - IR Wheel pre-fab testing 2025/02/18 - IR Wheel Pre-Fab Testing Round 2	
2025/02/18 - IR Wheel Pie-Pab Testing Round 2 2024/02/19 - IR Wheel Fabrication	
2025/02/19 - IR Sampling	
2025/02/27 - IR Sampling 2025/03/02 - IR Updated Code Testing	
2025/03/02 - IR Opdated Code Testing 2025/03/04 - IR Testing	
2025/03/04 - IN Testing 2025/03/13 - Complete Code Iteration 1	
2025/03/17 - Final Electrical Testing	
2025/03/17 - Final Electrical & Power Testing	
2025/04/10 - Final Prototype Fabrication	
	110

2025/04/16 - Fabrication of Prototype	
2025/04/24 - Fabrication & Testing	
James Waldenberger	
Research Notes	
Competing Designs	
9/12/24 Previous Work	
9/12/24 Competing Designs	
Components	
9/19/24 Force Sensors	
9/19/24 Movement Sensor	
9/26/24 Specific Sensors	
11/7/24 Voltage Regulators	
1/30/25 Power Supply and Regulation	
Design Process	
9/12/24 Preliminary Design Ideas	
10/16/24 Load Sensor Circuit	
10/24/24 Load Testing	
11/7/24 Power Supply	
11/7/24 Altium Schematic [Full Circuit]	
11/19/24 Load Sensor Calibration For Poster Presentation	
2/13/25 Power Supply and Regulation Integration	
2/21/25 Power Supply Fix	
2/25/25 Full Circuit Test	
3/6/25 Proto Board	
3/13/25 Final Soldering	
3/20/25 Proto Board Testing	
4/9/25 Load Cell Holder Assembly 4/10/25 Full Walker Assembly - IR and Screens	
4/10/25 Full Walker Assembly - Wires	
4/16/25 Full Walker Assembly - Protoboard	
4/16/25 Calibration	
4/21/25 IR Issue Resolving	
4/22/25 Load Cell Issue Resolving	
4/22/25 IR Testing	
4/23/25 Load Cell Recalibration	
4/23/25 Load Force Plate Testing	
Owen Kolnik	
Research Notes	
Biology and Physiology	
2025/2/6-SLA&AnisotropicMaterialBehavior	
Competing Designs	
2025/4/30-Walker Patent	
Design Ideas	
2025/1/25-Electrical Housing V1	
2025/2/03-Electrical Housing Version 2	
2025/2/12-Walker Leg Angle Measurements	
2025/2/12-ScreenHolderPiece	
2025/2/21 - Protoboard and Switch	
2025/2/21 - First IRL Assemby	
2025/2/28-System Block Diagram V1	
2025/3/4 - Load Cell Holder Design Meeting	
2025/3/4 - IR Sensor Testing	
2025/3/6 - NO ROTATION OF THE LEGS OF THE WALKER	
2025/3/6 - Initial Design Component List	
2025/3/6 - IR Sensor Holder V1 2025/3/7 - IR Sensor Holder V2	
2025/3/15-Load Cell Holder Updates 2025/3/15-Final Load Cell Holder Design	
2025/3/15-Final Load Cell Holder Design 2025/3/15-IR Sensor Holder V4	
2025/3/15-Wire Conduit Design	
2025/3/15-Final Screen Holder Design	
	E07

Fabrication & Testing	209
2025/2/26-Fabrication - Part 1	
2025/4/2-Final Load Cell Holder Fabriation and Leg Connection	
2025/4/9-Wiring Fabrication	
2025/4/17-Load Calibration	
2025/4/25-Plateform Fabrication	
2025/4/22-IR sensor code	
2025/4/23-Distance and Speed Testing	
2025/4/25-Load Testing	
2025/4/25-Final Code	
Misc.	
2025/2/24 - PICK JOURNAL	
2014/11/03-Entry guidelines	
2014/11/03-Template	



Jacob Parsons - Jan 29, 2025, 2:48 PM CST

Last Name	First Name	Role	E-mail	Phone	Office Room/Building
Nimunkar	Amit	Advisor	ajnimunkar@wisc.edu	N/A	ECB 1226
Kutschera	Dan	Client	kutschera@att.net	N/A	N/A
Kolnik	Owen	Leader	okolnik@wisc.edu	608-716-1701	N/A
BlomWillis	Nolan	Communicator	blomwillis@wisc.edu	920-287-1468	N/A
Schiltz	Eva	BSAC	emschiltz@wisc.edu	612-513-2314	N/A
Waldenberger	James	BWIG	jwaldenberge@wisc.edu	262-229-1557	N/A
Parsons	Jacob	BPAG	jcparsons@wisc.edu	262-232-5907	N/A



Jacob Parsons - Jan 29, 2025, 2:52 PM CST

Course Number: BME 402

Project Name: Smart Walker

Short Name: Smart Walker

Project description/problem statement:

In the rehabilitation process of acute strokes (or similar conditions), it is necessary for the patient to be able to walk independently so they can safely return home. Our team must design a device that works in conjunction with a standard walker that will measure the speed and distance the patient walks and the force applied to the walker.

About the client:

Our client is a physical therapist that works at a facility that deals with rehabilitation for acute strokes.



NOLAN BLOMWILLIS - Apr 28, 2025, 2:09 PM CDT

Title: 1st Client Meeting

Date: 9/12/24

Content by: Jacob Parsons

Present: Whole team

Goals: Gather an understanding of the project and client expectations

Content:

- See attachment below

Conclusions/action items:

The team will make a PDS with the information provided. The team will also begin conducting research on the sensors to be used and some background information besides what the client provided for us.

NOLAN BLOMWILLIS - Apr 28, 2025, 2:09 PM CDT

· Your thoughts on the previous semester's project, what went well? What didn't go well? Want semathing to use in the dinic
 Wires waren't in the tubing, glitchy, didn't quite gat the speed or distance done well • Foursed allot on pressure put through the walker Work in neuro rehabilitinic, acute strake hospital
 Standard walker with wheels, insurance companies are looking for a lot of Sumara to ware with reside, insources compares and several give a rot or
 electronic data programsion
 "Safe trainer", S5000, measures pressure, distance walked, deen't do speed, net
 functional or uscable for a patient:
 2 wheel walker as an assessment tool for the patient. a 2 wheele wake as an assessment tool for the part out.
between the wave and the part of Even y, normal reserve two is entited and on the set of the even of the county:
 Could we design our over? Or use evel thing
 Walker will be used every day, multiple times a day:LDS of use
 Are there any other measurements you used ble collected besides speed, distance and pressure? Make sure units are converted to "understandable values", customary system Height and quicking?
 Make sure to purchase a walker that is adjustable for patients of different sizes. • Weight limit? Walker should be able to withstand patient, this will be point of failure SkeLimit? Do ean't obstruct walking path • Live feedback? o Yes Display on walker for the patient? Distruction or motivation Budget?
 Eat him know, he can purch setherwalker S200 / S300
 Allow for whatever is viable

Download

Questions_to_Ask.pdf (35.1 kB)

NOLAN BLOMWILLIS - Apr 28, 2025, 2:08 PM CDT

Title: Client Meeting

Date: 1/31/25

Content by: Nolan

Present: Nolan

Goals: Update Client on progress as well as hear from client on other tools and the importance of what we are creating

Content:

-Client says the walker only needs to read in one direction, no need to worry about speeds during a turn.

-Happy with the direction the project is going in especially with the real time display

-Appreciates the start button for each trial

-Wants to make sure the wires are not a distraction was a point again made clear

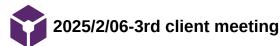
-Got to see the gait trainer, problem is it does not track speed just distance and is far from a real walker

-Long walks they will do will be roughly 100 feet is their final test

-Hopes to get the full team there for some media and testing

Conclusions/action items:

Continue to work forward on our prototype.



NOLAN BLOMWILLIS - Apr 30, 2025, 2:06 PM CDT

Title: Client Meeting

Date: 2/6/25

Content by: Nolan

Present: Nolan

Goals: Ask client about design requirements and make sure cuts can be made

Content:

-Client says that cuts will be fine to make

-Happy to hear that load cell testing works

-Wants to get full team out at the end for photo op

Conclusions/action items:

Continue to work forward on our prototype and make cuts



NOLAN BLOMWILLIS - Apr 30, 2025, 2:08 PM CDT

Title: Client Meeting

Date: 3/10/25

Content by: Nolan

Present: Nolan

Goals: Ask client about design requirements and make sure cuts can be made

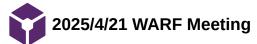
Content:

-Client says that extra budget is okay

-Excited to see final prototype

Conclusions/action items:

Purchase new walker and get going on fabrication



Jacob Parsons - Apr 29, 2025, 9:55 AM CDT

Title: WARF Meeting

Date: 4/21/25

Content by: Team

Present: Team

Goals: To provide more of an explanation to the WARF team what our product is.

Content:

- See PDF below

Conclusions/action items:

- Wait until May 16th to hear back from WARF

Jacob Parsons - Apr 29, 2025, 9:54 AM CDT

My 15h is when we will have back from them.
My 15h is when we will have back from them.
My 15h is when we will have back them.
My 15h is when we will have back them.
My 15h is when is a patient alternative the mail measure.
My 15h is a state of them have the mail have back to patient them.
My 15h is a state of them have them we have any them of the mail to a patient alternative them.
My 15h is a state of them have the mail to a docada to be them to the mail to a docada to be them to the mail to the mail to a docada to be them.
My 15h is a state of them have the mail to a docada to be them to the mail to a docada to be them.
My 15h is a state of them them have the back to be a state to patient them have them to a docada to be them.
My 15h is a state of the mail to the state the to be a state to patient the wolf them.
My 15h is a state will be mail to the state the to be a state to first states and them to the state to the states in flat and to the states in flat and to the states in flat and to the states in the mail to the states in the states in the states in the

Download

4_21_WARF_Meeting.pdf (48.3 kB)



James Waldenberger - Jan 29, 2025, 2:44 PM CST

Title: 1st Advisor Meeting

Date: 1/24/25

Content by: Nolan BlomWillis

Present: Full Team

Goals: Recap where we left off and get plans for the coming week

Content:

Jacob - Going to look at PCB board, as well as accelerometer

James - Working on power supply

Eva - Working on load cell holders

Owen - Working on circuit/main box

Nolan- Work on load cell holder testing, Reach out to contact regarding testing at the site

Conclusions/action items:

Look at content assignments

2025/1/31 - 2nd Advisor Meeting

Title: 1st Advisor Meeting

Date: 1/31/25

Content by: Nolan BlomWillis

Present: Full Team

Goals: Recap where we left off and get plans for the coming week

Content:

Jacob - Accelerometer was still wonky, might do an accelerometer with a gyroscope on it but will work on hall effect sensor in the meantime, Nimunkar speaks about laser based distance measurements

James - Worked on power supply, showing nimunkar different power supplies,

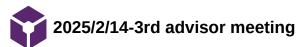
Eva - Working on load cell holders testing with Nolan and was a big flop, going to print off four holders

Owen - Worked on box build, sent an email to

Nolan- Worked on load cell holder testing with Eva, big flop, going to wait for the 4 prints and then attach the four, add wires to the load cells, and then wire through the walker

Conclusions/action items:

Look at content assignments



NOLAN BLOMWILLIS - Feb 14, 2025, 3:09 PM CST

Title:

Date: 2/14/25

Content by: Nolan BlomWillis

Present: Full Team

Goals: Recap where we left off and get plans for the coming week

Content:

Jacob - Worked with the IR sensor to get baseline testing done to get a proof of concept

James - Worked on power supply, asked Nimunkar for advice regarding

Eva - Working on load cell holders new iteration as well as adjusting to avoid shear stress.

Owen - Worked on housing and ordered parts to attach housing to.

Nolan- Worked with Eva and Owen on load cell holders to discuss new iteration

Conclusions/action items:

Owen-Print housing and holders for housing

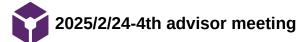
Eva-Get the holders printed

Nolan-Get protocols written up, and work on fabrication on Tuesday for the load cell holders

Jacob-Do larger scale testing for IR and start working on tying the electronic apartments together

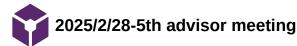
James-Figure out power supply

Look at protoboard



NOLAN BLOMWILLIS - Feb 24, 2025, 12:05 PM CST

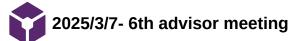
Title: 4th advisor meeting Date: 2/24/25 Content by: Nolan BlomWillis Present: Full Team Goals: Recap where we left off and get plans for the coming week Content: Jacob - Worked on IR sensor and implemented into the wheel. James - Set up voltage regulation, did some diagnosing of errors with Jacob for the load cell circuit. Setup screens and IR sensors. Eva - Printed four new load cell holders for next fabrication step Owen - Attached the display box and the electrical housing Nolan- Formulated the load cell holder fabrication protocol, is working on fabrication/drilling at 4pm Conclusions/action items: Owen-Reprint bottom plate, put heat inserts into new load cell holders, Eva-Get the holders printed Nolan-Figure out weight change of walker with all components, do drilling of holes for load cell holders Jacob-Do larger scale testing for IR and start working on tying the electronic apartments together James-Figure out power supply Look at protoboard One column report needed to be completed



16 of 233

Title: 5th advisor meeting Date: 2/28/25 Content by: Nolan BlomWillis Present: Full Team Goals: Recap where we left off and get plans for the coming week Content: Jacob - Worked on IR sensor and implemented into the wheel. James - Worked on power supply Eva - Helped with load cell holder fabrication Owen - Helped with load cell fabrication Nolan- Worked on fabrication of load cell holder Conclusions/action items: Owen-Work on load cell holders Eva-Work on load cell holders Nolan-Work towards figuring out what to do to stop x axis shifting. Jacob-Do larger scale testing for IR and start working on tying the electronic apartments together James-Figure out power supply and protoboard Look at protoboard

One column report needed to be completed



EVA SCHILTZ - Mar 07, 2025, 1:07 PM CST

Title: 6th Advisor Meeting

Date: 3/7/25

Content by: Eva

Present: Whole Team

Goals: To update the advisor on the previous weeks progress and issues.

Content:

New load cell holder design:

- make constraints tighter by using more of a vertical design
- currently trying to salvage this design

Horizontal cross bar

- curved to prevent interference with walker
- prevent independent wobble but legs will still move together

IR sensor securement

- replace ziptie with 3D printed design

IR sensor testing

- 16 trials mimicking actual rehab conditions
- 0.23% error
- low error even at faster speeds (2.5 mph)
- 1 mph average
- used from distance measurement, still have to program velocity code

Screens

- One broke

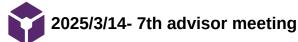
- Plan on ordering another

Protoboard

- Need header for the op amp
- Soldering planning done
- Different protoboard with rail for ground

Conclusions/action items:

Carry out individual action items and contact client regarding budget.



Title: 7th advisor meeting

Date: 3/14/2025

Content by: Eva

Present: Eva, Owen, Jacob, James

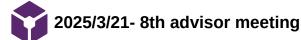
Goals: To discuss with the advisor new design project updates.

Content:

- Cut new hole in box Nimunkar recommends cutting the box not drilling
- Progress on new load cell holder design better length to radius ratio print Monday?
- Coding for full circuit testing later today
- Final check in with the client to determine metrics displayed
- Protoboard made connectors which allow individual components and boards to be disconnected modular

Conclusions/action items:

Keep making progress on design. Have advisor meeting next week on friday.



NOLAN BLOMWILLIS - Apr 04, 2025, 12:40 PM CDT

Title: 8th advisor meeting

Date: 3/20/2025 Content by: Nolan BlomWillis Present: Full Team Goals: Recap where we left off and get plans for the coming week Content: Jacob - Worked on Protoboard James - Worked on Protoboard Eva - Helped with load cell holder fabrication Owen - Helped with load cell fabrication Nolan- Worked on fabrication of load cell holder Conclusions/action items: Owen-Work on load cell holders Eva-Work on load cell holders Nolan-Work on new drill holes on the walker Jacob-Do larger scale testing for IR and start working on tying the electronic apartments together James-Figure out power supply and protoboard Fill out WARF



Title: 9th advisor meeting

Date: 4/04/2025

Content by: Nolan BlomWillis

Present: Full Team

Goals: Recap where we left off and get plans for the coming week

Content:

Made cuts on new walker

Jacob - IR sensor hole alignment, executive summary

James - Executive summary, protoboard

Eva - Helped with load cell holder fabrication

Owen - Helped with load cell fabrication

Nolan- Worked on fabrication of load cell holder

Conclusions/action items:

Owen-Drill new holes

Eva-Drill new holes

Nolan-Drill new holes

Jacob-Do larger scale testing for IR and start working on tying the electronic apartments together

James-Figure out power supply and protoboard



Title: 10th advisor meeting

Date: 4/11/2025

Content by: Nolan BlomWillis

Present: Full Team

Goals: Recap where we left off and get plans for the coming week

Content:

Combined all components and ran wires through

Jacob - Worked on wiring

James - Worked on wiring

Eva - Worked on wiring

Owen - Drilled holes for walker, printed new walkers

Nolan- Worked on wiring

Conclusions/action items:

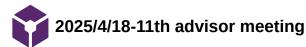
Owen-Complete fabrication, fix wire bunching issue

Eva-Complete Fabrication, fix wire bunching issue

Nolan-Complete Fabrication, fix wire bunching issue

Jacob-Complete Fabrication, fix wire bunching issue

James-Complete Fabrication, fix wire bunching issue



NOLAN BLOMWILLIS - Apr 18, 2025, 12:36 PM CDT

Title: 11th advisor meeting

Date: 4/18/2025

Content by: Nolan BlomWillis

Present: Full Team

Goals: Recap where we left off and get plans for the coming week

Content:

Combined all components and ran wires through

Jacob - Put it all together and got calibration curve for load cells James - Put it all together and got calibration curve for load cells Eva -Put it all together and got calibration curve for load cells Owen - Put it all together and got calibration curve for load cells Nolan- Put it all together and got calibration curve for load cells **Conclusions/action items:** Owen-Complete Testing work on poster presentation

Eva-Complete Testing work on poster presentation

Nolan-Complete Testing work on poster presentation

Jacob-Complete Testing work on poster presentation

James-Complete Testing work on poster presentation



Jacob Parsons - Apr 29, 2025, 1:31 PM CDT

Title: Block Diagram

Date: 4/29/25

Content by: Team

Present: Team

Goals: To layout the complete system in a block diagram

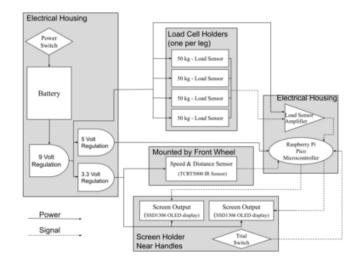
Content:

- See image attached below

Conclusions/action items:

N/A

Jacob Parsons - Apr 29, 2025, 1:30 PM CDT



Download

Component_Systems_Diagram_4_23_For_Report.png (95.4 kB)



Jacob Parsons - Apr 30, 2025, 3:23 PM CDT

Title: Expenses Sheet

Date: 4/30/25

Content by: Team

Present: Team

Goals: To lay out the expenses of the product

Content:

- See attachment below

Conclusions/action items:

- Obtain reimbursement from client

Jacob Parsons - Apr 30, 2025, 3:22 PM CDT



Download

Purchases.xlsx (11.8 kB)

Title: Fabrication Protocol

Date: 4/30/25

Content by: Owen Kolnik & James Waldenberger

Present: Group

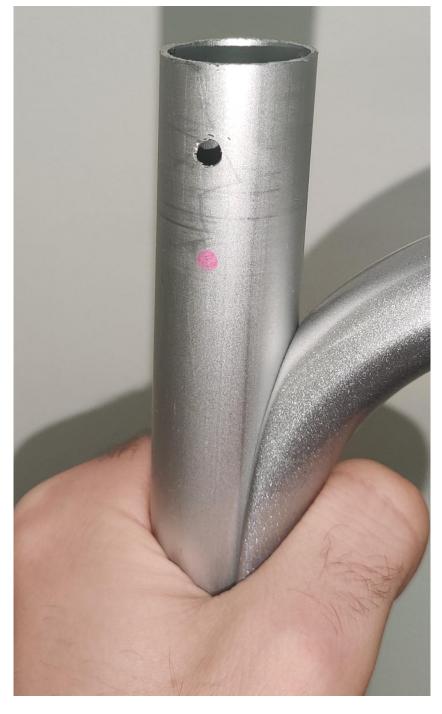
Goals: Create a protocol to outline fabrication methods used in the smart walker to fully document the processes used by the group, and ensure replicability of our design process.

Content:

Fabrication and Assembly Protocol

Load Sensor Holder Attachment

- 1. To introduce load sensing capabilities to a standard walker frame, load sensors must be integrated into all four legs.
- 2. Thus perpendicular cuts were made, using a level and a hand saw, in each of the four legs.
- 3. Subsequently, a standard rotary tool was used to smooth out the cuts and remove sharp edges.
- 4. Next, the front and rear load sensor holders were designed in SolidWorks, and then printed out of PLA using a standard FDM Bambu Labs 3D printer.
- 5. These holders were then attached to the walker frame, and marks were made through each holder component's bolt holes and onto the walker frame.
- 6. The holders were then removed from the frame.
- 7. These markings were used to accurately position a hand drill using a 0.149" drill bit to drill bolt holes into the frame (pictured below).
- 8. Then the top and bottom holders were reattached and secured to the frame using a 1 ½ "#6 bolt and nut (pictured below).





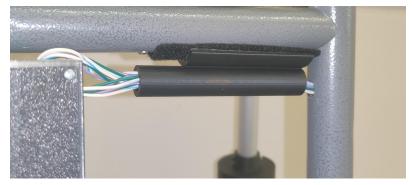
Mounting the Electrical Housing

- 1. The electrical housing must be centered and forward on the walker frame to ensure the device remains balanced.
- 2. Thus, rubber pipe clamps were used along with nuts and bolts to mount the electrical housing to both crossbars.
 - 1. A 1" diameter pipe clamp and a 2" long, ¼" diameter bolt were used to secure the housing to the top crossbar.
 - 2. Two ½" diameter pipe clamps were used to secure the housing to the bottom crossbar along with 1" long, ¼" diameter bolts.
- 3. The housing was then positioned centrally, and nuts were used to secure the clamps to the housing (pictured below).



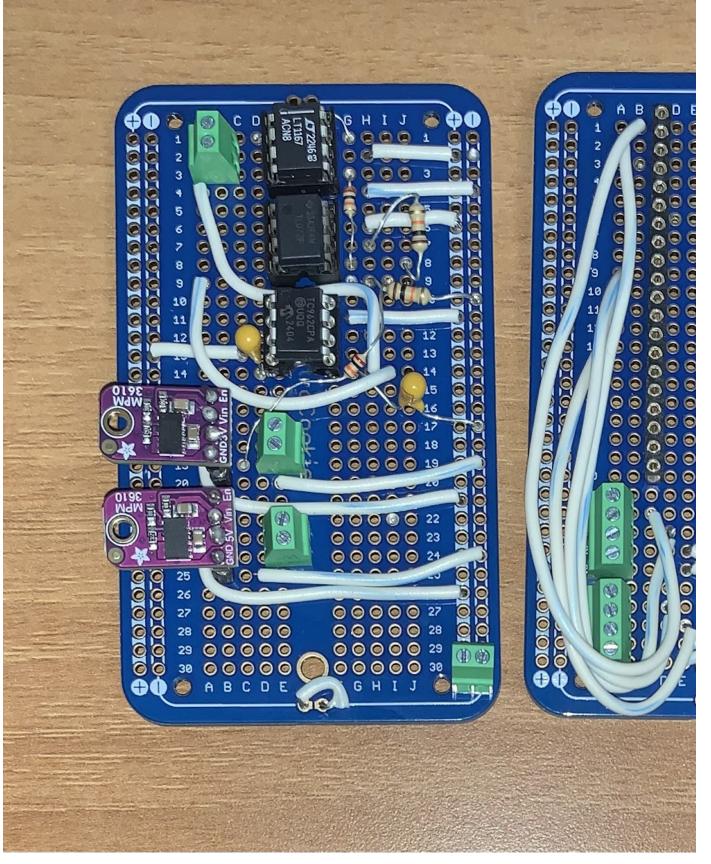
Wiring the Walker Frame

- 1. Most wiring is required to pass through the walker frame to ensure that no wires interfere with the patient's gait.
- 2. Thus, using 3%" drill bit and hand drill, holes were made in the walker's two front legs just below the top crossbar.
- 3. With the load sensor holders off, a guide wire attached to a weight was dropped down these holes and out through the legs where the perpendicular cu
- 4. This guide wire was then tied in a loop to ensure it was not pulled out of the walker tubing.
- 5. 22-gauge wire, for the load sensors and OLED displays, was then attached to the guide wire and pulled through the walker frame.
- 6. The wiring exiting the hole near the top crossbar was then passed through a wire conduit for support before entering the electrical housing (pictured be



Soldering of Electrical Components

- 1. Soldering of electrical components is done on two 3.5" by 2.05" breadboards using a soldering iron and solder material.
- 2. Large components are placed first, leaving open pins around them to make connections
 - 1. Large components are not soldered directly to breadboards.
 - 1. For amps, 8-pin headers were soldered to the board.
 - 2. For regulators, 4-pin headers were soldered to the board.
 - 3. For the Raspberry Pi Pico, four 10-pin headers were soldered to the board, forming two rows of 20 pins.
- 3. Connections between components on each breadboard are made using 22 gauge wire soldered directly onto the board.
 - 1. For wires traveling to sensors/circuitry not contained by a breadboard, screwable wire connectors were soldered in their stead.
 - 2. Resistors and capacitors were soldered directly to the boards
- 4. Ensure that ground connections are made across rails within each breadboard, and between the breadboards.
- 5. For reference to specific connections, see below.



Attachment and Positioning of the IR Sensors

1. In order to secure and ensure proper positioning of the Infrared (IR) sensor, concentric bolt holes and a larger viewing hole were drilled into the walker t

2. The IR sensor was then soldered to three wires.

- 3. The front right leg was removed and the sensor, along with the wires, was run down the leg towards the wheel.
- 4. A 1.5" long, 1/16" diameter bolt was passed through the previously mentioned bolt holes and through the IR sensors circuit board within the tubing, secur

Team activities/Fabrication/Fabrication Protocol

- 5. The emitter and receiver portions of the sensor were then pushed forward along this bolt so that they peeked out of the walker frame through the viewir
- 6. This positioned the emitter and receiver toward the marked wheel for proper measurement.
- 7. The IR sensor holder was then mounted to the main wheel bolt, and then the cross support of the holder was run underneath the emitter and receiver below).
- 8. Then the IR's wires were pulled out of the bottom adjustment pin hole to enable them to travel to the upper wire conduits outside the tubing.



Attachment and Positioning of the Load Sensors

- 1. Each strain gauge wire was run from the inside of the top holder and out through the top wire hole to ensure the sensor's wires passed into the frame.
- 2. These wires were then soldered to the 22-gauge wires that had already been run through the walker's frame for this purpose.
- 3. Then the sensors were positioned in the top face of the bottom load sensor holder component in the cut out.
- 4. The top and bottom components, with the load sensor properly placed, were then connected concentrically.
- 5. Then a c-ring was screwed into the bottom face of the top load sensor holder component to ensure the top and bottom components were unable to veri



Attachment and Positioning of the OLED Displays and Trial Switch

- 1. To avoid loose wires by the handles, a hole was drilled into the walker's tubing, forward of the handle pads on the left side.
- 2. Wiring exiting this hole was then soldered to the trial switch and OLED displays while these components were positioned within the screen holder.
- 3. Using a 1" pipe clamp and a ½" diameter bolt, the screen holder was mounted just forward of the left handle (pictured below).



Conclusions/action items:

Use this protocol if there is a need to make a duplicate smart walker, or to iterate on the smart walker design.



James Waldenberger - Apr 30, 2025, 8:33 PM CDT

Title: Calibration Protocol & Equation

Date: 4/18/2025

Content by: Nolan BlomWillis

Present: Full team

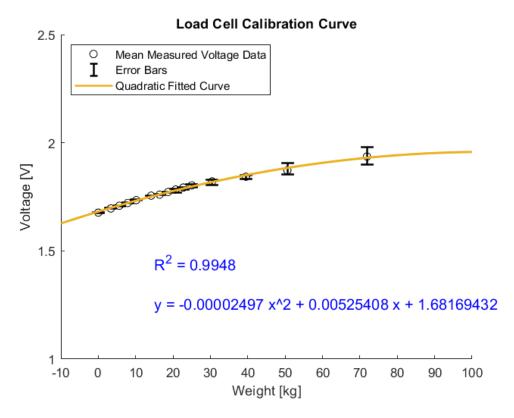
Goals: Get a calibration protocol written up for calibration

Content:

Load Sensor Calibration Procedure:

- 1. Measure weight of wood planks
- 2. Have nothing resting on walker
- 3. Press switch on walker to start run for values
- 4. Leave switch on for 5 seconds
- 5. Collect value outputted on screen in spreadsheet
- 6. Repeat steps 2-3 two more times for a total of 3 runs
- 7. Place planks across the walker and do steps 3-5 again 3 times.
- 8. Place 5lbs and do steps 3-5 ten times.
- 9. Continue by adding 5lbs on for the most precision.
- 10. Create a scatter plot of data points with weight on the x-axis and voltages on the y-axis.
- 11. Apply a quadratic polynomial fit to determine the equation of the line of best fit.
- 12. Upload this equation to the microcontroller to calculate applied load.





Curve used in final calibration of smart walker, equation shown on plot.

Raw data is attached below.

Conclusions/action items:

Complete calibration and update code into microcontroller

Jacob Parsons - Apr 30, 2025, 8:31 PM CDT

Download

cal2.xlsx (19.3 kB)



Jacob Parsons - Feb 12, 2025, 10:54 PM CST

Title: IR Strip Testing

Date: 2/12/25

Content by: Jacob Parsons

Present: Jacob

Goals: To set up the beginning testing for the IR sensor to evaluate its accuracy

Content:

- The content below sets up the IR testing

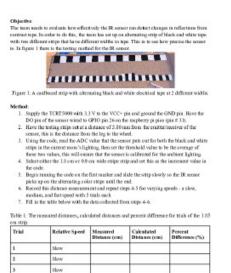
Conclusions/action items:

- The future steps are to conduct this testing for the current strips, and potentially make other testing strips

- Do additional math to see what increments can be used for the wheel (using rotational velocity and sampling frequency at 5.8 mm)

- Finally, we will need to compare this testing with the other speed sensor testing.

Jacob Parsons - Apr 29, 2025, 9:56 AM CDT



Download

Medius

IR_Preliminary_Testing_Protocol_2_.pdf (687 kB)



James Waldenberger - Apr 29, 2025, 9:53 AM CDT

Title: IR Wheel Pre-Fab Testing

Date: 2/17/25

Content by: Jacob Parsons

Present: Jacob Parsons

Goals: Establish preliminary testing with the tape on the wheel

Content:

- See PDF below

Conclusions/action items:

- Conduct testing

Jacob Parsons - Feb 17, 2025, 8:19 PM CST

Objective The same whites to see if the fully fabricated plane are a viable option to use the IR sensor with. In order to do this, the same has taped 10 black and 10 white places of tape along the trins of the wheat.



Figure 1: The inside of the walker wheel with 20 (10 of each) alternating colored taped strips

- Berghy the TCRT5000 with 3.3 V to the VCC+ pin and growned the GND pin. Have the DO pin of the sensor versal to GPIO pin 26 on the nepherry replace (gin # 21).
 There the uning write out at a dirace of 10 run from the enrithmenery of the sensor, the is the disconstruction to the sensor pin out for both the black and white setting in the energy of the ADC value that the sensor pin out for both the black and white setting in the energy of the ADC value that the sensor pin out for both the black and white setting in the energy of the first first setting the energy of these two values, this will besize that the sensor is calibrated for the anther Kighting.
 Set 2 can be increment and will be observed in the both the black and white setting in reacting the code on the fiber ranker and rester the whead runking energy to rank the setting interaction. For one fill movel its.
 Requesting the 6 for revolutions of 2 and 3.
 Requesting the 6 for revolutions of 2 and 1.
 Requesting the 6 for revolution of 2 and 1.
 Requesting the 6 for revolution of 2 and 1.
 Requesting the 6 for revolution of 2 and 1.

Table 1: The measured distances, calculated distances and percent difference

Trial	Measured Distance (cm)	Calculated Distance (cm)	Percent Difference
1			
2			
3			
4	- 8		

Download

IR_Pre-Fab_Wheel_Testing_Protocol_1_.pdf (635 kB)



Jacob Parsons - Apr 29, 2025, 10:02 AM CDT

Title: IR strip testing data & analysis

Date: 2/13/25

Content by: Team

Present: Jacob

Goals: To establish that the IR testing is feasible

Content:

- See PDF below

Conclusions/action items:

- The percent error decreases as the distance you measure (total length) increases this will be good for us
- If we are off by 1-3 cm for a 100 meter/yard trial that is MINIMAL error
- Conduct testing when this strip is applied to a wheel.

Jacob Parsons - Apr 29, 2025, 9:59 AM CDT

	lative Speed Measure Distance		
8	rw 33.6	31.45	6.61
5	rw 33,6	31.45	6.61
5	nv 33.6	31.45	0.61
3	diun 33.6	31.45	6.61
2	dian 33.6	31.45	6.61
3	stium 33.6	31.45	6.61
7	d 33.6	31.45	6.61
F	a 11.6	31.45	6.61
F	at 33.6	31.45	6.61
Average:	33.6	31.45	0.61
F	a 11.6 a 33.6	31.45 31.45	6.61

	Distance (cm)	Distance (cm)	Difference (%)
šlow	34.4	18	62.6
šlow	34.4	28.8	17.7
ilaw	34.4	45.6	34.2
dediam	34.4	18	62.6
detium	34.4	19.5	53.9
distinuis	34.4	16.2	71.9
Fest	34.4	7.2	130.1
fast	34.4	3.6	162.1
Past	34.4	12.6	92.8
fast	34.4	3.6	162.1

Download

IR_Preliminary_Testing_Results.pdf (88.8 kB)

Force Plate Testing Protocol

James Waldenberger - Apr 30, 2025, 7:51 PM CDT

Title: Force Plate Testing Protocol

Date: 4/24/25

Content by: Owen Kolnik

Present: Group

Goals: Outline a protocol to test walker weight measurement capabilities against force plate data.

Content:

Average and Instantaneous Load Testing Protocol

- 1. Place the walker device securely on top of in-ground force plates.
- 2. Ensure both systems (walker and force plates) are capable of recording synchronized time-series data.
- 3. Instruct a subject to apply load to the walker handles in a natural steady motion.
- 4. Ensure minimal movement of the walker during loading to reduce dynamic artifacts.
- 5. Recording the instantaneous load data from the in-ground force plates.
- 6. Simultaneously, record instantaneous load data from the walker device.
- 7. Ensure that the recording windows are synchronized due to the different sampling rates.
- 8. Plot the following instantaneous load vs. time for both measurement modalities:
 - 1. Force-plate readings.
 - 2. Walker device readings.
- 9. Identify the time window during which load was consistently applied.
- 10. Compute the average load over this interval:
 - 1. For the in-ground force plates.
 - 2. For the walker device.

11. Compare the average values and overlay plots to assess accuracy, consistency, and potential lag or deviation.

Conclusions/action items:

Use outlined protocol for testing to determine error in weight measurement by the smart walker.



Title: Distance & Velocity Measurement Testing Protocol

Date: 4/23/25

Content by: Owen Kolnik

Present: Group

Goals: Outline protocols to test the smart walker's ability to measure distance and velocity over a trial, as well as instantaneous velocity during a trial.

Content:

Average Distance and Velocity Testing Protocol

- 1. In a long, straight hallway, mark three distances from a common starting line:
 - 1. 15.24 meters (50 feet)
 - 2. 30.48 meters (100 feet)
 - 3. 45.72 meters (150 feet)
- 2. Place the walker behind the starting line.
- 3. Begin recording the time as the subject starts walking.
- 4. Push the walker in a straight line at a consistent pace (as specified below).
- 5. Stop timing when the front wheels of the walker cross the end mark.
- 6. Repeat steps 2-5 three times for each marked distance (15.24 m, 30.48 m, or 45.72 m).
- 7. At three target walking speeds (9 trials per distance, for a total of 27 trials):
 - 1. ~0.33 m/s
 - 2. ~0.66 m/s
 - 3. ~1.00 m/s
- 8. Record the known distance traveled based on floor markings.
- 9. Record the measured time for each trial.
- 10. Calculate the expected average velocity by taking distance divided by time.

Average Velocity = Distance/Time (3)

11. Compare calculated values to the device's measured velocity and distance.

Instantaneous Velocity Testing Protocol

- 1. In a long, straight hallway, mark three distances from a common starting line:
 - 1. 3.048 meters (10ft)
 - 2. 6.096 meters (20ft)
 - 3. 9.144 meters (30ft)
- 2. Place the walker behind the starting line.
- 3. Begin timing as the subject starts walking.

Team activities/Testing and Results/Protocols/Distance & Velocity Measurement Testing Protocol

4. Push the walker past all three markers at a consistent pace.

5. At each marker:

- 1. Record the time elapsed at each marker (i.e., time since the previous marker).
- 2. Record the instantaneous velocity displayed by the device.

6. Upon reaching the 9.144 m (30 ft) mark:

- 1. Stop pushing the walker
- 2. Record the final elapsed time since the previous marker.
- 7. Repeat steps 2-6 three times for the 30ft path at each of the following target speeds (9 total trials):
 - 1. ~0.33 m/s (slow)
 - 2. ~0.66 m/s (moderate)
 - 3. ~1.00 m/s (fast)
- 8. For each interval (0-10 ft, 10-20 ft, 20-30 ft):
 - 1. Calculate the instantaneous velocity (expected velocity):

v = Distance Interval/Elapsed Time for Interval (4)

9. Compare each expected velocity to the corresponding device-reported instantaneous velocity.

Conclusions/action items:

Apply protocol to test distance and velocity measurement capability by the smart walker.



James Waldenberger - Apr 30, 2025, 8:27 PM CDT

Title: Force Plate Testing Data & Analysis

Date: 4/30/25

Content by: Team

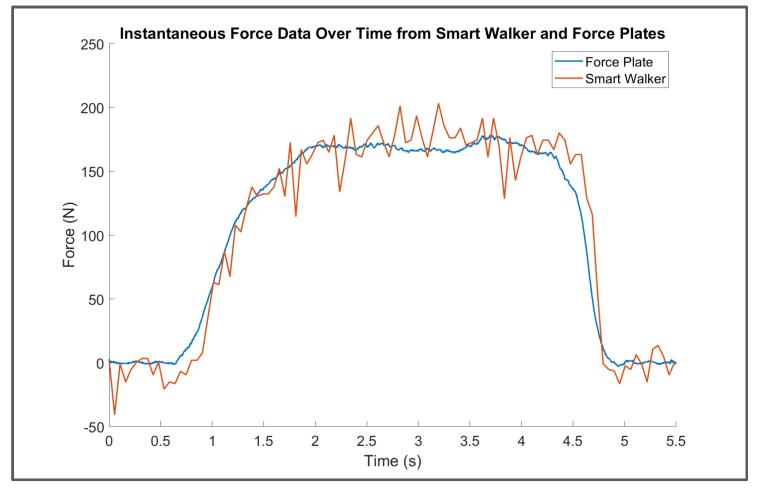
Present: Group

Goals: Provide a place to display force plate testing data, and outline our analysis methods to figure out error.

Content:

- See attached raw data below

- Average percent error from each trial was calculated between the load cell and Smart Walker measurements when force was applied



- This is 1 trial's overlay of the Smart Walker measured force (orange) and force plate (blue)

Conclusions/action items:

- Use this data to verify the validity of the prototype

- As seen, there is a lot of noise in the Smart Walker measured forces.



Download

Jacob Parsons - Apr 30, 2025, 8:09 PM CDT

⁻ Average % error across every trial was 2.43%

Team activities/Testing and Results/Experimentation/Results/Force Plate Testing Data & Analysis

eval.csv (862 B) 10 trials of data taken from Smart Walker

Jacob Parsons - Apr 30, 2025, 8:09 PM CDT



eva2.csv (1.02 kB) 10 trials of data taken from Smart Walker

Jacob Parsons - Apr 30, 2025, 8:09 PM CDT



<u>Download</u>

eva3.csv (1.13 kB) 10 trials of data taken from Smart Walker

Jacob Parsons - Apr 30, 2025, 8:09 PM CDT



<u>Download</u>

eva4.csv (1.15 kB) 10 trials of data taken from Smart Walker

Jacob Parsons - Apr 30, 2025, 8:09 PM CDT



Download

eva5.csv (1.03 kB) 10 trials of data taken from Smart Walker

Jacob Parsons - Apr 30, 2025, 8:09 PM CDT



Download

james1.csv (1.43 kB) 10 trials of data taken from Smart Walker

Jacob Parsons - Apr 30, 2025, 8:09 PM CDT



<u>Download</u>

James2.csv (1.02 kB) 10 trials of data taken from Smart Walker

Jacob Parsons - Apr 30, 2025, 8:09 PM CDT



<u>Download</u>

james3.csv (986 B) 10 trials of data taken from Smart Walker



Download

james4.csv (1.14 kB) 10 trials of data taken from Smart Walker

Jacob Parsons - Apr 30, 2025, 8:09 PM CDT



<u>Download</u>

james5.csv (774 B) 10 trials of data taken from Smart Walker

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



Download

eval.csv (862 B) 10 trials of data taken from floor integrated load cells

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



Download

eva2.csv (1.02 kB) 10 trials of data taken from floor integrated load cells

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



Download

eva3.csv (1.13 kB) 10 trials of data taken from floor integrated load cells

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



Download

eva4.csv (1.15 kB) 10 trials of data taken from floor integrated load cells

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



<u>Download</u>

eva5.csv (1.03 kB) 10 trials of data taken from floor integrated load cells

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



<u>Download</u>

james1.csv (1.43 kB) 10 trials of data taken from floor integrated load cells

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



James2.csv (1.02 kB) 10 trials of data taken from floor integrated load cells

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



james3.csv (986 B) 10 trials of data taken from floor integrated load cells

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



Download

james4.csv (1.14 kB) 10 trials of data taken from floor integrated load cells

Jacob Parsons - Apr 30, 2025, 8:11 PM CDT



<u>Download</u>

james5.csv (774 B) 10 trials of data taken from floor integrated load cells

45 of 233

Distance & Velocity Measurement Data & Analysis

OWEN KOLNIK - Apr 30, 2025, 9:20 PM CDT

Title: Distance & Velocity Measurement Data & Analysis

Date: 4/30/25

Content by: James Waldenberger

Present: Group

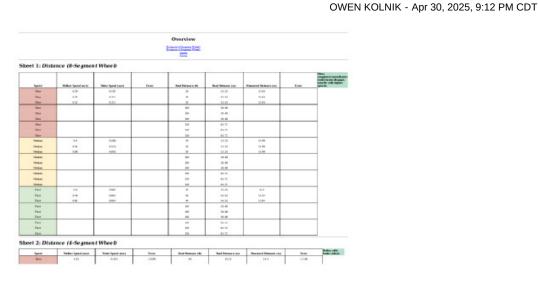
Goals: Provide a place for distance and velocity data, and outline our analysis methods to figure out error.

Content:

- Average Distance Relative Error: 1.25%
- Average Velocity Relative Error: 1.20%
- Average Instantaneous Velocity Relative Error: 20.64%

Conclusions/action items:

• Use this data to validate the IR sensors accuracy for measuring distance and velocity.



Download

Distance_and_Speed_Testing_Results.xlsx (21.1 kB)

OWEN KOLNIK - Apr 30, 2025, 9:15 PM CDT

Speed	Walker Speed (min)	Waleo Speed (min)	Relative Coror	Real Distance (N)	Real Distance (m)	Measured Distance (m)	Relative Error
Stew	0.35	0.363	-3.58%	50	15.24	14.0	-2.23%
Stew	0.35	0.348	1.16%	50	15.28	15.10	4.32%
Stew	0.35	0.354	-1.13%	50	15.28	14.99	-1.64%
Sine .	0.4	0.401	4.28%	100	30.48	36.18	4.90%
5 km	0.41	0.412	4.49%	100	30.48	36.18	4.96%
Size .	0.38	0.388	-1.50%	100	30.48	28.99	-1.67%
Sine .	0.30	0.308	3.01%	158	46.72	44.96	-1.67%
Since	0.38	0.378	0.57%	150	45.72	45.05	-1.47%
Sine	0.36	0.360	-2.44%	158	45.72	45.05	-1.47%
Medium	0.51	0.508	0.30%	50	15.24	15.10	-4.37%
Medium	0.6	0.61	-164%	50	95.24	15.00	4.96%
Medium	0.61	0.61	0.00%	58	15.24	15.19	-0.37%
Medium	0.58	0.586	-1.02%	100	30.48	36.09	-1385
Medium	0.56	0.564	471%	100	30.45	36.09	-1.26%
Medium	0.57	0.564	1.00%	100	36.48	36.09	-128%
Medium	+57	6.579	-1.98%	158	45.72	45.06	-1.47%
Medium	0.56	0.564	-871%	158	45.72	45.06	-1.475
Medium	0.61	0.618	-1.29%	158	45.72	45.05	-1.475
Fast	0.00	0.306	447%	540	15.3a	15.09	-4.96%
Fast	1.15	1.00	5.58%	58	15.34	14.9	-2.29%
Fast	0.95	6.953	-0.31%	58	15.34	15.19	-4.37%
Fast	1.15	1.129	1.87%	100	30.40	25.99	-1075
Fast	1	0.963	1.79%	100	30.48	36.09	-1.26%
Fast	1.87	1.051	1.01%	100	30.48	29.99	-101%
Fast	0.92	0.900	-1.39%	158	45.72	44.90	-162%
Fast	1.07	1.960	0.66%	158	45.72	44.79	-2.67%
Fast	11	1.115	-1.35%	158	45.72	45.00	-1.475
		ARRAGE	1,39%			ALCONC.	

Download

Distance_and_Average_Speed_Results.png (58.9 kB)

OWEN KOLNIK - Apr 30, 2025, 9:16 PM CDT

 30 % Trial
 Marker (H)
 Marker (n)
 Video Time (a)
 Video Velocity (min)
 Walker Velocity (min)
 Emor

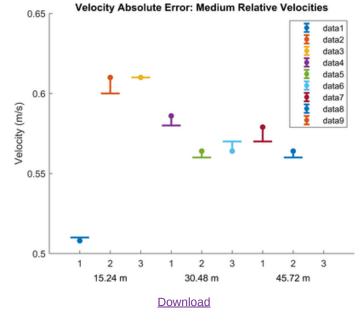
 10
 3.05
 11.59
 0.263
 0.34
 29.295

4	-20.96%	0.23	0.291	10.49	6.1	29	siow
4	15.94%	0.29	0.248	12:28	9.94	30	
4	-10.03%	0.26	0.289	10.56	3.85	10	
	-20.67%	0.25	0.315	8.67	6.1	29	2
6	-15.79%	0.23	0.273	11.10	9.14	50	
4	-20.40%	0.16	0.201	15.14	3.85	10	
A AVERAGE	-15.29%	0.20	0.236	12.92	6.1	29 30	3
	14.29%	0.24	0.210	94.52	9.14	30	
4	-10.00%	0.42	0.467	6.53	3.85	10	
	5.59%	0.49	0.464	6.57	6.1	29 30	medium
4	26.41%	0.54	0.427	2.14	9.14	30	
	3 69%	0.42	0.405	7.53	3.85	10	
4	17.74%	0.54	0.459	6.65	6.1	29	2
4	35.80%	0.54	0.396	7.67	9.14	29 30	
	4.64%	0.42	0.450	6.78	3.05	10	
AVERAGE	23.89%	0.64	0.517	5.9	6.1	29	3
6 8	29.47%	0.64	0.494	6.17	9.94	30	
	0.81%	0.85	0.845	3.61	3.05	10	
6	30.73%	1.32	0.967	3.09	6.1	29	feet
6	-15.41%	0.75	0.867	3.44	9.94	29 30	
4	50.40%	1.18	0.740	4.12	3.05	10	
6	20.01%	0.96	0.011	3.76	6.1	29	2
4	42.35%	1.00	0.759	4.02	9.94	30	
	3.83%	0.78	0.751	4.05	3.85	10	
AVERAGE	29.22%	1.18	0.913	3.34	6.1	29	3
6 3	29.17%	0.90	0.758	4.02	9.54	30	

Download

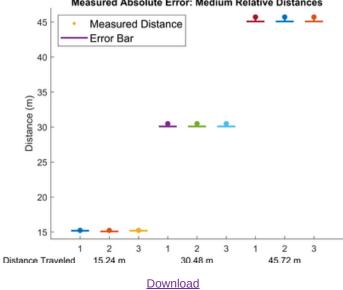
Instantaneous_Velocity_Testing_Results.png (47.5 kB)

OWEN KOLNIK - Apr 30, 2025, 9:22 PM CDT



Trial_Set_2.png (391 kB)

OWEN KOLNIK - Apr 30, 2025, 9:22 PM CDT



Trial_Set_2_Distance.png (358 kB)

Measured Absolute Error: Medium Relative Distances



James Waldenberger - Apr 03, 2025, 9:50 PM CDT

Title: WARF Innovation Disclosure

Date: 4/3/25

Content by: Team

Present: Team

Goals: Create a document to send to WARF to inform them about our intent to file a patent for the Smart Walker, and outline our current design to them to see if it is applicable.

Content:

See attached file.

Conclusions/action items:

Wait for a response from WARF and determine if we want to go ahead with the patent if accepted.

Jacob Parsons - Apr 28, 2025, 10:12 PM CDT

Background

This device was contrained and developed as part of a service design peoplet in the Bennedical Engineering peoplem. Our client, Mr. Daniel Hotscheen, is a Clience Physical Theoretics (FT) working in a storke inhibitition to the the sequential the dovelopment of a galaxiessment inparies motility on gala atterministic. Nations are hybrid to dovelopment of the integration case when the supervising FT detamines that they can walk with minimat skinnes on a walks. This device will be used for a Thrait Intel is assess the patient dovelopment of the valket to finder device and the user for a Thrait Intel is assess the patient dovelopment of the valket to the device and the users, its hard devices that they can walk with minimat skinnes on a walks. This device a disclosure is a Thrait Intel is assess the patient dovelopment as the valket to inter-dencing docidionnelsky. The client weekling there is a the start of the splanet's devices through the lags. Spectraph, this movies determining how much all the patient's weight is patient through the lags. Spectraph, this movies device inter the weight is spectraphic to the valket to through decision patient and such exists the remain weight as spectraphic to the valket through the lags. Spectraphic through exists the remain weight as spectraphic to the valket through decision decision and quartificable traphic sense the remaining PTs to make an informed darket age decision.

What's Novel?

What's Novel? Current Torologis on the method can measure parameters such as validity and speed, the tra-Carrier Walker, the them is no commercially available pedict that measures applied chical band. Some devices contain faces emones attended to walker females to metricar applied band, this include Simble To do services. Fuel Free services, and AMT issues. The creates a method that and the contained attends, which for all services and contained to the file include Simble To do services. The creates are services at a service that and services and contained to the service applied band, this include Simble To do services. The creates are services at the contained method of the services and the services and the services are services at a service at a service and the service and the services are services at the contained band to the service and the services at the service measurement to be doned to the services and the services at the service the service at the services at the service at the service at the service at the service that and the services and the services at the services at the service at the service of a theory of the services and the services and the services and the services and the service and the services and the services are reasonable to all services and the services contain the service in the services at heads of the service of a theory of the services and the services and the services at the service and the services and the services contains the service of a service and the services and the services and the services in the service of the services and the services contains the service of the services and the services contains the service of the services and the services contains the service of the services and the services and the services and the services and the services are serviced in the service the service of a service of services and the services contains the service of the services and the services are serviced in the service the services and the services and the servic

Download

Innovation_Disclosure_-_SmartWalker_UW-Madison_dept._of_BME_1_.pdf (72.2 kB)



Jacob Parsons - Apr 28, 2025, 10:14 PM CDT

Title: Executive Summary

Date: 4/28/25

Content by: Team

Present: Team

Goals: To complete the executive summary

Content:

- See attachment below

Conclusions/action items:

- Prepare our talk during the Tong speech.

Jacob Parsons - Apr 28, 2025, 10:13 PM CDT

402 - Tong - 22 - SmartWalker - Executive Summary

Impaired antibulities is a common consequence for patients admitted to the looping discussion of the second patients of the looping of the second patients of the looping of the looping of the looping discussion of the looping of th

A motion of communically available valuer devices trench that them are none capable of instituteneous constraining useral and host data, firm physical thempions will not be table to getthe full associated and the state of the state manufactories. However, there is notifying on the state full the state of the state of the state manufactories. However, there is notifying on the state full the state of the state of the state manufactories. However, there is notifying on the state full the state state of the state of the state state of the state of

The control products consists of modifications down to an emiring malter that could a logmanuax quoted, discusses, and applied hand in rate of mays, as trait product. To meansus quoted and discusses, as without works one program of the relation to the control product of the second could alternate, and and discusses can be considered and the log of the well search of forces for second could alternate, applied discusses can be considered using a second could be discussed as without discusses can be considered using a second could be discussed as a second discusses can be considered using a second second second second second transition, quoted and discusses can be considered using a second sec

Validation of the forign consider of electricity measurement a comparison of employment sectors, sourcing the structural integrity of the value, and assessing power angle capability. The distance and posel to sing wave preference and in early were compared to known (singtware and posel and end to a given present energy and 2.9%. To conduct tuting of the land cells, various leads ware applied to a biblionism call, and then is the value. The present energy process to insignize an index of the biblionism call, and and as given its relativity predication. Final distance of locar one for the biblionism call, the limit is the biblionism of the biblionism of head of the size of the biblionism of the biblionism of the biblionism of the biblionism of head of the biblionism of the biblionism of head to enfort the distribution. The biblionism of head of the biblionism of the biblionism of head on the biblionism of head of the biblionism.

Control to over a second down in the same to subserve the lay known in the second down in the same halfs when the same second down in the same halfs when the same second down in the Child Share is the same second down in the same second down in the Child Share is the same second down in the

Locale et al. (2027) * Admicinent al. (2027) * K.M. Bergen et al. (2022) * 000-00026

Download

402_-_Tong_-_22_-_SmartWalker_-_Executive_Summary.pdf (93.7 kB)



Jacob Parsons - Apr 28, 2025, 10:48 PM CDT

Title: PDS

Date: 4/28/25

Content by: Team

Present: Team

Goals: To lay out the product design specifications

Content:

- See attachment below

Conclusions/action items:

- Ensure that the device meets these specifications

Jacob Parsons - Apr 28, 2025, 10:47 PM CDT

BMEDesign: Product Design Specification

Date: 0/12/2024 Team project: Smart Walker Lab aedion: 400 Group members Leade (Communicato ti Nolen Bio mWills (Bornwills (Borke, ed.s.) BIAC: Eva Schitt (enach Ital)(existent arguitzated) BWG: James Michael teager (enacher arguitzated) BWG: James Pressets (paracraig) who acts) Client: Das Kutscheta Advisot: Amit Nimunkar

Function

The which liketion process of acute stations or similar considers, it is measured for the patient to be able to not well encode to be watering home to encour their addy. The tiert, the Dark Scholten, is a physical liketing if their values aparticle if the one term on a rot and to be left. If the acute has added all rippines the molecular physical for the patient and the left in the status and a scholten all rippines the molecular physical for the patient and the left in the status and a scholten all rippines the molecular physical scholten and the physical scholten and the status and the status and the status of the patient and the patient physical scholten and the scholten form of disks which are the patient physical scholten they are scholten and physical to the phase are applied to the value for the patient Add of these senses will be to scholt and the there. The disk While west the theorem the ability of excluder to evaluate the status first process of the patients.

Client requirements

- The decise the designed to enhance a standard physical theory waker so it can be used in a circle lasting for the circle.
 The decise the designed to enhance a standard physical theory waker so it can be used in a circle lasting be with block disk (usage, year tood with minimal mains because).
 The decise the manufactured within the toolyst of 3300, what will be purchased with the backgrown standard and within the toolyst of 3300, what will be purchased with the backgrown standard disk of the tool in a constant of the tool in a constant of the tool of the solution of the solutio

Download

Smart_Walker_PDS_1_.pdf (176 kB)



Jacob Parsons - Apr 28, 2025, 10:51 PM CDT

Title: Preliminary Presentation	
Date: 4/28/25	
Content by: Team	
Present: Team	
Goals: To lay out the preliminary presentation	
Content:	
- See attachment below	
	Jacob Parsons - Apr 28, 2025, 10:51 PM CDT
	Fabruary Bits, 2024



Spring_Preliminary_Presentation_Smart_Walker.pptx (7.54 MB)

Poster

Jacob Parsons - Apr 28, 2025, 10:54 PM CDT

Title: Poster

Date: 4/28/25

Content by: Team

Present: Team

Goals: To prepare the final presentation

Content:

- See content below

Conclusions/action items:

- Finish the final article

		Sma	art Walker		
BME		Client: Mr.I	va Schiltz, James Wald Deniel Hutschera - ThedaCare r - UW Department of Biomedical	lenberger, Jacob Parsons	Ø
	em Statement	Proto	type Fabrication	Discussion and R	esults
due can be used to an relativities. Walking through observations in the fragmal, representation applied have in the walk in the physical on the wal- momentum rates. This are a sensitivities of the MOEEVALUE • People rates meanwrite discribes and tapares. The mean common rate of the discribes and tapares.	on & Background	Dedge: Componente COLED Poppis 1 Stal and Prove Sensitiv 1 General Round 1 General Round 1 General Round 1 General Round 1 General Round 1 Stalance 1 St		Contension reverse plant and the second	L ed ever a short annual asian or recoverses. And relative receives of Nativeliaries receive of a Browney, shis a
quality of hits and local	are developed a series and a series of the s	Land Meanwenterst. Each legitacherst malified to meaning a to	Speed and Elizance Meanwrenew: A TORTOTOTOTOTOTOTOTOTOTOTOTOTOTOTOTOTOTO	Fature Work	
clinically nilevan data	white could inform participant of the second		the second second	 I Pursue significant and improve instances I but hangs: improve undergo if instantances I but hangs: improve under go if inst	dans. nye and olive consistent enternal device.
 Device must be able to with a menimum walking 	right humates; date must be displayed in-		an and the factor that the state of the	The torus result for a local galaxies of the state and the state of the state of the state of the state and the state of the state of the state of the state and the state of the state of the state of the state of the state and the state of the stat	Das Kalubera, for de not, Dr. Nimaskar, fo cot. Dr. whole doings (2000) Named N. 4, 200

<u>Download</u>

Final_Poster_-_SmartWalker.pptx (2.66 MB)

Jacob Parsons - Apr 28, 2025, 10:53 PM CDT



Title: Final Report
Date: 4/30/25
Content by: Team
Present: Team
Goals: Present our work and testing in a final report
Content:
See attachment
Conclusions/action items:
Publish to the journal.

James Waldenberger - Apr 30, 2025, 10:38 PM CDT



<u>Download</u>

Final_Report__Journal.pdf (12.4 MB)



NOLAN BLOMWILLIS - Apr 18, 2025, 1:03 PM CDT

NOLAN BLOMWILLIS-Sep 13, 2024, 1:46 PM CDT

Title: Research on Smart Walker study Date: 1/29/25 Content by: Nolan BlomWillis Present: Myself Goals: Gain an understanding of the use of a walker Content:

[1]

S. B. Thies *et al.*, "Are older people putting themselves at risk when using their walking frames?," *BMC Geriatrics*, vol. 20, no. 1, 2020, doi: https://doi.org/10.1186/s12877-020-1450-2.

- Load Cells on the bottom legs to track pressure induced

- Must take into account the time an individual may lift a walker up
- Gait measurements studies have been done a lot but not much on Gait stability which is what this works on
- The big takeaway is that when individuals use a walker in a clinical setting it is done much better than when at home.

Conclusions/action items:

Understand the use of walkers and got a good basis and ideas for these walkers. Going to research sensors next and what could be used for pressure measurements in the walker.



NOLAN BLOMWILLIS - Apr 18, 2025, 1:04 PM CDT

Title: Gait Analysis Patent
Date: 9/19/24
Content by: Nolan BlomWillis
Present: Myself
Goals: Look into what is out there for Gait Analysis
Content:

[1]

"JP2012000343A - Gait analysis system and gait analysis method - Google Patents," *Google.com*, Jun. 18, 2010. https://patents.google.com/patent/JP2012000343A/en?q=(walker+measurement)&oq=walker+measurement (accessed Sep. 20, 2024).

- This is attaching the gait sensor to the patient not a walker or device

- This gait sensor should be able to have 3D tracking

Conclusions/action items:

A gait sensor would not be able to apply to the walker we are working with and our requirements

NOLAN BLOMWILLIS - Apr 18, 2025, 12:45 PM CDT

Title: Drill Walker holes

Date: 1/30/2025

Content by: Nolan BlomWillis

Present: Myself, Owen Kolniek, Eva Schiltz

Goals: Drill hole for wires to run through

Content:

Down in the team lab, drilled holes that the wires would run through.

Got the hole drilled on the side where wires will run through to the electronics box.

There is room for roughly 12 wires to run through this hole, 22 gauge wire size.

Conclusions/action items:

Move forward with load cell holder application



NOLAN BLOMWILLIS - Feb 14, 2025, 1:17 PM CST

Title: First iteration of load cell holders

Date: 2/14/25

Content by: Myself

Present: Myself and Owen Kolnik

Goals: Complete the wiring and get load cell holders put into the walker

Content:

Attached below is a picture of the load cell holders attached.

Conclusions/action items:

Edit the load cell holders to now account for the walker leg offset.



Download

WalkerPicture.jpg (916 kB)

NOLAN BLOMWILLIS - Feb 14, 2025, 1:17 PM CST



NOLAN BLOMWILLIS - Feb 23, 2025, 9:21 PM CST

Title:

Date: 2/23/25

Content by: Nolan BlomWillis

Present: Myself

Goals: Create a fabrication protocol for load cell holders

Content:

- 1. Cut legs off of the top handle section at the appropriate length chosen.
- 2. Measure the new angle measurements that have been created by the cut.
- 3. Drill a hole on both sides of the top handle section in parallel with the bar that the display case will be attached to.
- 4. Tie a nut to a spare wire that will be fed through the walker leg.
- 5. Once spare wire is through, attach red, white, and black wire to the spare wire and feed set of three wires through for load cells
- 6. Repeat steps 4 and 5 for a set of red white and black wires for IR sensors.
- 7. Using the new angle measurements, fabricate load cell holders accordingly.
- 8. Drill holes for load cell holders to be held in place on all four legs. Use a drill press for accuracy.
- 9. Cut extra IR sensor and Load cell wires short and solder each load cell together as well as IR sensor.
- 10. Place Load cell holders into legs, use bolts and nuts to hold in place through holes that were drilled in step 8.
- 11. Connect load cell wires together by display case for voltage outputs.

Conclusions/action items:

Use for fabrication of load cell holders



Title: Load cell holder fabrication

Date: 2//28/25

Content by: Nolan

Present: Nolan and Owen

Goals: Complete the drilling for the load cell holders attachment

Content:

Below are images of the nuts and bolts in the load cell holders.

The steps were to mark up where the drilling needed to occur, then drill, then use the dremel to get the holes the correct shape for the bolt, then debur the holes and attach the nuts and bolts.

Conclusions/action items:

Feed through wire and attach load cells for testing.



Download

WalkerLeg1.jpg (428 kB)

NOLAN BLOMWILLIS - Feb 28, 2025, 12:05 PM CST



NOLAN BLOMWILLIS - Feb 28, 2025, 12:05 PM CST



<u>Download</u>

Walker_Leg_2.jpg (499 kB)

2025/3/4 - Load Cell Holder Design Meeting With Owen

NOLAN BLOMWILLIS - Apr 18, 2025, 12:57 PM CDT

Title: Design Consultation

Date: 3/4/2025

Content by: Jesse

Present: Nolan & Owen

Goals: To fix the leg wobble

Content:

Main High-Level Takeaways:

- Redesign the load cell holders.
- · Add an additional verticle cross-bar to the front legs, curved if needed to avoid patients gait, for added structural integrity.

NEW DESIGN:

- See Sketches Below
- Add nubs to the load cell holder, where the frame enters the component.
- Increase L in L/D to minimize wobble.
- Restrict to minimum number of degrees of freedom.
- Make sure planes of top and bottom pieces, where the load sensor will sit, are parrallel with the ground.
- Ensure the axis for which the top and bottom piece are concentric is normal to the ground.
 - This allows tighter dimensions, so a tighter fit is enabled.
- Thus the holes into the frame will have to be a different angles, i.e. the one drilled in the top and the one drilled on the bottom of the cut.
- Could make the male and female profiles square.
- have the stem that enters the frame, and the portion the meets the other piece be at different angles, measured via imageJ, this may take iterations.

Conclusions/action items:

		1 Al		9
	00		1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-	
- Lu	1/2			
	1	-		

NOLAN BLOMWILLIS - Apr 18, 2025, 12:57 PM CDT

Download

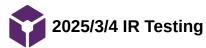
1741128028598341154976968665824.jpg (1.85 MB)

NOLAN BLOMWILLIS - Apr 18, 2025, 12:57 PM CDT



Download

17411280504743436752777929161758.jpg (1.79 MB)



NOLAN BLOMWILLIS - Mar 06, 2025, 11:55 PM CST

Title: Nolan BlomWillis

Date: 3/4/25

Content by: Myself

Present: Owen, Jacob, Myself

Goals: Conduct IR sensor testing

Content:

Attached below is an image of Jacob and I doing larger scale testing of the walker leg with the IR sensor. Took 5 trials at 30ft, 5 trials at 60ft, 5 trials at 90ft.

Conclusions/action items:

Work on soldering longer .22 wires for better connection.



Download

835436086515403037.jpeg (204 kB)

NOLAN BLOMWILLIS - Mar 06, 2025, 11:55 PM CST



NOLAN BLOMWILLIS - Mar 20, 2025, 10:50 PM CDT

Title: Load Cell Holder Iteration

Date: 3/20/25

Content by: Nolan BlomWillis

Present: Owen Kolniek, Nolan BlomWillis

Goals: Check fit of first two load cell holders

Content:

Check image below to see walker with new holders on it.

Conclusions/action items:

Holders need to be tweaked and the margin between top and bottom fit needs to be tweaked to about 1/6 of a mm instead of 1/8mm



Download

WalkerPicture2.jpg (1.1 MB)

NOLAN BLOMWILLIS - Mar 20, 2025, 10:52 PM CDT



2025/4/18-Load cell holder calibration testing protocol

NOLAN BLOMWILLIS - Apr 18, 2025, 12:56 PM CDT

Title: Pressure Calibration testing protocol

Date: 4/18/2025

Content by: Myself

Present: Full team

Goals: Get a calibration protocol written up for calibration

Content:

Load Cell Calibration Procedure

Details of Test:

- 1. Measure weight of wood planks
- 2. Have nothing resting on walker
- 3. Press switch on walker to start run for values
- 4. Leave switch on for 5 seconds
- 5. Collect value outputted on screen in spreadsheet
- 6. Repeat steps 2-3 two more times for a total of 3 runs
- 7. Place planks across walker and do steps 3-5 again 3 times.
- 8. Place 5lbs and do steps 3-5 three times.
- 9. Continue by adding 5lbs on for the most precision.

Conclusions/action items:

Complete calibration and update code into



EVA SCHILTZ - Sep 19, 2024, 5:36 PM CDT

Title: Walking Aid Standard

Date: 9/19/24

Content by: Eva

Present: Eva

Goals: To understand the requirements for walkers in order to write my sections of the PDS.

Content:

Search term: 'Walking Aid Standards

Title: 'Walking aids manipulated by both arms - Requirements and test methods - Part 3: Walking tables'

Citation: [1] "ISO 11199-3:2005," ISO, https://www.iso.org/standard/41191.html (accessed Sep. 19, 2024).

- When folded into its position for transport or storage, the walking table should stay folded when lifted

- For cleaning purposes, the materials and surface treatments used should withstand ordinary alkaline domestic cleaning detergents or spirits, and be easy to dry. After such cleaning agents have been used, corrosion or ageing of the walking table materials should not accelerate.

- Braking test: Activate the brakes by applying to one or each of the running brake operating devices, depending on whether there are central brakes or not, a pulling force of $40 \text{ N} \pm 2 \%$ or a pushing force of $60 \text{ N} \pm 2 \%$ along the grip distance, whichever is the motion to activate the brakes.

- Static strength test: Apply a loading force of 1 500 N \pm 2 % for a user mass of 100 kg

Conclusions/action items:

This standard lists values for braking forces and static strength forces that the walker should be able to withstand. It also offers insight into the other standards which walkers must meet during storage or operation. This information will be very useful in completing my portions of the PDS.



EVA SCHILTZ - Nov 15, 2024, 4:25 PM CST

Title: Neurorehabilitation Research

Date: 9/11/24

Content by: Eva

Present: Eva

Goals: To learn background information about the motivation for creating a smart walker.

Content:

Search term: 'Neurorehabilitation Gait Analysis'

Title: Gait Analysis in Neurorehabilitation: From Research to Clinical Practice

Citation: [1] M. Bonanno *et al.*, "Gait analysis in neurorehabilitation: From Research to Clinical Practice," *Bioengineering*, vol. 10, no. 7, p. 785, Jun. 2023. doi:10.3390/bioengineering10070785

- Gait/postural impairments are most frequent symptoms of neurological diseases - cause great reduction in quality of life, increased risk of falls and subsequent hospitalization

- Ex. of neurological diseases - acquired brain injury (stroke and traumatic brain injury), neurodegenerative disorders (Parkinson disease, cerebellar ataxia and multiple sclerosis)

- Reduction in speed walking, difficulties walking in tandem and in maintaining balance

- Observational gait assessment methods widely used by physiotherapists

- clinical tests for acquired brain injury patients include 10-min walking test, functional ambulation scale or motor assessment scale

- Article includes more information on gait alterations of specific neurological diseases

-Increased variability and asymmetry during walking - most important predictive characteristics for risk of falling

Search term: 'Neurological Rehabilitation Motivation'

Title: Leveraging Factors of Self-Efficacy and Motivation to Optimize Stroke Recovery

Citation: [1] R. Gangwani, A. Cain, A. Collins, and J. M. Cassidy, "Leveraging factors of self-efficacy and motivation to optimize stroke recovery," *Frontiers in Neurology*, vol. 13, Feb. 2022. doi:10.3389/fneur.2022.823202

- 'Stroke rehabilitation practice and research now acknowledge self-efficacy and motivation as critical elements in poststroke recovery, and increasing evidence highlights their contributions to motor (re)learning

- Influence constructive behaviors, attitudes, and beliefs in post-stroke recovery. Influence an individuals engagement in and adherence to the rehabilitation process

Conclusions/action items:

These sources clearly show the importance of gait analysis measurements in neurological rehabilitation. They also show how a device which helps to improve self-efficacy and provides motivation could help with the neurological rehabilitation process. This information will be helpful in writing about the motivations of this project.



EVA SCHILTZ - Apr 29, 2025, 11:02 PM CDT

Title: Resources for Introduction

Date: 4/29/25

Content by: Eva

Present: Eva

Goals: To provide more references for the introduction paragraph of the final report.

Content:

[1] R. S. Calabrò et al., "Gait rehabilitation following neurological disorders: Are robotic devices the future?," Innovations in clinical neuroscience, https://pmc.ncbi.nlm.nih.gov/articles/PMC6292714/ (accessed Apr. 29, 2025).

- Gait abnormalities due to neurological disorders are often disabling and can negatively affect a patient's quality of life.¹ Regaining the ability to walk is considered one of the primary objectives of neurorehabilitation.

- An effective rehabilitation program is commonly focused on task-specific training, in which the patient practices all walking movements, repetitively and in a physically correct manner, to induce improvements of motor cortex representations, recover and strengthen the capabilities of the muscle groups, and improve coordination

[2] S. A. Moore, P. Boyne, G. Fulk, G. Verheyden, and N. A. Fini, "Walk the talk: Current evidence for walking recovery after stroke, future pathways and a mission for research and clinical practice," Stroke, https://pmc.ncbi.nlm.nih.gov/articles/PMC9613533/ (accessed Apr. 29, 2025).

- Walking problems are common after stroke experienced by approximately 80% of stroke survivors. (<u>1</u>) Achieving safe, independent, effective, and efficient walking are top priorities for stroke survivors to enable quality of life and future health.

- [3] S. M. P. CM;, "The twist algorithm predicts time to walking independently after stroke," Neurorehabilitation and neural repair, https://pubmed.ncbi.nlm.nih.gov/29090654/ (accessed Apr. 29, 2025).
- The ability to walk independently is the most common rehabili tation goal after stroke.1 While up to 85% of all stroke survivors are able to walk independently by 6 months,2 only 60% of those who require assistance to walk early after stroke regain independent walking.

[4] K. M. Pattison, D. Brooks, J. I. Cameron, and N. M. Salbach, "Factors influencing physical therapists' use of standardized measures of walking capacity poststroke across the care continuum," Physical therapy, https://pmc.ncbi.nlm.nih.gov/articles/PMC4625060/ (accessed Apr. 29, 2025).

Some therapists described only using standardized tools to assess walking in patients who were independent ambulators and tended to prefer observational gait analysis in patients who needed a lot of physical assistance

A few participants felt that observation, specifically examining gait patterning, was the best method of assessing walking ability across the continuum poststroke but that a standardized method is lacking: "I've never read anything that assisted me in assessing it. For me, it's always feeling the weight, seeing what's going on. That's how I do it."

Conclusions/action items:

Add this information and references to the final report.



2025/4/12- Distance Measuring Walker Patent

EVA SCHILTZ - Sep 12, 2024, 11:01 PM CDT

Title: Distance Measuring Walker Patent

Date: 9/12/24

Content by: Eva

Present: Eva

Goals: To understand the existing intellectual property in the smart walker space.

Content:

Search Term: 'Walker measurement'

Title of Patent: Walker distance measuring device

Citation: [1] "US7044361B2 - Walker Distance Measuring Device," Google Patents, https://patents.google.com/patent/US7044361B2/en (accessed Sep. 12, 2024).

- Features distance and speed measuring sensors built into the wheels of the walker
- Also includes a display which would display information from the sensors?
- Not a lot of information included

- No pressure measurements recorded

107

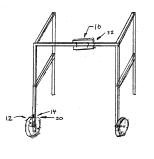


FIGURE 1

Conclusions/action items:

The sensor built into the wheels and the display seem like elements we would want to include in our design. However, this patent does not include weight/ pressure measurements or include many details on the sensor mechanism.



EVA SCHILTZ - Jan 31, 2025, 12:32 PM CST

Title: Load Cell Holder Initial Testing

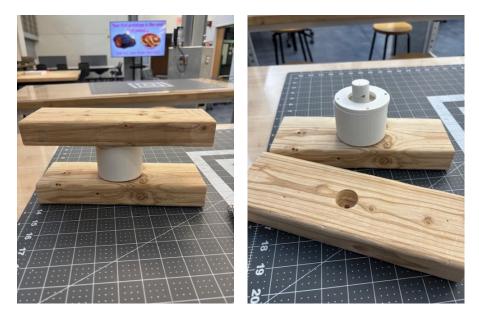
Date: 1/30/25

Content by: Eva

Present: Eva, Nolan

Goals: To perform initial testing to determine the accuracy of the current load cell holder design/dimensions before 3D printing final prototypes.

Content:



I planned to test the load cell holder using a basic setup, by comparing the weight measured by the load cells while inside the load cell holder to the weight measured by a scale. I created these two pieces testing fixtures so the load cell would have a stable base and a larger area to rest the weights on top. Unfortunately I did not realize that the wheatstone bridge circuit would not function with weight only applied to one of the load cells.

Nolan and I attempted to get around this issue by measuring the changes in resistance of the singular load cell holder while applying a variety of weights. This would allow us to create a calibration curve and perform further testing with the load cell holder. Unfortunately, the change in resistance seemed variable, first decreasing then increasing as weights were progressively added. We determined that testing the load cell holders would have to be done once all four were printed.

After discussion we determined that the fit between the top and bottom of the load cell holder should be closer to ensure the legs wouldn't tilt while in use. This could either be done by adjusting the dimensions of the load cell holder or by using wrapping a low-friction material around the edge of the load cell holder. I will discuss with the team to determine which course of action seems most preferable.



Nylo-Tape Friction-Free Drawer Slide Tape

Nylo-Tape Friction-Free Drawer Slide Tape | Rockler Woodworking and Hardware

Conclusions/action items:

I will discuss with the team whether to adjust the dimensions of the load cell holders, add a friction reducing material or both. I will then print all 4 load cell holders. Next week we will need to make plans for testing with all four load cell holders and write a testing protocol.



EVA SCHILTZ - Feb 14, 2025, 1:12 PM CST

Title: Adjusted Load Cell Holder Solidworks Design

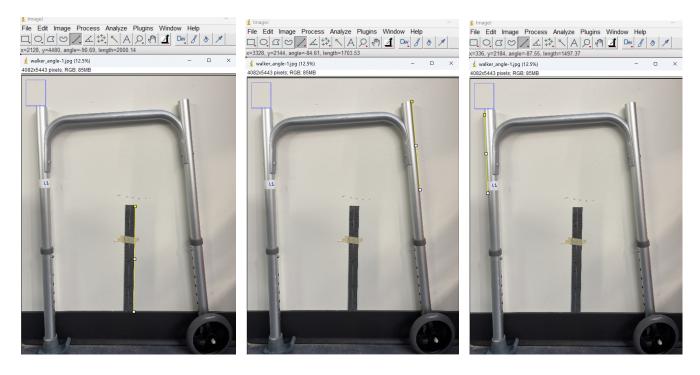
Date: 2/14/25

Content by: Eva

Present: Eva

Goals: To adjust the Solidworks design for the load cell holders to improve strength against shear forces and account for the angle of the walker legs.

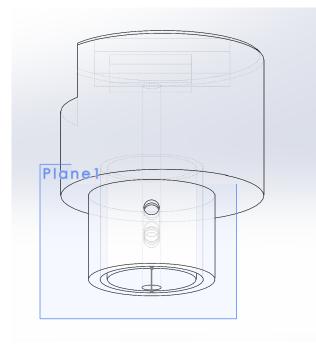
Content:

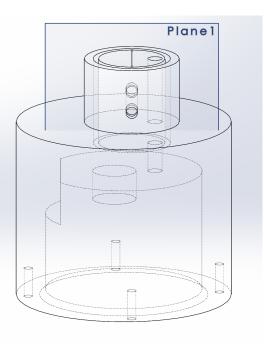


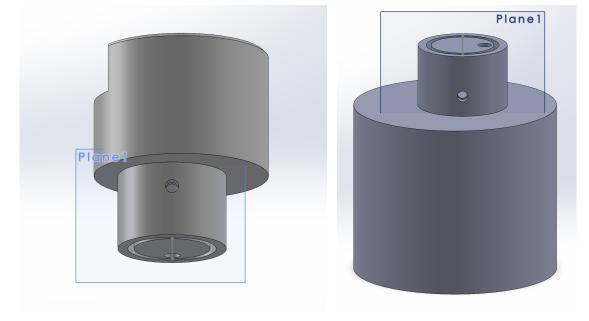
Eva Schiltz/Design Ideas/2025/2/14 - Adjusted Solidworks Design

	Check washer	(J) 11.425 m
	allovance	2010.7 = 1.4
9	1 + 1 1	415 9 m 4.77 9.525mm
000	K h	1
() () () () () () () () () () () () () (4.6
*		
() () () () () () () () () () () () () (-	10,61 -> 90° 84,86 -> -84,17° 7,55 -> 86,86°
49 49 49	3.14° 86.86°	585° N 84.17°
4 4 4	×1	X
	$s_{1n}(3,14) = \frac{x_{\pm}}{54}$	$s_{in}(S, S_3) = \frac{x_2}{c_1}$
9	$x_{1} = 2.95\%$ mm $\frac{x_{1}}{2} = 1.479$ mm	5.485=x2 2 = 2.7426 mm
2		· · · · · · · · · · · · · · · · · · ·

By using imageJ I was able to determine the angle of the walker legs. I then calculated the distances that would need to compensated due to the angles of the walker. I divided these distances by two and then adjusted each of the smaller cylinders which inserted into the walker by this amount.







I also updated the design to reduce shear both by creating an outer shell around the walker leg tube as well as creating a cut so the walker leg tube would sit further into the load cell holder, being supported by the full width of the housing cell. This will help support the load cell holder in resisting shear forces. Finally I added a hole in the load cell holder bottoms for the wiring from the speed measuring sensors to run through.

Conclusions/action items:

I will adjust the dimensions of the screw holes to accommodate heat inserts and run the design by the team. We can then print the new design and if all goes well, continue fabrication and testing.

EVA SCHILTZ - Feb 14, 2025, 12:50 PM CST



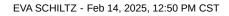
Download

LCH_Top_Adj3deg.SLDPRT (169 kB)

EVA SCHILTZ - Feb 14, 2025, 12:50 PM CST



LCH_Bottom_Adj3deg.SLDPRT (174 kB)





LCH_Top_Adj5deg.SLDPRT (169 kB)

EVA SCHILTZ - Feb 14, 2025, 12:51 PM CST



<u>Download</u>

LCH_Bottom_Adj5deg.SLDPRT (181 kB)



EVA SCHILTZ - Feb 24, 2025, 10:54 AM CST

Title: Load Cell Holder Final Print

Date: 2/21/25

Content by: Eva

Present: Eva

Goals: To print the final version of the load cell holder to be able to assemble it with the walker.

Content:

First I tested the last load cell holder design to ensure that the changes because of the angle of the walker was a success. The lateral adjustment of the pieces that insert into the walker tubing fit well with the rest of the walker. Also the problems with shear forces seemed to be minimized as twisting the pieces around the walker didn't lead to any breaks even though they were lower infill.

I made some adjustments to the screw holes so heat inserts could be used for connecting the two pieces. This is the heat insert Owen found which worked with the dimensions and material of the load cell holder:



Brass Tapered Heat-Set Inserts for Plastic

M3 x 0.5 mm Thread Size, 6.4 mm Installed Length

I then started the final print of the load cell holders, barring any unforeseen issues.

Conclusions/action items:

Once the pieces are finished printing Nolan and Owen are planning on assembling them into the walker. Testing can then be started to ensure the load cells get accurate readings when used with the printed pieces.



EVA SCHILTZ - Feb 24, 2025, 10:55 AM CST

<u>Download</u>

LCH_Bottom_Adj3deg.SLDPRT (166 kB)





Download

LCH_Top_Adj5deg.SLDPRT (169 kB)

EVA SCHILTZ - Feb 24, 2025, 10:55 AM CST



<u>Download</u>

LCH_Top_Adj3deg.SLDPRT (169 kB)

EVA SCHILTZ - Feb 24, 2025, 10:55 AM CST



Download

LCH_Bottom_Adj5deg.SLDPRT (181 kB)

EVA SCHILTZ - Feb 24, 2025, 10:55 AM CST



Download

Washer.SLDPRT (96.4 kB)



EVA SCHILTZ - Feb 28, 2025, 12:16 PM CST

Title: Initial Load Cell Holder Assembly

Date: 2/28/25

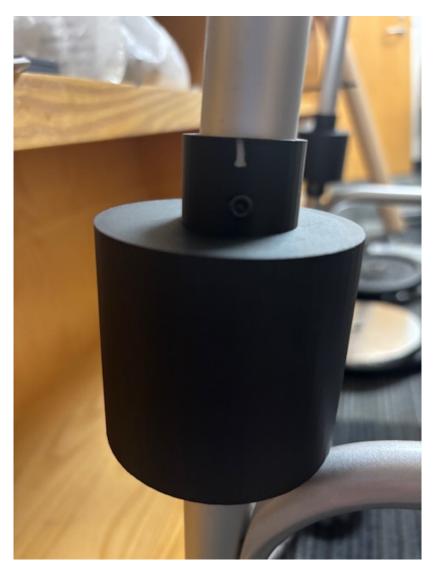
Content by: Eva

Present: Eva

Goals: To begin the process of integrating the load cell holders into the walker.

Content:

Though I wasn't present for the actual fabrication, I helped with initially fitting the load cell holders into the walker leg and marking where the drill holes needed to be made. I also marked the outer sides of the load cell holders in silver sharpie to make it easier to distinguish their orientation as the load cell holders for the different angles look very similar (As shown below)



I also worked on the preliminary report this week.

Conclusions/action items:

Next week I plan to assist with testing for the load cell holders based on the testing protocols already developed. I will also reach out to the rest of the team to see what else needs to be done.



EVA SCHILTZ - Mar 07, 2025, 11:03 AM CST

Title: Jesse Adjusted Load Cell Holder

Date: 3/7/25

Content by: Eva

Present: Eva

Goals: To update the load cell holder design based on comments from a design consultation meeting with Jesse Darley in an effort to make the load cell holders more stable.

Content:

Changes made:

- Ridges added to increase stability. This should reduce the space between the upper and the lower load cell holder but while allowing us to sand down the edges as needed.

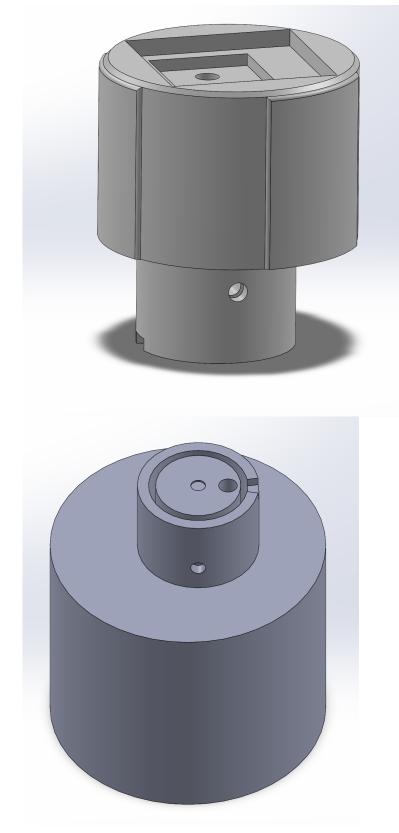
- Markers to indicate which holders go on the front vs back legs and the desired rotation of the load cell holders

- Increased the surface area between the upper and lower load cell holders

- Eliminate key detail as rotation between the two load cell holders should not be a concern

Changes to be made:

- Adjust the size of the wire holes to accommodate thicker wires



Conclusions/action items:

Determine the dimensions and number of wires to be run through each of the load cell holders and adjust design. Print new load cell holders and test the stability after integration into the walker. Possibly pivot to Owen's Solidworks design.



EVA SCHILTZ - Mar 14, 2025, 12:14 PM CDT

Title: Plan for Load Cell Holders with New Budget

Date: 3/14/25

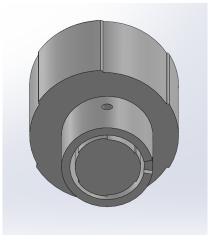
Content by: Eva

Present: Eva

Goals: To establish our plans for the load cell holders with the remaining weeks and budget.

Content:

As our budget increased by \$100 and we have a few aspects of the design we need to spend more money on, we likely only have room in the budget for one more print. For this reason we have to decide which load cell holder design we want to commit to. I updated the previous load cell holders to include ridges on the cylindrical shells the walker legs insert into and increased the diameter of the wire holes.



However I don't think these changes will solve the overall issues that come with the load cell holders translating at an angle. It would also require a lot of manual adjustments to ensure that the increased stability that comes with the inclusion of the ridges doesn't compromise the accuracy of the load cell readings.

For this reason I think we should move ahead with the new load cell holder design that Jesse came up with. The drawbacks of this design are that we won't have much room to iterate with the design, however if we make the design less complex perhaps it could also bring down printing costs. I think overall having a design which translates vertically is more likely to increase the accuracy of the design. I also believe that we can still make manual adjustments to the new design if necessary.

Conclusions/action items:

Share my thoughts with the team and our advisor. Ensure everyone is on the same page before moving forward with the new load cell holder design. Get the design printed and tested.



EVA SCHILTZ - Apr 30, 2025, 8:19 PM CDT

Title: Final Load Cell Holder and Fabrication

Date: 4/4/25

Content by: Eva

Present: Eva, Nolan and Owen

Goals: To prepare the walker for integration with the load cell holders.

Content:

The final version of the load cell holders were printed. As a result this week we redrilled the holes for the screws which will hold the load cell holders in place in the leg of the walker. This process was a bit complex as, due to the angle of the walker, the ends of the walker legs don't sit fully within the load cell holders. This meant that the hole we needed to drill would need to be carefully lined up with the load cell holders each time.

Conclusions/action items:

We need to begin assembling all the pieces of the walker together. Once the load cell holders are integrated into the walker we can begin testing to ensure that they are getting accurate readings.



EVA SCHILTZ - Apr 30, 2025, 8:10 PM CDT

Title: Walker Fabrication

Date: 4/11/25

Content by: Eva

Present: Everyone

Goals: To finish assembling the walker.

Content:

We did a lot of work to run the wires through the walker frame. This was a very difficult process involving first drilling holes for the wires to enter and exit. Then a guide wire tied to a washer would need to be sent through the walker frame tubing. This was mainly accomplished using gravity as well as a long pair of tweezers in the green room. Then the wires would be taped to the guide wire and pulled through. For the hole on the leg with the IR sensor we had to run about 10 wires through the same hole. Each had to be done individually otherwise they would get stuck and pull out of the tape. For this reason we tied the guide wire in a circle to be able to use it continuously.

Conclusions/action items:

We still need to get the wires soldered and connect the pieces of the walker with the load cell holders. Then we can begin testing to see if all the pieces function when fully assembled.



EVA SCHILTZ - Apr 30, 2025, 8:02 PM CDT

Title: Walker Speed And Distance Testing

Date: 4/22/25

Content by: Eva

Present: Eva, Owen, James

Goals: To determine the accuracy of the IR speed sensor setup now that the walker is assembled.

Content:

We measured out 10, 20, 30, 50, 100 and 150 ft distances in a hallway with tape. Then we tested the assembled walker at slow medium and fast speeds by recording a video while walking. We would divide the distance by the time registered in the video and compare it to the average speed output on the walker. We did three rounds of testing for each speed.

We also attempted to test instantaneous speed by taking lap time measurements with a stopwatch while the walker user called out instantaneous velocities output by the walker. These speeds seemed much less accurate.



An image of one of the instantaneous velocity trials. We first attempted to record the wheel passing over the tape and sync the recorded values this way but the camera could not focus on the screen and the wheels. This led to the other testing method we came up with. It was a bit difficult to sync times however.

Conclusions/action items:

We will need to process this data to determine the average error between trials. We will also be able to analyze trends - does it work better with faster/slower speeds over longer/shorter distances. This information will then need to be summarized and put onto the final report.



Jacob Parsons - Apr 27, 2025, 8:20 PM CDT

Title: Biology & Physiology Background

Date: 4/27

Content by: Jacob Parsons

Present: n/a

Goals: Find some information on the biology and physiology of stroke patients

Content:

- Stroke is a leading cause of long-term disability in the United States, with nearly 800,000 people affected each year. Many survivors suffer from persistent motor impairments that impact walking ability, such as gait asymmetry and uneven weight distribution. These issues are often addressed using walkers and assistive devices during rehabilitation, but clinicians primarily rely on qualitative observations—such as visual assessments of limb usage or balance—to determine walker dependence and gait recovery. These assessments, while practical in a clinical setting, lack objectivity and fail to capture subtle biomechanical progressions that may correlate with patient outcomes

Conclusions/action items:

- Strokes have various effects on individuals, but for our case we care about the effects on their walking

- It varies person to person, but their gait pattern and rhythm are hindered post stroke



Jacob Parsons - Apr 27, 2025, 8:08 PM CDT

Title: Competing Designs

Date: 4/27

Content by: Jacob

Present: N/A

Goals: To find competing designs

Content:

- Camino Smart Walker: Electric powered walker with auto-boost, auto-brake, and lighting systems. Obstacle detection & user assistance focus
- · Walkwise: Remote monitoring solution that can clip on to walkers, canes, or wheelchairs
- Research walker with handle based measurements that is used in conjunction with motion capture to look at patient gait
- Mobility Assistance Apparatus patent: Incorporates various sensors, including load sensors, strain gauges, proximity sensors, and inertial sensors (e.g., accelerometers), to monitor user interactions and movements.

Conclusions/action items:

Current products on the market can measure parameters such as velocity and speed, like the Camino Walker, but there is no commercially available product that measures applied clinical load. Some devices contain force sensors attached to walker handles to monitor applied load, this includes StrideTech Go sensors, FlexiForce sensors, and AMTI sensors. This creates a niche for a device that combines distance, velocity, and load-measuring capabilities. Our design offers these biometric measurement capabilities at a cost-effective price, making it suitable for use in both inpatient and outpatient physical therapy clinics for walker-assisted gait assessments. Our device meets the client's needs by measuring average applied load, instantaneous applied load, trial time, average speed, instantaneous speed, and distance traveled during a trial. It accomplishes this at minimal expense by integrating various sensors with a standard walker. Load is measured via strain gauge load sensors mounted in the four legs of the walker to quantify the patient's reliance on the walker. These sensors are housed in load cell holders that replace part of each leg's structure. Velocity and distance are measured using an infrared sensor positioned near the right wheel to maintain sight of the wheel for detection of highcontrast markings along the wheel's edge; enabling accurate tracking of the number of wheel rotations over time. Time is measured via a Raspberry Pi Pico microcontroller, for cost-effectiveness and processing capabilities, located in the electrical housing. This microcontroller, along with amplifiers for sensor signals, handles data processing and calculation based on sensor outputs. Processed data is displayed on two OLED screens which are mounted near the walker handles to provide readouts of all biometric data for both the patient and the supervising clinician to view. Additionally, the infrastructure added to a standard walker supports the attachment or removal of sensors as needed by the physical therapist to enable customization such as integrating additional sensors or recalibrating the device for specific clinical needs. This modular design allows the device to be tailored to a broader range of clinical needs, enhancing its utility across diverse rehabilitation settings. For instance, a gyroscope can be added to monitor the walker's level and detect tipping events, alerting the therapist when tipping occurs. Wireless data exchange can be integrated based on clinical needs to export patient information to an external database for continuous tracking and analysis. Customization can be achieved through minor wiring changes, mounting modifications, and minor software updates. Currently, no other commercially available product offers all of this information in a single, affordable package

2024/02/2 - Other speed measuring devices

91 of 233

Jacob Parsons - Fel

Title: Other speed measuring devices

Date: 2/2/25

Content by: Jacob Parsons

Present: Jacob

Goals: To find cheap, alternative speed measuring devices

Content:

- Other choices for measuring speed are a different accelerometer, a hall effect, and a light based hall effect sensor

- We have already selected a different accelerometer with a gyroscope built in: it is the MPU 6050

- It only utilizes I2C and costs \$5.99 on amazon

https://www.amazon.com/SHILLEHTEK-Accelerometer-Raspberry-Compatible-Unsoldered/dp/B0CWFG3LFF/ref=asc_df_B0CWFG3LFF? mcid=d1308dd660ba33bba9fb35c27ef1008a&hvocijid=12765252442221877172-B0CWFG3LFF-&hvexpln=73&tag=hyprod-20&linkCode=df0&hvadid=721245378154&hvpos=&hvnetw=g&hvrand=12765252442221877172&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9018948&hvtargid=pl

- We currently own a hall effect sensor

Magnets

https://www.digikey.com/en/products/detail/radial-magnets,-inc./9049/6030786?

utm_adgroup=&utm_source=google&utm_medium=cpc&utm_campaign=PMax%20Shopping_Product_High%20ROAS%20Categories&utm_term=&utm_content=&utm_id=go_cmp-202227175(_prd-6030786_sig-Cj0KCQjwpP63BhDYARIsAOQkATYo3egrimMdsZoVNG_NfkeTktZwAP5R4GE1A7mIHFXLx1Wi-

4E6Ui4aAtylEALw_wcB&gad_source=1&gclid=Cj0KCQjwpP63BhDYARIsAOQkATYo3egrimMdsZoVNG_NfkeTktZwAP5R4GE1A7mIHFXLx1Wi-4E6Ui4aAtylEALw_wcB

Hall effect

https://www.digikey.com/en/products/detail/rochester-electronics,-llc/DRV5023BIQLPGM/13506615? utm_adgroup=Sensors%2C%20Transducers&utm_source=google&utm_medium=cpc&utm_campaign=Shopping_DK%2BSupplier_Rochester&utm_term=&utm_content=Sensors%2C%20Trans 14247218536_adg-126150562316_ad-539598865099_pla-354083421525_dev-c_ext_prd-13506615_sig-Cj0KCQjwxsm3BhDrARIsAMtVz6Nyy4UZp4uwDTAUtrqTXglxUPhOf2ASsthXy9JFdcGYB1i7nG43XsaAmJwEALw_wcB&gad_source=1&gclid=Cj0KCQjwxsm3BhDrARIsAMtVz6Nyy4UZp4uwDTAUtrqTXglxUPhOf2ASsthXy9JFdcGYB1i7nG43XsaAmJwEALw_wcB

- I found a TCRT5000 IR sensor from digikey and amazon; but amazon has the added other components to make it more funcitonal

https://www.amazon.com/HiLetgo-Channel-Tracing-Sensor-Detection/dp/B00LZV1V10/ref=asc_df_B00LZV1V10?mcid=867059e770613aa9981138d8b9e05038&hvocijid=40384479714128665(&hvexpln=73&tag=hvprod-

20& linkCode = df0& hvadid = 721245378154& hvpos = & hvnetw = g& hvrand = 4038447971412866508& hvpone = & hvptwo = & hvqmt = & hvdev = c& hvdvcmdl = & hvlocint = & hvlocint = & hvlocint = bvlocint = bvlocint

Conclusions/action items:

The team will purchase the MPU 6050 and the TCRT5000. Then they will evaluate which one of these two sensors along with the hall effect to determine which one is the best.

Jacob Parsons - Feb 04, 2025, 1:00 PM CST

by a d	sing a half affect sensor in conjunction with some magnets to measure the speed to valid hists wakes the idea is to attach 3 magnets equi-distance along the inner timof the with the half effect located on the tac, are the magnets accreased the heli effect.
be a v hall of	win his near energit scaled on the eg, as the hisghest approach the numerics, then will shage spike measured, i was curious if there is technology that can be used instead of a scland magnets, but tather a light based sensor that picks up on a LED lights whech wheel
ChatG	
Merro	ry upstalad
Yes.y	ou can use an optical sensor instead of a Half affection sor and magnets. Here are a fore:
1.	Reflective Optical Sens or (Infrared or Visible Light)
	 An infrared (IR) emilter and photodiode can be used to detect changes in light reflection as the wheel retates.
	 Attach reflective tape or paints mall reflective spots on the wheel.
	The soneor will detect variations in reflected light as the wheel moves.
2.	Optical Encoder with a Patterned Disk
	 Printa black-and-white striped or segmented pattern on the wheel.
	 Use an optical encodersensor (like those in computer mice or rotary encoders) to detect motion.
	Time-of-Flight (ToF) or LIDAR Sensor
	 A short-range ToF sensor can detect datance changes as the wheel moves.
	 Lass dependent on specific reflectors but nev siguine careful positioning.
4.	Laser Sensor with a Reflective Surface
	 A small laser module almed at a retroreflective sticker could provide accurate seatings.
	o The sensor detects interruptions in the reflection as the wheel totales.
	yau kika halp sekacling a specific sensorbased on your constraints (power, budget, weent, etc.) ?
4a	
You na	id:
50.00.0	urteam will be using a rappberry pilpico to process all of the data and we will be using
	to write mic opython for the code, our team has a low budget of a tout \$200 and this take around 1/3 of that budget.
Charles	Taald
ChatG	PT
40	
You as	iat .

<u>Download</u>

chatgpt_sensor_discussion.pdf (165 kB)



Jacob Parsons - Feb 17, 2025, 5:02 PM CST

Title: Wheel and Leg dimensions

Date: 2/12/25

Content by: Jacob Parsons

Present: Jacob Parsons

Goals: To know the dimensions of the bottom part of the leg for testing and fabrication plans.

Content:

- Distance a is 5.8 mm (distance from wheel to leg)
- Distance b is 126 mm (outer diameter of wheel)
- Distance c is 98 mm (inner diameter of wheel)
- Therefore the thickness of the rubber wheel is 14 mm
- Place the IR sensor at the 3rd row away from the vertical powerlines.

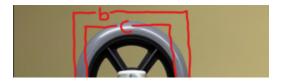
Conclusions/action items:

- This can be used for the IR and hall effect sensor testing & potential fabrication



Download

wheel_side.png (1.18 MB) Side view of wheel



Jacob Parsons - Feb 12, 2025, 11:08 PM CST

Jacob Parsons - Feb 12, 2025, 11:07 PM CST

93 of 233



<u>Download</u>

wheel_front.png (1.41 MB) Front view of wheel

2025/01/29 - adxI345 accelerometer work

Jacob Parsons - Jan 30, 2025, 1:21 PM CST

Title: adxl345 accelerometer work

Date: 1/29/25

Content by: Jacob Parsons

Present: Jacob and James

Goals: To see if the drift issues with the accelerometer can be resolved. Also go over power supply parts.

Content:

- First James shared with me what research he has done and what he has found for power supply and voltage regulator options.

- Then we rediscovered a youtube video from earlier that we were able to pull functioning code from.

https://github.com/shillehbean/youtube-channel/blob/main/adxl345_pi_pico.py

- We then consulted chatgpt for assistance in adding math that we wrote out to calculate the velocity and distance traveled.

- This code then yielded results that seemed similar to what our original code did - with drift issues that when potentially resolved lead to deceleration issues.

- If this is unable to work, then we will plan to purchase the MPU 6050 or potentially begin working with the hall effect sensor.

Conclusions/action items:

I consistently struggled with balancing the ability of the sensor to pick up on the decelerations or having too much drift. So the next step as a team would be to purchase a different accelerometer with a gyroscope, or to switch technologies and work on a hall effect sensor. The hall effect would lead to more wiring; however the new accelerometer (MPU 6050) would require more code.

Jacob Parsons - Jan 31, 2025, 12:06 PM CST

from mechine import Pin, I2C
impoit time
impost ustruct
Constants
ADXL345_ADDRESS = 0x53 # 12C address for ADXL345
ADXL345_POWER_CTL =0x2D # Powe roomtrol register
ADXL345_DATA_FORMAT = 0x31 # Deta forme1 sigister
ADXL345_DATAND = 0x32 # Start of X-exits data
Scaling factor for full-resolution +/- 16g mode (datasheet: 0.0039 g/LSB)
ACCEL_SEALE = 0.0030 * 9.81 # Convert to m/e*
Sampling rate
DT = 0.1 # Time step (ed)ust as reacted)
#Initialize BC
21c = 12C(0, ada=Pin(0), acl=Pin(1), freq=400000)
#Initialize AD01.345
def int_adx(345):
20.witato_mem(ADXL345_ADDRES8, ADXL345_POWER_CTL, tyteenay (0x08)) #
Enable measurement mode
Ec.writelo_mem(ADXL345_ADDRE55, ADXL345_DATA_FORMAT, byte array (0x0B)) #
Pul-resolution, +J-16g
Read acceleration data
def wad_accel_data():
data = 02.needfotr_mem(ADXL345_ADDRESS, ADXL345_DATAX0, 6)
x, y, z = ustruct.urpsck(*3h/, data)
Naturn X, Y, Z
Initialize sensor
int_adx045)
Motion Variables
velocity_x = 0.0 # Initial velocity (m/s)
pastion_s = 0.0 # Initial position (m)
start_time = time ticle_me() # Start time for tracking
num_samples = 0 # Count of samples
sum_velocity = 0.0 # Sum of velocity for averaging
Main kop
while True:

Download

adxl345_code_from_youtube.pdf (49.6 kB)

from machine import Pin, I2C	
impoit time	
import untruct	
# Constants	
ADXL345_ADDRESS = 0x53	
ADXL345_POWER_CTL =0x2D	
ADXL345_DATA_FORMAT = 0x31	
ADXL345_DATAX0 = 0x32	
G_CONVERSION = 0.15256374 #	Adjust this based on the sensitivity setting (0.0039)
#Initialize DC	
i2c = t2C(0, scl=Pin(1), sda =Pin(0))	
#Initialize the wire (acting as a swite	ch)
switch = Pin(15, Pin, N, Pin, PULL_0	COWN) # Ensure this matches your GPIO setup
definit_adx045();	
20.write to_mem(ADXL345_ADD)	RES8, ADXL345_POWER_CTL, byteenay (0x08)) #
Enable measurement mode	
Ec.writeto_mem(ADXL345_ADD)	REISS, ADVL345_DATA_PORMAT, byle artey (0x02)) # 00,
01,02,03	
def mad_accel_data():	
	HS_ADDRESS, ADXL345_DATAX0, 6)
x, y, z = ustruct.unpeck(*3h/, data	
# Convert raw data to g-force using	ng the scaling constant
x = x * G_OONVERSION	
y = y * G_CONVERSION	
z = z ' G_CONVERSION	
returnix, y, z	
def calculate_velocity_distance ():	
weaked by = D	
distance = 0	
total_velocity = 0	
0=truco_elqnise	
start_time = time.ticks_ms()	
provious_time = stat_time	
	ring while the wire is connected to 3.3V
current_time = time.tcks_me()	
delta_time = [current_time - pro	evious_time}/ 1000 # Convert to seconds

Download

adxl345_code_from_last_semester.pdf (53.4 kB)



Jacob Parsons - Feb 05, 2025, 12:45 AM CST

Title: Hall Effect Beginning

Date: 2/5/25

Content by: Jacob Parsons

Present: Jacob Parsons

Goals: To learn how the hall effect sensor works and get it picking up signals from the magnets

Content:

- The hall effect seems to detect changes in polarities when they are presented very close
- This was observed by putting the magnet very close, then flipping it over and repeating
- This is what changed the code from saying magnet detected to no magnet

Conclusions/action items:

- Some future changes to the code may be necessary to ensure that this is proper function
- I would like to find the threshold and see if its a gradient or not
- Then I'll need to crosscheck to see if this fabrication would be possible
- I will then need a model prototype and see how much error it presents and compare the feasibility to the other devices.

Jacob Parsons - Feb 05, 2025, 12:42 AM CST

from moshina import Pin Import Pin (%), Pin RK Pin PULL_UP) # GPIO %) with pull-up with True: Find generacyclus() ==0: pin(Theory Kolosobolf %) else: pin(Theory Ref %) firm.steep(3.2) # Adjust delay as needed

Download

hall_effect_fundementals.pdf (26.6 kB)



Jacob Parsons - Feb 06, 2025, 10:35 AM CST

Title: IR Sensor Beginning

Date: 2/6/25

Content by: Jacob Parsons

Present: Jacob, Owen, James

Goals: To get the IR sensor working

Content:

- We have the IR based sensor working in its most fundamental form

- We thought of fabrication methods to attach the sensor to the inside of the leg shaft

Conclusions/action items:

- Improve the threshold to distinguish between the two
- Begin testing with alternating black and white tape
- See if different light environments change anything.

Jacob Parsons - Feb 06, 2025, 10:35 AM CST

frommachie import.ADC, Pin impat imm 364 up the ADC pin (Use GP28, GP27, or GP28) sonar + ADC(Pin(201) # Adjust GRID pin Fracessary white Tue: 1946 = Sensor read_uf60; If Fload ADC value (U-65536) prithytek) 1956 a Preschied Issued on calibration #Therefueld issued on calibration #Therefueld issued on calibration #Therefueld issued on calibration #Therefueld issued on calibration If the last - Interview If print;"Block surface detected") # print;"Block surface detected") #themachiegB.fl.

Download

ir_fundementals.pdf (31.9 kB)

2025/02/12 - IR Strip Testing

Jacob Parsons - Feb 13, 2025, 1:40 PM CST

Title: IR Strip Testing

Date: 2/12/25

Content by: Jacob Parsons

Present: Jacob Parsons

Goals: To get a base idea for the IR sensor error

Content:

- I followed the IR strip testing protocol

- The sensor, at 5.8 mm away, can pick up increment distances of 1.8 and 0.9 cm at speeds of 180 mm/s and 90 mm/s

- I'll need to calculate the speeds when attached to the wheel in the future

- Upon testing, I determined that the 5.8 mm distance is to close and have switched to 10mm away - this will require washers to be used to get the wheel further from the leg

- I also determined that the 0.9 cm strips were to small, and that likely 1.5 cm strips is the smallest I can go - also with the imperfect fabrication, I am calling the increment 1.85 cm

- The data has a slight built in error due to the last increment never being measured and the first increment may add 1 whole value though it may be less than that

- In the attached documents are my data

Conclusions/action items:

- Potentially make a 1.5 cm strip to see if this works
- Do some math before I make the ring strips to fit to the wheel to ensure that they will detect the differences

- Begin plans on how to attach the IR sensor to the wheel

Jacob Parsons - Feb 13, 2025, 1:53 PM CST

Objective The term most to evaluate how effectively the IR sensor can detect changes in reflections for contrast type. In order to do fais, the term has set up an alternating strips of black-and white to with two different within the law of different widths in type. This is to sus how precise the sense that the sense of the sens is. In figure 1 there is th



Figure 1: A cardboard strip with alternating black and white electrical type at 2 different widths.

- between 1. Supply the TCRT-5000 with 3.3 V to the VCC+ pix and ground the OND pix. Have the DO pix of the sensor winded to GPDO pin 36 on the mayberry pi pixo gits i a 54 at a 64 attace of 5.10 nm. Done the exultativative of the sensor, this is the distance from the lags to the wheed.
 J. Using the code, and the ADC value that the sensor parts on the block and while senser, this will be used for the threshold value to be the events of the block.
 M. Stephen and the ADC value that the sensor parts of the block and while senser, this will be used the fer sensor is closered for the threshold value to be the events of the threshold value to be the events of the threshold value to be the events of the 1.8 on or 0.9 on wide strips strip and set this as the intercent value in the code. the code
- 5. Begin musting the code on the first marker and slide the strip slowly so the IR sensor
- picks up on the alternating color strips until the end. 6. Record this distance measurement and repeat steps 4-5 for varying speeds a slow,
- medium, and fast speed with 5 trials each 7. Fill in the table below with the data collected from steps 4-6

Table 1: The measured distances, calculated distances and percent difference for trials of the 1.85

Trial	Relative Speed	Measured Distance (cm)	Calculated Distance (cm)	Percent Difference (%)
1	Slow	33,6	31.45	6.61
2	Slow	33.6	31.45	6.61
3	Slow	33.6	31.45	6.61
4	Madium	33.6	31.45	6.61

Download

IR_Preliminary_Testing_Protocol_1_.pdf (671 kB) First round of testing

Jacob Parsons - Feb 13, 2025, 1:53 PM CST

Elerrie	resol Hualgo 10pcs TCRT5000 (nitree/d Reflective Sensor IR Protoelectric Switch r Line Obstacle Avoidance Module Tracing Sensor Tracing Module for Adules Smart Dar and warked to know here quickly it and elect the environment from 5.5 mm away, i also
	te detasheet of the tort5000, i would like to know the sampling frequency as well and assertial information
Chat	PT said
	the TGRTSSOC datasheet, here are some key parameters reinvant to your question about rpling frequency and detection speed:
Dete	ction Speed
	Operating Range: 0.2 mm to 15 mm
	Peak Operating Distance: 2.5 mm
•	Response Time (Rise and Fall Time): Typically 10 µs each
Sam	pling Frequency
•	Given that the response time (both rise and Git) is around 10 µs, the sensor can thereafted by operate at the "theoretical (in 10μ -t () μ -t (
Othe	r Essential Information
	Emitter Wavelength: 950 nm (infrand)
	Typical Output Current: 1 mA
	Operating Voltage: Up to 70V (collector-a mittar voltage) Current Transfer Ratio (CTR): Depends on distance and inferred reflection.
fypu	are detecting objects at 5.6 mm, you can expect the sensor to work effectively within its
	lonal range. The separate time ensures quick ensite mendal detection, making it suitable
for hig	his peed applications like obstacle detection in robots or encoding systems.
Would	you like assistance with interfacing it with a microcontrollar for real-time data collection?
40	
Yes a	id:
	alternating colors in tape (black and while) that are at 1.5 mm in width, what appends can recordeted the changes in incriments?
ChatG	PT said:
	that you have allo meting black and white tage segments of

Download

IR_Sensor_Component_Info_1_.pdf (114 kB) My notes and me double checking with ChatGPT

Jacob Parsons - Feb 17, 2025, 4:04 PM CST

from mechine import ADC, Pin import time

Set up the ADC pin for the TCRT5000 sensor (GPI0.26) sensor = ADC(Pin(26)) # Analog input

Calibration values (act) ust based on tasting) threshold = 30000 # Actjust this to property differentiate black vs. while

0.5Valables for tracking changes prev, piles = warrangened (0.5Valables = Black) distance, prev of 0.5 Biblioma counter distance, prev of 0.5Biblioma counter tape, width con 2.5Biblioma counter tape, width con 2.5Biblioma counter tape.

print/"Starting TCRTS000 Sensor Reading ...")

while True: while True: while True: while True: state = while > threshold # Convert to black/while boolean

Delecta terrelion (block → while OR while → block) # convert_state to pay state: distance_om + = tape_width_om # increament distance print#*** constant distance. (distance_om) om/

prev_state = current_state # Update previous state time.site.p(0.05) # Small delay to avoid false triggers

Download

ir_strip_testing_code.pdf (36.2 kB)



Jacob Parsons - Feb 20, 2025, 10:35 AM CST

Title: IR Wheel Fabrication

Date: 2/17/25

Content by: Jacob Parsons

Present: Jacob

Goals: To establish the measurements for the IR fabrication and then cut the holes

Content:

- Based off of measurements, seems that adjusting hole 1 is unusable
- If we do the 3D print idea, we can have all holes of adjustability in use
- I taped the wheel as seen below
- Having 1.5 cm taped heights is sufficient (width of tape is width of segments)
- I marked off where we can cut the holes if we go with the original plan (as seen in the second image)

- Bottom marker is for the securing hole, the next marker is the bottom of the rubber wheel, the third marker from the bottom is for the sensor hole, and the top marker is for the edge of the wheel

- The distance between the two holes should be 20.355 mm from center to center
- The securing hole for the sensor should be similar to the diameter of the hole: 3.25 mm
- The sensor hole needs to have it fit through, so 11 mm in diameter (it should be 10, but I want extra space in case)

Conclusions/action items:

- Reach out to client to ask if they use this and what range of pegs they use
- Drill the holes
- Fabricate the sensor leg system



Jacob Parsons - Feb 17, 2025, 7:54 PM CST

<u>Download</u>

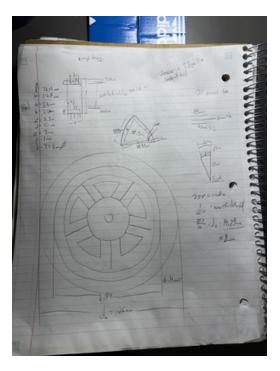
IMG_5418.JPG (5.37 MB) taped wheel

Jacob Parsons - Feb 17, 2025, 7:55 PM CST



<u>Download</u>

IMG_5420.JPG (3.17 MB) scaffold markings for legs



Jacob Parsons - Feb 17, 2025, 7:56 PM CST

<u>Download</u>

IMG_5421.JPG (2.51 MB) hand calcs



Jacob Parsons - Feb 17, 2025, 8:31 PM CST

Title: IR Wheel Pre-Fab Testing

Date: 2/17/25

Content by: Jacob Parsons

Present: Jacob Parsons

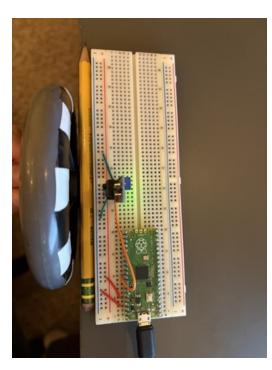
Goals: To see if the strip testing results translated to the tape being on the wheel

Content:

- In the 2 images below I've shown the top and side profile views of the testing
- The pencil is there to ensure that the wheel is 10 mm from the sensor (which was determined to be an ideal distance earlier).
- The sensor is also positioned where it will be due to the measurements made in the "IR Wheel Fabrication" entry under prototype work
- See the PDF below for the testing results

Conclusions/action items:

- At higher speeds, the sensor had issued picking up on incremental increases
- Therefore I am going to make the strips twice as wide
- I will then test this, if this doesn't work I may make them 3 times as wide as originally planned, or 4 depending on how the math adds up.



Jacob Parsons - Feb 17, 2025, 8:08 PM CST

Download

IMG_5422.JPG (4.4 MB) top view of test



<u>Download</u>

IMG_5423.JPG (4.33 MB) side view of test

Jacob Parsons - Feb 17, 2025, 8:17 PM CST

Film 1	Rushpate = a fundamental ag
Addhut, Minis Addhing Addhut, Mahamid an, Atlanda Aykamid an, Atlanda Aykamid ang ang Pintas ang Isa ang Isa a	Non-exciton spect BK, Pin Section spect BK, Pin Section spect BK, Pin Section Secti
	Montheline Residence & Read (20) & (200) +

<u>Download</u>

taped_wheel_results.png (264 kB) first trial results for 1 rotation

Jacob Parsons - Feb 17, 2025, 8:30 PM CST

Objective: The tens witches to use if the fully fabricated plane are a visible option to use the IR sensor with. In order to do this, the tenn has taped 10 black and 10 white pieces of type along the rire of the wheat.



Trial	Relative Speed	Measured Distance (cm)	Calculated Distance (cm)	Percent Difference (%)
1	Slow	40	40	0
2	Slow	40	40	a
3	Slow	40	40	0
4	Madium		12	

Download

IR_Pre-Fab_Wheel_Testing_Protocol_2_.pdf (636 kB)



2025/02/18 - IR Wheel Pre-Fab Testing Round 2

Jacob Parsons - Feb 18, 2025, 3:23 PM CST

Title: IR Wheel Pre-Fab Testing Round 2

Date: 2/18/25

Content by: Jacob Parsons

Present: Jacob

Goals: Determine the correct width for alternating strips

Content:

- Due to the testing yesterday, with 20 total strips, I determined that they were too thin to pick up the faster speeds
- I attempted 10 total strips, and it still wasn't enough
- I then had it at 8 total strips and it is currently promising.

-

Conclusions/action items:

- Integrate the sensor into the leg of the walker
- Conduct the same testing but utilizing the complete walker to simulate a measuring wheel
- Integrate the sensor and wires into the complete walker (through the load cells and into the housing chamber



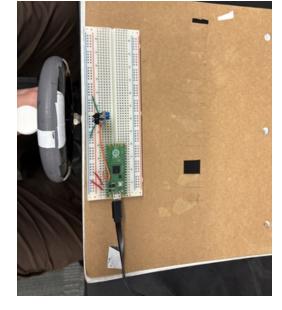
Jacob Parsons - Feb 18, 2025, 3:19 PM CST

Download

IMG_5434.JPG (4.74 MB) wheel with 8 alternating strips



Jacob Parsons - Feb 18, 2025, 3:20 PM CST



Download

IMG_5433.JPG (4.83 MB) Top view of testing environment

Jacob Parsons - Feb 18, 2025, 3:20 PM CST

Download

IMG_5430.JPG (3.52 MB) Side view of testing environment

Jacob Parsons - Feb 18, 2025, 3:22 PM CST



Download

IMG_5432.mov (32.8 MB) Video of one of the trials



Jacob Parsons - Feb 20, 2025, 11:01 AM CST

Title: IR Wheel Fabrication

Date: 2/19/25

Content by: Jacob Parsons

Present: Owen and Jacob

Goals: To integrate the IR sensor into the leg

Content:

- Used drill press to drill the through hole that will be used to secure the sensor to the leg
- Used drill press to start the "sensor hole", the hole that will allow the IR emitter and receiver to poke out
- Used a Dremel to expand the sensor hole to properly fit the emitter and receiver
- Utilized zip ties to secure the sensor into place so it doesn't move during walking
- Replaced the screw that use to hold the wheel in order to get more threads since the wheel placement was too close to the sensor (see images 2-4 below)
- Conducted preliminary tests to evaluate if the fabrication allows the sensor to still work
- The sensor does work as expected, however it had a 6.6% error for 12 foot trials

Conclusions/action items:

- A fair amount of washers were used to reach the desired length, so a counterweight may need to be added to the other side
- The zip ties being used to secure the sensor is not ideal, so future attachment plans may be necessary

- The testing wasn't a complete success; however, for the 12 foot trials the percent error is about the same as the strip testing percent error, so that should be looked into.

- I personally believe the percent error is coming from the code and that can be improved and potentially larger color alternating strips need to be used: TBD

- Overall, this was a good step in the right direction for the IR sensor



Jacob Parsons - Feb 20, 2025, 10:48 AM CST

IMG_5437.JPG (3.62 MB) A close up of the IR sensor within the leg (no wheel)

Jacob Parsons - Feb 20, 2025, 10:51 AM CST



Download

IMG_5442.JPG (3.55 MB) Side profile of IR sensor's leg

Jacob Parsons - Feb 20, 2025, 10:53 AM CST



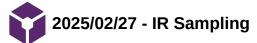
Download

IMG_5443.JPG (3.59 MB) Front profile of IR sensor with tape strips visible



<u>Download</u>

IMG_5444.JPG (1.67 MB) Close up of IR sensor integrated into leg (with wheel)



Jacob Parsons - Feb 28, 2025, 12:43 PM CST

Title: IR Sampling Calculations

Date: 2/27/25

Content by: Jacob Parsons

Present: N/A

Goals: To determine if the width of the tape is ample for a sampling rate

Content:

- 1 kHz sampling for TCRT5000 IR sensor
- Calculated necessary sampling rate is 180.9 Hz

Conclusions/action items:

- The necessary sampling rate for the speed of 4 mph is 180.9 Hz, which is well below the practical sampling rate of the TCRT5000
- This means that the current code is not efficient enough
- Once this code is fixed then it should work.

A colored for Callon Stard.	with with layboldy
(V) Jadent was & examinate	
L. Lathandlar the fire	
We and former good and 1. Apple (M) Jig of 3 X We a	1745 2808; 14 -0R
B= n=63-	
N N	2º N. Y. web
3%	WIT.
	PULLIQUIT POD
	R. 15% Olmi Obs. = NSOF, ask
A	
Eles 1	1108 5 = 91.544 mg/s STTS = 91.544 mg/s P. feale 3.5. scandel (Ka)
Kok= Sitay Tax 21.	44-j
1 (2.9%) Tree 1 352~	
TRACTOR	
3	

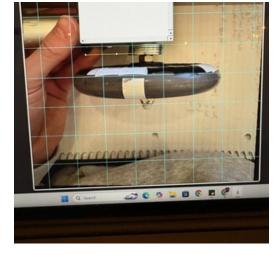
Download

IMG_5512.JPG (4.35 MB) Work to calculate the necessary sampling rate.

Jacob Parsons - Feb 28, 2025, 12:40 PM CST

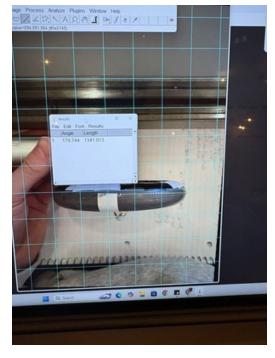


Jacob Parsons - Feb 28, 2025, 12:39 PM CST



<u>Download</u>

IMG_5510.JPG (2.8 MB) imageJ dimensional analysis



<u>Download</u>

IMG_5509.JPG (2.11 MB) ImageJ dimensional analysis

Jacob Parsons - Feb 28, 2025, 12:40 PM CST



Jacob Parsons - Mar 02, 2025, 5:27 PM CST

Title: IR Updated Code Testing

Date: 3/2/25

Content by: Jacob Parsons

Present: Jacob

Goals: To update the code and get some testing done

Content:

- I updated the code (see below) to avoid "sleeping" during the testing.
- This will prevent the "misses" in readings
- This seemed to work
- I did preliminary testing of 9 ft trials
- The first trial was about 8.75 ft, but this was due to the wheel being too tight and instead of rolling it "slid" across
- After loosening the screw I had 3 successful 8.9 ft trials, which is as close as it can be due to the 5 cm increments.

Conclusions/action items:

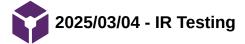
- The updated code seems to work.
- More testing will be done tomorrow with it more integrated into the walker.
- This will be one of the last tests done with just the IR sensor by itself.

Jacob Parsons - Mar 02, 2025, 5:27 PM CST

frommoshire import Phi, ADC import ulma # Secup to ADC phi for the TOHTSKOG sensor (SPH0.26) sensor + ADCPH2(1) # Analog input # Calibration values judjust taosed on tearling) threated = 30000 # Adjust the to popely differentiate table kas, while # Valable Soft transform, compared to the sensor of the tearling table is an encourted on the sensor of the sensor and on the sensor of the s

Download

ir_updated_code.pdf (39.8 kB)



OWEN KOLNIK - Mar 07, 2025, 12:57 PM CST

Title: IR Testing

Date: 3/4/25

Content by: Jacob Parsons

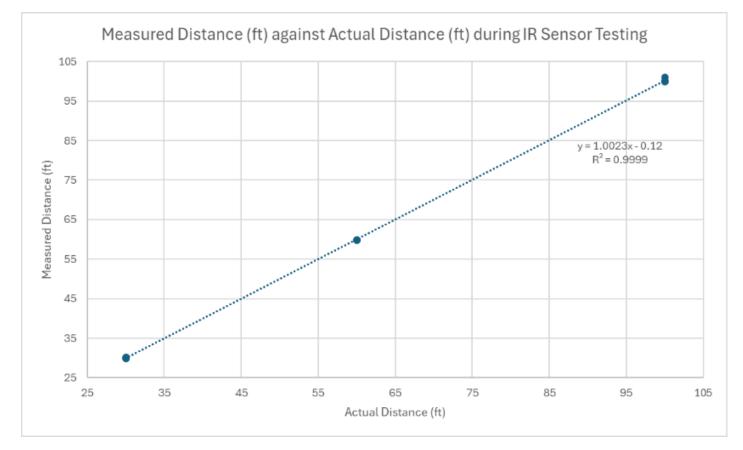
Present: Jacob, Nolan, Owen

Goals: To test the IR sensor

Content:

- Last night I soldered wires to the IR sensor to avoid issues in loose wire connections (which we had issues with the testing the day before)

- We marked off 100 ft with markers every 10 ft
- We then walked with one half of the walker with the IR sensor in the leg (carrying the computer)
- We conducted 5 trials at distances of 30 ft, 60 ft, and 100 ft
- We measured the calculated distance and time
- See the Excel below for the data



Conclusions/action items:

- We had an average percent error of 0.237% over 16 trials.

- This is great news for the team, future testing will be conducted when the entire prototype is brought together

- Potential future work will be to print a holder to better secure the IR sensor to the leg - instead of using a zip tie.

Test	Database 1	۳.,	0.000	ORD .	Permittee	lation of the later of the late	
ι.	3.11.16	284	NAMES ADDREES OF T	L W SILL POINT	4.1404-040401	4.68	
		10	1.000711	10012-00120-002	10.00.001001	1.0000000000	
- 2	X.14.16	184	ALC: UNK AND	CHEEP CONTRACTOR	 4.114046-048-0481 	4.48	
		-	1.00000111	INCOME.	10.000.000.001	A MORE WANTED	
5		-	ACCOUNTS AND ADDRESS OF	100103-002	A COMPANY OF A REAL POINT	1.10	
					A ACCESSION OF	1-12-2008	
	0.110	-				10.000	
	N 14 M				 A RODULED DE LA COLORIS 	1-17 1008 008 108	
					 A ROBARDED 	100000000000000000000000000000000000000	
-	10.01.00		10.0751		1.0.00.00.001	1000000000000	
×	1.00 11.00		O MACENTERO	1.DEX NO	1.801000-00101	1100000000000	
	10.111.00	10.1	C APPENDING	1.01030-00180	3.0000 NOV 100 1	5 NUMBER OF STREET	
	100403-005	14.1	A reviser service	114106-00140	A CONTRACTOR OF	111 March 1997	
						4.11410-00810-008101	
15	10.10.00	14.1	CONTRACTOR OF A	1.4 per setter tette		11110-0030-00310-0	
				10.000	1.0000 000 000 000	1.00000000000	New Yorks
					110000-0000-000	1.0000000000000000000000000000000000000	
					1208240000100		
					A DESCRIPTION OF ADDRESS		

<u>Download</u>

ir_testing_hallway.xlsx (16.7 kB)



Jacob Parsons - Mar 14, 2025, 12:13 PM CDT

Title: Complete Code Iteration 1

Date: 3/13/25

Content by: Jacob

Present: Jacob

Goals: To make the code for the entire walker circuit

Content:

- See PDF attached below for full code

Conclusions/action items:

- I will need to test to see if this works.
- If it does not, I will need to create further iterations so the circuit works as planned.

Jacob Parsons - Mar 14, 2025, 12:12 PM CDT

rom mechine import Pin, I2C, ADC
mpo f and 1306
TIDO & BITTE
mpolit ulime
mpo f. colinc form
x Display Setup
2x0 = (2Ci0, sol=Pin(1), sdia=Pini01, fiag=100000)
2c1 = (2Ci1, sci=Pin(7), sda=Pin(6), teg=100000)
elect_width = 128
elect_height = 32
ked0 = ssd1306.88D1306_I2C(olad_with.olad_height, 2x0)
led1 = sed1306.88D1306_I2C(oled_with, oled_height, i2o1)
lafokar_displays();
0.600.5803
a led0.show()
o kott.\$NO)
aled1.stew()
lear_displays()
Load Cell Setup
edc had call = ADC/Pin(27))
lef read voltage jado, vref=0.3);
raw value = add. and une()
voltage = (nw. volue / 65535) * vref
return vo tage
lef calculate_weight/voltage):
weight = (voltage - 1.6709) / 0.0032
return weight
r IR Sansor Satup
w neor = ADIC(Pin(28))
hreahold = 30000
letence_cm = 0
ape_width_cm = 0.18233598
perv_state = sensor.read_u18() > the shold
lef sensor, i niemuptija inj :
global pav_stala, distance_cm

Download

complete_code.pdf (57.1 kB)



Jacob Parsons - Mar 17, 2025, 6:44 PM CDT

Title: Final Electrical Testing

Date: 3/17/25

Content by: Jacob Parsons

Present: n/a

Goals: To test the final circuit and code before integrating it into the walker

Content:

- See attachment below for code

- I found out we need to add a wire solder connection for output of load cell circuit

Conclusions/action items:

- Integrate this into the walker

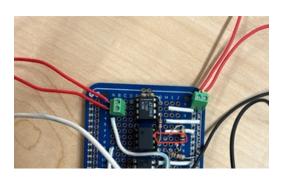
Jacob Parsons - Mar 17, 2025, 6:44 PM CDT

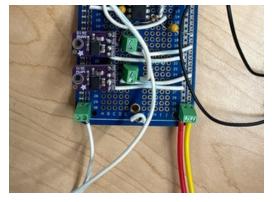
from machine import Pin, I2C, ADC import audi 306 import time # Display Setup	
impot time	
a Display Salar	
di	
12x0 = 12C(0, sci=Pin(1), sds=Pin(0), frsq=100000)	
i2o1=i2O(1, sol=Pin(7), sda=Pin(6), feq=100000)	
pled width = 125	
oled_height = 32	
pledD = aud 1306.55D1306_I2C(pled_with, pled_heig	
pled1 = ad1306.55D1306_I2C(pled_with, pled_heig	pht, (2c1)
defokar_displays();	
a incl0.118(3)	
o kd0.showD	
o kod1.5801	
olecti.stow()	
clear_displays()	
# Loed Cell Setup	
ado_bad_oall = ADC(Pin(27)) # GP27 (ADC1)	
def mad_voltage(adc, vref=0.3);	
saw value = ado, and urigi)	
voltage = (orw volue / 65535) * verf	
ratum vo tago	
def calculate weight/voltage/c	
return (voltage - 1.8709) / 0.0032 # Calibration equ	noite
# IR Sensor Setup	
sensor = ADC(Pin(26)) # GP26 (ADC)	
threshold = 30000	
distance_cm=0	
tape width cm = 0.18233598	
perv_state = serser.read_u W() > theshold	
defsensor_interruptipint:	
global prev stata, distance cm	
wake = serect med_ut60	
current_state = value > fimeshold	

Download

functioning_final_code.pdf (60.3 kB)

Jacob Parsons - Mar 17, 2025, 6:45 PM CDT





Download

IMG_5590.JPG (1.04 MB) missing wire

Download
IMG_5591.JPG (6.34 MB) functioning test

Jacob Parsons - Mar 17, 2025, 6:46 PM CDT



Jacob Parsons - Mar 21, 2025, 12:17 AM CDT

Title: Final Electrical & Power Testing

Date: 3/20/25

Content by: Jacob

Present: James & Jacob

Goals: To ensure that the code can be uploaded and the power runs by itself

Content:

- James and I were able to fix the solder mentioned in the last part
- We also set up the load cells in the iterations prior to the ones printed today.
- We then uploaded the code to the raspberry pi and supplied the circuit via the 12 V battery
- The device worked successfully, with the "pre-trial", "during trial", and "post trial" events
- When we applied weight the scale increased as expected though the calibration was off
- See PDF below for images of testing.

Conclusions/action items

- I will need to make minor tweaks to display and units
- I will need to calibrate the load cells once everything is integrated into the walker



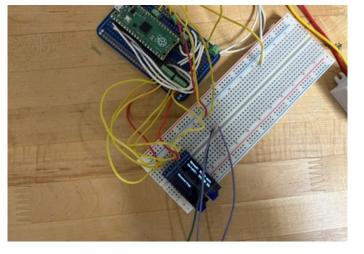
Download

IMG_5599.JPG (5.65 MB) Weight applied.

Jacob Parsons - Mar 21, 2025, 12:17 AM CDT



Jacob Parsons - Mar 21, 2025, 12:17 AM CDT



<u>Download</u>

IMG_5598.JPG (5.15 MB) Display



Jacob Parsons - Apr 10, 2025, 10:39 AM CDT

Title: Final Prototype Fabrication

Date: 4/9 & 4/10

Content by: Jacob

Present: Everybody

Goals: Put together the entire prototype

Content:

- The team worked to put together the final prototype

- Holes for the wires from the load cells and IR sensor can exit the upper leg/handle area so they can go to the central housing

- A hole was also drilled near the left handle for the wires of the OLED display and switch to travel through the frame
- This included wiring the IR sensor wires through the lower leg, load cell holder, and upper handle area into the box

- This included attaching the load cell holders, securing the load cells within the holders, soldering 22 gauge wires to the load cells, wiring them to the central box, and soldering the proper connections to complete the Wheatstone bridge.

- The team also soldered wires to the OLED displays and switch, then wired these through the upper handle to the central housing unit
- Once all of these wires were brought to the central housing box, they were then connected to the proto-boards
- These protoboards, along with the battery, were secured with Velcro to the housing unit
- Finally, the switch for the power was soldered
- The team then ensured that all connections were solid and conducted a preliminary test to ensure the device worked as intended.

Conclusions/action items:

- The team will conduct thorough prototype testing and evaluation these next coming weeks to ensure that the device functions



Jacob Parsons - Apr 16, 2025, 7:08 PM CDT

Title: Fabrication of Prototype

Date: 4/16/25

Content by: Jacob

Present: Everoyone

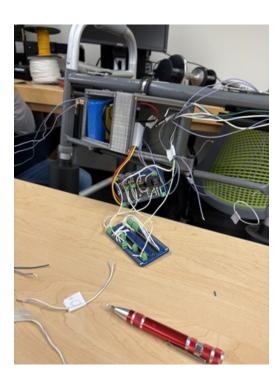
Goals: Put all of the cords into the protoboard and see if it works

Content:

- I soldered the load cell wires together to complete the Wheatstone bridge
- Then I worked with James to connect all of the wires via the connecters within the load cell
- We then conducted testing to ensure that the device still worked
- The device did still work, so we then calibrated the load cells.
- This calibration protocol can be found in protocols, and the raw results are seen below
- We weighed up to 206.5 lbs on the frame of the walker if a user is applying more pressure than that they are not capable of walking
- We then velcroed the protoboards in

Conclusions/action items:

- See if IR sensor works when we get the new print
- Conduct final testing



<u>Download</u>

IMG_5732.JPG (4.44 MB)

Jacob Parsons - Apr 16, 2025, 7:10 PM CDT



<u>Download</u>

IMG_5731.JPG (3.02 MB)

Jacob Parsons - Apr 18, 2025, 12:32 PM CDT



Download

load_cell_calibration_final.xlsx (29.6 kB)



Jacob Parsons - Apr 27, 2025, 7:02 PM CDT

Title: Final Fabrication & Testing

Date: 4/24

Content by: Jacob Parsons

Present: Whole Team

Goals: Finish the device

Content:

- I worked on fixing small issues with the wires
- I assisted in testing of the IR sensor for speed and the load cells
- We changed our IR code to use the analog pin instead of the digital pin this improved the error that we were having
- We applied up to 200 lbs of weight to the walker to gather a calibration curve
- We used the force plates in the teaching lab to compare how our device measures force

Conclusions/action items:

- The team has completed the project
- Now we just need to finish final delicerables

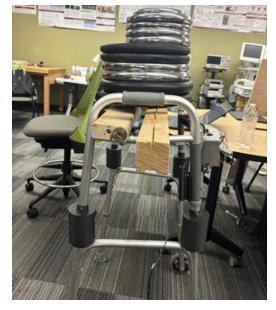


Download

IMG_5754.JPG (4.51 MB)



Jacob Parsons - Apr 27, 2025, 7:02 PM CDT



Download

IMG_5753.JPG (5.07 MB)

Jacob Parsons - Apr 27, 2025, 7:02 PM CDT



<u>Download</u>

IMG_5752.JPG (6.38 MB)

Jacob Parsons - Apr 27, 2025, 7:02 PM CDT



<u>Download</u>

IMG_5751.JPG (6.32 MB)



James Waldenberger - Sep 13, 2024, 1:40 PM CDT

Title: Previous Work

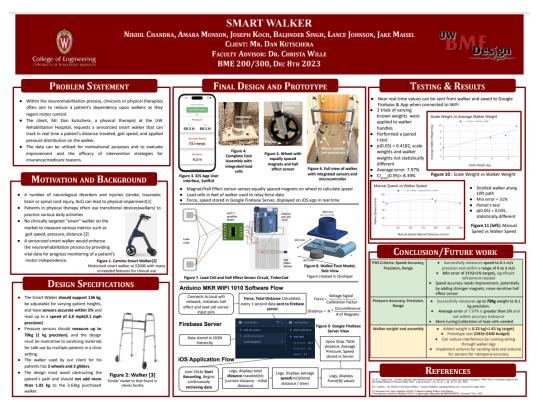
Date: 9/12/2024

Content by: James Waldenberger

Present: N/A

Goals: Analyze the previous team's work on the Smart Walker and determine what went well and what didn't.

Content:



The previous smart walker project was on the right track with what the client is looking for, but failed to deliver in terms of accuracy and lacked a proper housing for the electronic components. The previous team used a load cell to measure the force through the legs of the walker and a hall effect sensor to sense the rotation of the wheel and estimate the distance traveled, the ladder of which was wildly inaccurate.

Pros

- Tailored to the user's needs very well and even incorporates an app that shows the user their biometrics during their walk in real-time
- · Very simple circuits and mechanical components mean that this prototype is cheap compared to other options
- Their application of load cells, while slightly outside of their PDS range for error, showed promise for this specific application
- Could feasibly be modified to be an attachment to an existing walker rather than an entirely new walker, meaning an
 expanded market

Cons

· No housing for the electrical components

James Waldenberger/Research Notes/Competing Designs/9/12/24 Previous Work

• Hall effect sensor and magnetic wheels did not really work for their intended purpose, likely meaning that a new approach is needed for this semester's project to work

Conclusions/action items:

Incorporate the pros into our design and try and find design solutions to the cons.

9/12/24 Competing Designs

James Waldenberger - Sep 13, 2024, 1:45 PM CDT

Title: Competing Designs

Date: 9/12/2024

Content by: James Waldenberger

Present: N/A

Goals: Look at designs for various smart walker type devices that are already on the market/patented and see what they have in common and what design decisions that we'll have to make in regards to sensors type and sensor location.

Content:

Camino Smart Walker

Search term: "smart walker"

Google

https://caminomobility.com/

More orientated to be a product than a device for medicine, however it does have some interesting features. Most of the "smart" parts of the walker are used for navigation, with built in boost and breaks, and sensors to help move the walker on an incline. The part most similar to our project is the integration of AI to track 22 different gait metrics (however it doesn't say what ones). That being said, there probably isn't much similarity between this product and our project because of the different use-cases. Also to note, something of this complexity is already costing around \$2,500.

Volaris Smart Rollator Walker

Search term: "smart walker"

Google

https://xlentcare.com/product/volaris-smart-rollator-walker/

Concerns itself heavily with the ease-of-use and convenience of the walker. Has some very good features that could be implemented if we were to make a walker from scratch for this project, although that doesn't seem to be the case.

Walker with anti-fall technology for elderly safety

Search term: "walker with sensors"

Google

https://www.frontiersin.org/journals/neurorobotics/articles/10.3389/fnbot.2020.575889/full

Slightly unwieldy walker packed chock-full of technology to help the elderly navigate while also protecting from a fall. It senses pressure from the grip of the user and determines whether or not a fall is predicted with that information via microcontroller. The pressure is measured by air pressure sensors that are within the sponge grip of the walker, so they can detect how much it is being squeezed. They also bring up the concern that a touch UI could be difficult for people who are severely limited with their movement to use, so we need to keep that in mind when designing buttons or controls for our walker.

James Waldenberger/Research Notes/Competing Designs/9/12/24 Competing Designs

129 of 233

Mobility assistance apparatus

Search term: "smart walker"

Google patents

https://patents.google.com/patent/US20220211568A1/en?q=(smart+walker)&oq=smart+walker

Uses loading cells and strain gauges to determine the force through the walker's limbs, and this data, among other biometrics being derived from a number of different types of sensors, is output to the user to determine their health. The kinematics part of the biometrics is mainly being done by accelerometers and IMUs.

Instrumented mobility assistance device

Search term: "walker with sensor"

Google patents

https://patents.google.com/patent/US7826983B2/en?q=(walker+sensor)&oq=walker+with+sensor

Similar to some of the other walkers, this one uses sensors in the handle to measure the force transmitted through the user to the walker. The peaks and valleys of the output force vs. time graph are correlated to parts of the users gait, and can be used to make calculations to infer about the users gait speed, travel distance, and stability/balance when using the walker. The load cells used on the handle are commercially-available 6-DoF sensors.

Conclusions/action items:

This research has led me to have a couple of questions about the project. Namely, we need to decide on an interface that is accessible to people who have trouble moving, as a touch screen (and possibly buttons) could be too difficult to use. With force sensing, there seems to be two popular locations for the load cells/force sensors: The handle, or the legs of the walker.



James Waldenberger - Dec 11, 2024, 9:46 PM CST

Title: Force Sensors

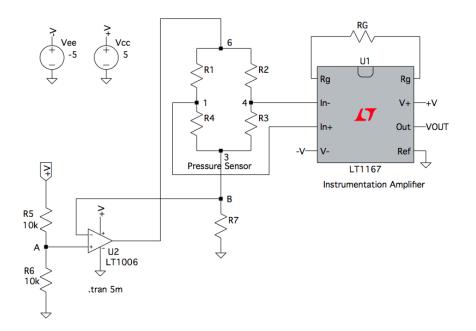
Date: 9/19/2024

Content by: James Waldenberger

Present: N/A

Goals: Get a grasp on the different types of sensors that can measure force for that aspect of the Smart Walker, and then figure out how to implement them into a circuit to accurately determine the force through the legs of the walker.

Content:



As Nimunkar mentioned last week, we have previously used a pressure sensor circuit in BME 310, so something similar to the above circuit might work for our design in 401. We would copy this setup and create the Wheatstone bridge with the load sensors.

https://www.iqsdirectory.com/articles/load-cell/force-sensors.html

This source goes into some detail about different types of force sensors, their applications, and some pros/cons about them. Listed here are the different types:

- Inductive sensor
- · Capacitive sensor
- Magnetic sensor
- Piezoresistive sensor
- Strain gauge sensor

Out of all of these the most realistic and cost-effective option seems to be the strain gauge sensor. Be sure to ask Nimunkar his opinion on sensor option.

https://www.800loadcel.com/white-papers/how-a-load-cell-works.html

According to this source, load cells are strain gauges arranged on a body called a spring element and arranged into a Wheatstone bridge conformation, wherein an applied deformation results in a change in voltage that can be measured and be used in calculating force based on the calibration curve of the sensor. However,

James Waldenberger/Research Notes/Components/9/19/24 Force Sensors

131 of 233

price of these load cells according to Google seems to be pretty expensive? The picture below is similar to what the past team used for their force sensor, although they were slightly less accurate than expected.



Conclusions/action items:

Make a decision on the type of sensor we want to use moving forward.

Comments	Amit Nimunkar Please add entry for the Biology and Physiology in context with the project you are working.	Sep 29, 2024, 9:27 AM CDT
	Amit Nimunkar Please provide circuit diagram on how this load cell would be connected.	Sep 29, 2024, 9:27 AM CDT



James Waldenberger - Sep 20, 2024, 12:07 PM CDT

Title: Movement Sensor

Date: 9/19/2024

Content by: James Waldenberger

Present: N/A

Goals: Start to understand the different methods of sensing distance traveled by the Smart Walker, and the working principle of the sensors used.

Content:

Accelerometer

https://www.geeksforgeeks.org/accelerometer/

There are multiple different working principles for accelerometers, but they all do the same thing on the big picture scale. Converts acceleration of the sensor into an electrical signal, that can be integrated once or twice to determine velocity and distance respectively.

With this integration however, it would mean that any error in the accelerometer's measurement would be intensified each time.

Optical sensor

Another method of measuring the distance and speed of the walker would be to have a camera or other optical sensor pointed towards the ground to detect high-contrast markings with known distance between them.

What kind of camera/sensor would be best?

Optical encoder

https://www.encoder.com/article-what-is-an-optical-encoder

Detects beams of light that slip through slits in a disk as it spins around, thus creating a sinusoidal-like waveform that can determine how many rotations have occurred. This could be used in our situation to measure total number of rotations of the wheels of the walker, which would in turn give us a decent measurement of distance traveled and speed.

This is similar to the method that the previous team used, so there could be some concern with the accuracy, but having a prebuilt sensor to do all the work seems like a better option than their magnets. However, if the wheels slip or are otherwise don't have perfect traction on the ground, then there would be some error in the measurement.

Conclusions/action items:

Figure out what type of sensing we want the walker to use to measure distance and speed.



James Waldenberger - Sep 26, 2024, 11:29 PM CDT

Title: Specific Sensors

Date: 9/26/2024

Content by: James Waldenberger

Present: N/A

Goals: Research specific load cells and accelerometers to find one of each that fits our requirements for the project, and then get it ordered shortly

Content:

Specific Sensors

Accelerometers

ADXL345

- Datasheet: https://www.analog.com/en/products/adxl345.html#part-details
- Tutorial: https://www.youtube.com/watch?v=NPTK0inTldw
- · Go to accelerometer for a lot of different Raspberry Pi projects
- About \$3, very small
- 2.0-3.6 volt supply
- 10-13 bit resolution
- There are a lot of "frills", maybe ADXL335 would be better suited: https://www.analog.com/en/products/adxl335.html#part-details

LIS2DW12TR

- Website: https://estore.st.com/en/lis2dw12tr-cpn.html?srsltid=AfmBOoqJg4qEEzXO_JyIqaPc3vKesHqCIxDkWbNHn2s2SI-SaCWi0PM
- Similar to the ADXL345: 1.6-3.6 volt supply and low power consumption, about \$3
- 16 bit resolution

MPU-6050

- Website: https://www.adafruit.com/product/3886
- · 6 DoF sensor (gyroscopes included, is that needed?)
- · Largest out of the three, but not too big
- Simple connections
- Most expensive at \$13

Load cells

Building a weight sensor example: https://tutorials-raspberrypi.com/digital-raspberry-pi-scale-weight-sensor-hx711/

Generic Sparkfun Load Sensor (1 strain gauge)

- Website: https://www.sparkfun.com/products/10245
- 50kg weight (is that enough?)
- Requires 4 in a wheatstone bridge conformation with amplification
- · Use-case: https://learn.sparkfun.com/tutorials/getting-started-with-load-cells
- Load cell amplifier: https://www.sparkfun.com/products/13879
- ~\$31 for all of the components



Conclusions/action items:

Combine research with team and decide on the sensors we want to use for the project, and order them shortly thereafter.

James Waldenberger - Dec 11, 2024, 5:25 PM CST

Title: Voltage Regulators

Date: 11/7/24

Content by: James Waldenberger

Present: N/A

Goals: Get an idea of how voltage regulators work and find some that will work for our specific case with the Smart Walker.

Content:

DC to DC buck converters:

https://www.adafruit.com/product/2745#technical-details

https://www.sparkfun.com/products/21337?gad_source=1&gclid=Cj0KCQiA57G5BhDUARIsACgCYnynKAaxXzPy-eeI45isqqXIvXzx9E_8kEVkA5qnxSTJ5muNPAkSHnwaAtzKEALw_wcB

These are both 6 volt inputs and 3.3 volt outputs, there doesn't seem to be a 12-3.3 volt converter, what do we do?

Conclusions/action items:

Continue research into finding the proper voltage regulators for the project.



OWEN KOLNIK - Feb 05, 2025, 3:08 PM CST

Title: Power Supply and Regulation

Date: 1/30/25

Content by: James Waldenberger

Present: Jacob Parsons

Goals: Get some ideas for what is needed for the power supply and voltage regulation for the Smart Walker, and find links to any component that we need to buy to do so.

Content:

Load Sensor Circuit

LT1920 = ±18 V

TL072 = ±20 V

TC962 = 3-18 V

Current draw of load sensor circuit including Wheatstone bridge = ~16 mA

Microcontroller (https://datasheets.raspberrypi.com/pico/pico-datasheet.pdf)

Raspberry Pi Pico = 1.8-5.5 V

Average current draw at room temp = ~86.5 mA

SSD1306 OLED Display (https://cdn-shop.adafruit.com/datasheets/SSD1306.pdf)

Vdd [IC logic] = 1.65-3.30 V

Datasheet says current = 15 mA

Test current draw with multimeter

ADXL345 (https://www.analog.com/media/en/technical-documentation/data-sheets/adxl345.pdf)

Supply voltage = 2.0-3.6 V

I/O voltage = 1.7-Vs V

12.5-3200 Hz in regular mode = 50-140 uA

12.5-400 Hz in power saving mode = 34-90 uA

- 12 V voltage regulation for amp power
- 3.3 V voltage regulation for accelerometer and level shifter input
- 5 V voltage regulation for microcontroller wire?

Battery

James Waldenberger/Research Notes/Components/1/30/25 Power Supply and Regulation

Recharging circuitry

Step-down converters

Low power indicator - Display power when not in a trial!

12V, 2.6Ah Li-Ion battery with charger - Output displayed on page says 9-12.6 V, does that mean it will fluctuate between these values? If so, would we want to regulate at 9 V instead of 12 V OR look for a higher voltage battery?

DC to DC Buck Converter, 12V to 5V

DC to DC Buck Converter, 12V to 3.3V

https://www.dfrobot.com/product-2599.html?srsltid=AfmBOooQCFrC_HUUAsx1IL0dPu8iRf7KajB1joqfh4wfsKiyOnZ2mDTU

Conclusions/action items:

Talk with Dr. Nimunkar and see if the listed components work for our purposes, update as needed.



James Waldenberger - Sep 13, 2024, 1:45 PM CDT

Title: Preliminary Design Ideas

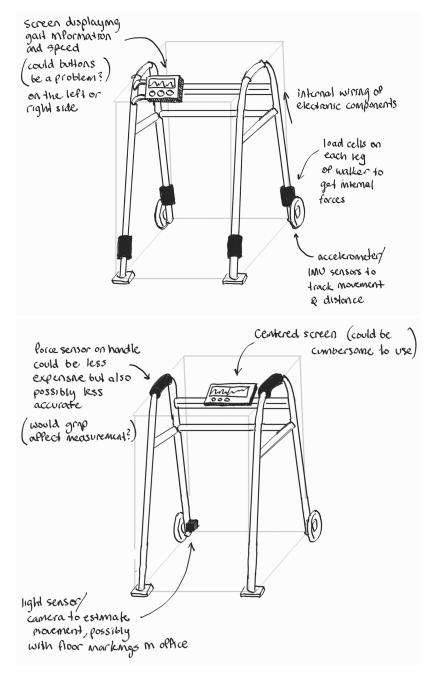
Date: 9/12/2024

Content by: James Waldenberger

Present: N/A

Goals: Present preliminary ideas through a couple of drawings to visualize different components the design.

Content:



Conclusions/action items:

Finalize design ideas and make an improved drawing of the design for the preliminary presentation.



James Waldenberger - Oct 24, 2024, 11:17 PM CDT

Title: Load Sensor Circuit

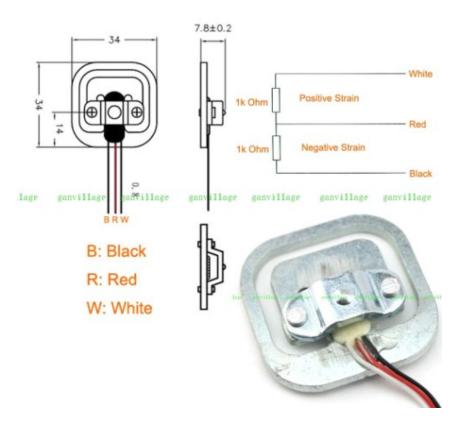
Date: 10/16/24

Content by: James Waldenberger

Present: N/A

Goals: Design a circuit for the load sensor to get force input and output readings from the Pi Pico.

Content:



Possibly a good resource: https://electronics.stackexchange.com/questions/102164/3-wire-load-cells-and-wheatstone-bridges-from-a-bathroom-scale#comment201017_102167

Gain Calculation:

According to datasheet, resistance can be 1000+/-20 ohms on the input and output resistance of the load sensor

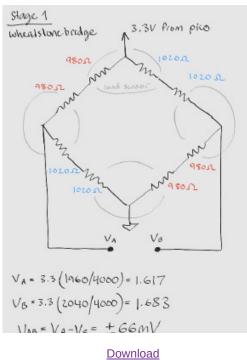
In a voltage divide with a 1kohm fixed resistor, this value will fluctuate by no more than 17mv in either direction 1.65 - 3.3(980/1980) = 0.0167V and 3.3(1020/2020) - 1.65 = 0.0163V, meaning gain g = 3.3/0.017 = 194.12 V/V

However, voltage divider is not the only possible circuit setup. Here I will explore some options for the force measurement circuitry:

Conclusions/action items:

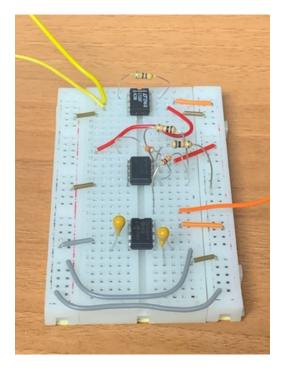
Finish building circuit and start calibrating load cells based on voltage increase/decrease from microcontroller input.

James Waldenberger/Design Process/10/16/24 Load Sensor Circuit



Load_Sensor_Circuit_diagram_241018_105414.pdf (2.52 MB)

James Waldenberger - Dec 11, 2024, 9:26 PM CST



Download

Breadboarded_Circuit_.jpg (157 kB)



James Waldenberger - Nov 11, 2024, 1:50 PM CST

Title: Load Testing

Date: 10/24/24

Content by: James Waldenberger

Present: N/A

Goals: Try out the load sensor circuit and see if it is functional. If so, then calibrate the circuit based on weight input to get a calibration curve that can be used to plot the voltage to force relationship.

Content:

Within Expectations

- Resistance between Wheatstone bridge terminals with no load = ~2 kOhm <- good because each load cell is approximately 2 kOhm, so 4k || 4k = 2kOhm

- Voltage of each terminal of Wheatstone bridge with no load = 1.660-1.662 V (each one measured separately, yields similar voltage values)

- From 5 V Nucleo power, and 3.3 V Nucleo input into level shifter, there seems to be minimal noise, and the level shifter output is centered around 1.644 V (with 1.65 V expected)

Existing issues (to be fixed for show and tell)

- 25 mv difference from LT1920 output that decreases to zero if pressure is applied -- I had thought that the voltage difference should increase.

- Approximate 20 mv change in voltage from pressure to an individual load sensor, doesn't seem to change at all when multiple sensors have pressure applied.

- Fixed all wiring errors on breadboard. [10/24]

- Insecure connections.

Further Testing

LT1920 input with one load sensor (V+ to white, GND to black, red wire to non-inverting terminal) and 1k/1k voltage divider (middle to inverting terminal) gave an output voltage that INCREASED with an increase in pressure to the load sensor, meaning the white-to-red resistance decreases and the black-to-red resistance increases with pressure applied. This was consistent between all four load sensors. This means that the Wheatstone bridge should be between similar wires connecting each load sensor, as was drawn in the *Load Sensor Circuit* entry. That also means that the lack of voltage output change with pressure to the Wheatstone bridge was caused by something else, although Jacob and I hooked up the Wheatstone bridge to the circuit and it gave a +1V change when pressure was applied to all four load sensors (what is the reason behind this inconsistency? It's possible that I hooked something up wrong with my first test).

Conclusions/action items:

Fix existing issues in the circuit for show and tell.



James Waldenberger - Nov 14, 2024, 9:38 PM CST

Title: Power Supply

Date: 11/7/24

Content by: James Waldenberger

Present: N/A

Goals: Run some calculations to see what power supply will be needed for the circuitry.

Content:

Load Sensor Circuit

LT1920 = ±18 V

TL072 = ±20 V

TC962 = 3-18 V

Current draw of load sensor circuit including wheatstone bridge = ~16 mA

Microcontroller (https://datasheets.raspberrypi.com/pico/pico-datasheet.pdf)

Raspberry Pi Pico = 1.8-5.5 V

Average current draw at room temp = ~86.5 mA

SSD1306 OLED Display (https://cdn-shop.adafruit.com/datasheets/SSD1306.pdf)

Vdd [IC logic] = 1.65-3.30 V

Vcc [Panel Driving] = 7-15 V

Idd = 430 uA

Icc = 50 uA

Iseg [Segment Display] = 100 uA (depends on contrast)

Iref = 12.5 uA

ADXL345 (https://www.analog.com/media/en/technical-documentation/data-sheets/adxl345.pdf)

Supply voltage = 2.0-3.6 V

I/O voltage = 1.7-Vs V

12.5-3200 Hz in regular mode = 50-140 uA

12.5-400 Hz in power saving mode = 34-90 uA

• 12 V battery

3.3 V voltage regulator for microcontroller and accelerometer? OR will 5 V be necessary for the Raspberry Pi?

Update 11/14/2024

12V power bank

12V regulator - L7812CV

https://www.digikey.com/en/products/detail/stmicroelectronics/L7812CV/585973

Possibly would need a higher voltage power bank to use this. Need a 0.33uF and 0.1uF capacitor to hook up along with the chip to get a better output (see load regulation circuit on datasheet). Output would go to positive rail of breadboard, input from power bank.

12V to 5V DC to DC converter - 78SRH-5/2-C

https://www.mouser.com/ProductDetail/Murata-Power-Solutions/78SRH-5-2-C/?qs=35WhQNrE6p2IJ6BniHrImQ%3D%3D

2A output with 2% output voltage accuracy, 8-32Vdc input from the 12V regulator, would be used to drive Pico. How would you go from output wire to micro-USB? Or is there a place to power the Pico elsewhere?

Could also use another L7805 possibly (same as above).

3.3V regulator

Use regulated 3.3V output from the accelerometer, rated for ____ amps, goes to level shifter non-inverting terminal.

Conclusions/action items:

Get the circuit running with regulation and portable, rechargeable power supply.



11/7/24 Altium Schematic [Full Circuit]

James Waldenberger - Dec 11, 2024, 9:48 PM CST

Title: Altium Schematic [Full Circuit]

Date: 11/7/24

Content by: James Waldenberger

Present: N/A

Goals: Create a schematic for the full circuit including Raspberry Pi microcontroller and all other accessories.

Content:

List of components

- LT1167 instrumentation amp
- 480 ohm resistor
- 2x 10 kohm resistors
- 2x 20 kohm resistors
- TL072 op amp
- 2x 10 uF capacitors
- TC962CPA
- 4x Load sensors
- Raspberry Pi Pico microcontroller
- ADXL345 accelerometer
- 2x SSD1306 OLED display

Conclusions/action items:

Update when new components are added/existing components are tweaked.



James Waldenberger - Nov 19, 2024, 5:45 PM CST

Title: Load Sensor Calibration For Poster Presentation

Date: 11/19/24

Content by: James Waldenberger

Present: N/A

Goals: Calibrate the load sensor circuit with a calibration curve to be used by the microcontroller during the poster presentation to display the weight placed on the platform based on the voltage input to the microcontroller.

Content (Also see Team activities -> Testing and Results -> Protocols -> Load Cell Calibration Curve Testing):

Weight (lbs)	Force (N)	Avg Vout (V)	Min Vout (V)	Max Vout (V)
0	0	1.665	1.64	1.69
15	66.75	1.730	1.71	1.75
30	133.49	1.775	1.76	1.79
45	200.24	1.820	1.80	1.84
60	266.98	1.860	1.85	1.87
75	333.73	1.915	1.90	1.93
90	400.48	1.955	1.94	1.97
100	444.97	1.980	1.96	2.00
125	556.22	2.075	2.05	2.10
150	667.46	2.165	2.14	2.19
175	778.70	2.240	2.22	2.26
200	889.95	2.320	2.30	2.34

With reversed leads gives:

Weight (lbs)	Force (N)	Avg Vout (V)	Min Vout (V)	Max Vout (V)
0	0	1.665	1.64	1.69
15	66.75	1.590	1.57	1.61
30	133.49	1.525	1.51	1.54
45	200.24	1.470	1.45	1.49

60	266.98	1.450	1.43	1.47
75	333.73	1.410	1.39	1.43
90	400.48	1.360	1.34	1.38
100	444.97	1.325	1.31	1.34
125	556.22	1.235	1.22	1.25
150	667.46	1.155	1.14	1.17
175	778.70	1.070	1.05	1.09
200	889.95	0.990	0.970	1.01

Testing done without non-inverting amplifier stage (just instrumentation amp and level shifter which has about 50 V/V of gain total)

Other notes from testing:

- Slightly noisy signal, as apparent in the difference between max and min values in the graph above. However, this was done without voltage regulation from the 12V power and 3.3V power, so improvements could be seen by implementing some changes outline in my power supply notes
- Level shifter output was spot on at 1.64-1.69V (1.65V expected), non-inverting amp stage messed with this value and brought it down to about 1.0 V (is a voltage buffer necessary if that were to be implemented?)
- Could increase gain leaving the circuit as-is, OR could increase gain and remove level shifter (so long as the leads give a positive voltage based on instrumentation amp output), which would effectively double the gain. HOWEVER, Rg for the LT1920 is already practically as low as possible, this would require another amplification stage.

Conclusions/action items:

Try to improve the noisiness of the signal and the total gain of the signal for the finished product next semester.



2/13/25 Power Supply and Regulation Integration

James Waldenberger - Apr 07, 2025, 1:49 PM CDT

Title: Power Supply and Regulation Integration

Date: 2/13/2025

Content by: James Waldenberger

Present: N/A

Goals: Integrate the battery and voltage regulators into the load cell circuit and test for any problems.

Content:

Current Draw:

- Load cell circuit = 10-20 mA
- 3.3V to level shifter = 0.1 mA
- Pico = >300 mA

Significant current draw from the Pico, way more than what was expected. The 5V voltage regulator output was hooked up directly to the Pico, but maybe there needs to be a current-limiting resistor as well?

Voltages:

- 9V, 3.3V, and 5V regulators all output voltages decently close to what was advertised.
- · Load cell circuit was not working as intended, however

I was getting around a 5V output from the level shifter when it's supposed to be around 1.65V. It also didn't change with applied pressure to the load cells. It's possible that something was hooked up wrong, but more investigation is needed.

Conclusions/action items:

Make changes to the load cell circuit to eliminate any problems.

James Waldenberger - Apr 07, 2025, 1:48 PM CDT

Title: Power Supply Fix

Date: 2/21/25

Content by: James Waldenberger

Present: Jacob Parsons

Goals: Fix the problems from the power supply from the previous attempt at putting the whole circuit together.

Content:

• Voltages in circuit fixed, DC to DC converted was wired incorrectly for -9V

Fixed Circuit = 14-18 mA (similar as with external power)

• Pico problems were because I had used an old Pico W instead of a regular one, leading to much more current being drawn than needed

Fixed Pico = 17 mA (a lot less than expected, so that's good for the battery life)

Conclusions/action items:

Now that the power supply all works, it's time to test the whole circuit and see if each facet works as intended, and displays accurate data values accordingly.



James Waldenberger - Apr 07, 2025, 2:06 PM CDT

Title: Full Circuit Test

Date: 2/25/25

Content by: James Waldenberger

Present: Jacob Parsons

Goals: Test the whole circuit (IR sensor, screens, load cells) all in tandem and see if accurate values are calculated and displayed by the microcontroller.

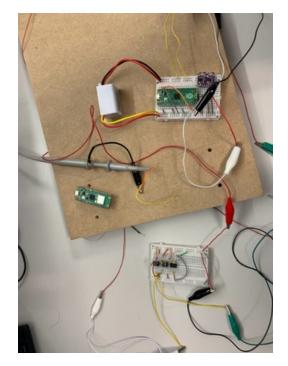
Content:

- · We connected everything, including the battery, regulation, IR sensors, screens, load cell circuit, and Pico with wires or alligator clips
- · Load sensors were put in their respective holders on the wooden board (similar to a bathroom scale, pictured below)
- Uploaded blinking LED code to the Pico, and it still worked when unplugged from computer using battery power. This means that our final code will also be able to function once it's uploaded to the Pico
- Entire circuit (including 2x screens and IR sensor) was hooked up and worked properly, with the exception of one screen that had some I/O errors
 - Resolder screen that threw errors, problem should be fixed
 - Values for IR sensor looked realistic close to real distance value
 - Values for load cell circuit weren't tested very accurately, but an increase in weight was displayed on the screen as it was applied
- Don't know the regular current draw for the entire circuit yet because the multimeter was causing issues when hooked up in series with the battery
 - Test battery once final circuit is ready

Conclusions/action items:

Solder components together on a proto board instead of using a breadboard to ensure connections stay secure for a long while.

James Waldenberger - Apr 07, 2025, 1:58 PM CDT



Download

Breadboard_Test.jpg (148 kB)



James Waldenberger - Apr 07, 2025, 2:03 PM CDT

Title: Proto Board

Date: 3/6/25

Content by: James Waldenberger

Present: Jacob Parsons

Goals: Soldering didn't go as planned, make a template of the components on the proto board to figure out how to solder

Content:

Template below shows the connections needed for the load sensor circuit.

Green = wire connectors

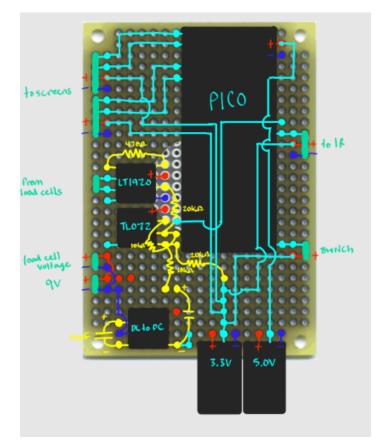
White = wires

Black areas = pin headers, unusable space

Red = positive potential

Blue = ground

Yellow = resistors or capacitors



I am concerned at parts where there needs to be multiple connections to the same node (i.e. ground or power) because each pin is separate from adjacent pins, meaning the soldering could get really messy/out of control quickly, which has been shown to be bad for long-term connections.

Conclusions/action items:

Need advice on how to do many different connections together without rails (i.e. ground or power)



James Waldenberger - Apr 07, 2025, 2:10 PM CDT

Title: Final Soldering

Date: 3/13/25

Content by: James Waldenberger

Present: Jacob Parsons

Goals: Purchase new proto board with a classic breadboard layout and solder components on exactly the same as on the breadboard itself.

Content:

- We didn't end up using the diagram from my previous entry for the design
 o Instead, we replicated what was already done on the breadboard
- 8 pin headers were used for the amps
- 4 pin headers were used for the regulators
- A combination of 10 pin headers were used for the Pico
- · Wire connectors were used for any wires that would be extraneous to the breadboard itself
- · 24 gage multi-threaded wire was used for connections between pins

Link to wire connectors:

https://www.amazon.com/Molence-Terminal-Connector-Terminals-26-18AWG/dp/B09F6TC7RP/ref=asc_df_B09F6TC7RP? mcid=13416068e09e3043be240ff8bba58453&hvocijid=14574968898387925761-B09F6TC7RP-&hvexpln=73&tag=hyprod-20&linkCode=df0&hvadid=730312820598&hvpos=&hvnetw=g&hvrand=14574968898387925761&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9018944&hvtargid=pl 2281435179538&psc=1

Link to proto board:

https://www.amazon.com/ElectroCookie-Solderable-Breadboard-Electronics-Gold-Plated/dp/B07ZV8FWM4/ref=asc_df_B07ZV8FWM4? mcid=98c57796c077375ea28cad4a577596aa&hvocijid=14897081058880657222-B07ZV8FWM4-&hvexpln=73&tag=hyprod-20&linkCode=df0&hvadid=730312820598&hvpos=&hvnetw=g&hvrand=14897081058880657222&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9018944&hvtargid=pl 2281435177898&th=1

See below for a picture of the proto board.

Conclusions/action items:

Once again, we want to test each component. Same test as the full circuit test to make sure that the solder connections are good.



Download

SolderedBoard.jpg (188 kB)

3/20/25 Proto Board Testing

James Waldenberger - Apr 07, 2025, 2:09 PM CDT

Title: Proto Board Testing

Date: 3/20/25

Content by: James Waldenberger

Present: Jacob Parsons

Goals: Test components on the proto board to ensure solder connections are secure.

Content:

- Mostly the same setup as the Full Circuit Test entry
- · Load cells were tested INSIDE the holders to ensure that our design functions together properly
 - Weights were placed on top of all load cell holders
 - · Weight numbers were not correct, so recalibration must occur again for the final design
 - However, weight went up and down accordingly as things were placed on the holders, meaning that the design functions.
 - See picture below for testing setup
- Everything else looked good!

Conclusions/action items:

Put all the electrical components in their respective places on the walker and calibrate the whole thing.

James Waldenberger - Apr 07, 2025, 1:59 PM CDT



Download

Protoboard_Test.jpg (194 kB)



4/9/25 Load Cell Holder Assembly

James Waldenberger - Apr 11, 2025, 1:35 AM CDT

Title: Holder Assembly

Date: 4/9/25

Content by: James Waldenberger

Present: Whole group

Goals: Assemble the load sensors and load cell holders into their final housings on the walker

Content:

- For each leg:
 - Bottom load cell holder bolted on to leg of walker
 - Load cell went into slot
 - Thread wires through hole on top piece of load cell holder
 - Bolt the top load cell holder to attach the rest of the walker
 - Screw in ring holding two piece together on bottom
- For IR sensor leg, an additional three wires must be brought through the entire load cell holder
- Additionally, wires were ran through the body of the walker and out near the top of the leg to connect the loose wires from the load cell to the microcontroller
- Labeling of all wires fed through the walker is imperative to keep track of what goes where

Conclusions/action items:

Need to solder wires connecting load cell wires to the housing case on the front of the walker, and finish up with the assembly of the whole walker.



Title: Full Walker Assembly - IR and Screens

Date: 4/10/25

Content by: James Waldenberger

Present: Whole group

Goals: Continue with the assembly of the walker, finalize connections of load cell holders and work on IR sensor and screens/switch.

Content:

- · Issue: IR sensor mechanism/wires block the bottom two (sometimes three) pegs of the adjustability setting of the wheel from use
 - Can't fix the first two pegs, they will remain unusable in the current design
 - Third peg can be relatively easily reached, but sometimes wire bunching in the leg can make it difficult
 - Any way to fix strain on soldering join of IR sensor? Prevent wire bunching?
- · Wires from load cell have been extended and reach through the legs of the walker to where the housing goes
- All 10 wires from the screens/switch have been threaded through towards the housing as well
 - Bottom piece of the screen/switch case needs to be remodeled to allow 10 wires of decent gage size to fit through
 - Currently fits only around 4 wires
- Issue: IR sensor holding print broke
 - Solution: Reprint
- Issue: Bottom load cell holder (specific to IR sensor leg) must be adjusted to that the hole for the wires aligns closer to the above hole on the top piece to prevent wires from interfering with sensor/ceiling interface.
 - Solution: Fix and reprint

Conclusions/action items:

Nearly done with walker assembly, some stuff with the wires remains.



Download Screenholder.jpg (151 kB) James Waldenberger - Apr 28, 2025, 11:38 PM CDT



James Waldenberger - Apr 16, 2025, 5:49 PM CDT

Title: Full Walker Assembly - Wires

Date: 4/15/24

Content by: James Waldenberger

Present: Jacob Parsons, Owen Kolnik

Goals: Continue the assembly of the walker.

Content:

- Issue: IR sensor wire bunching up when wheel is adjusted
 - Solution: Bring wire outside instead of through the load cell
 - We need to shrink wrap this wire eventually
- · Connected electrical housing to walker
- · Brought all screen, switch, and load cell wires through to the housing and pulled them taught
 - Some abrasion happens on the wire-walker interface because the holes are not entirely smooth
 - Long term issues?
- · Connected all load cell components, including bottoms, tops, and C-shaped stops
- Connected entire walker together

Conclusions/action items:

We need to connect all the wires to the protoboard and test/calibrate design.

James Waldenberger - Apr 28, 2025, 11:39 PM CDT



Download

Wirewalker.jpg (147 kB)

James Waldenberger - Apr 28, 2025, 11:40 PM CDT





<u>Download</u>

Fullwalkerwires.jpg (255 kB)



James Waldenberger - Apr 16, 2025, 5:57 PM CDT

Title: Full Walker Assembly - Protoboard

Date: 4/16/25

Content by: James Waldenberger

Present: Whole group

Goals: Screw wires into their respective holders on the protoboard.

Content:

- All Connections:
 - 9V regulator +
 - 9V regulator ground
 - LT1920 input +
 - LT 1920 input -
 - Load cell power +
 - Load cell ground
 - Load cell pin
 - 5V regulator to Pico Vsys
 - 3V regulator to 2nd breadboard
 - Ground to ground between breadboards
 - IR power
 - IR ground
 - IR pin
 - Screen 1 +
 - Screen 1 ground
 - Screen 1 pin 1
 - Screen 1 pin 2
 - Screen 2 +
 - Screen 2 ground
 - Screen 2 pin 1
 - Screen 2 pin 2
 - Switch +
 - Switch pin
 - Power switch +
 - Power switch ground
- Screens work individually
- IR sensor works individually

James Waldenberger/Design Process/4/16/25 Full Walker Assembly - Protoboard

• Load cells output increasing weight (not accurate yet)

Conclusions/action items:

Calibrate load cell curve.

James Waldenberger - Apr 28, 2025, 11:39 PM CDT



<u>Download</u>

Protoboardassembly.jpg (137 kB)



James Waldenberger - Apr 30, 2025, 4:55 PM CDT

Title: Calibration

Date: 4/16/25

Content by: James Waldenberger

Present: Whole group

Goals: Incrementally increase weight on the walker and get a calibration curve.

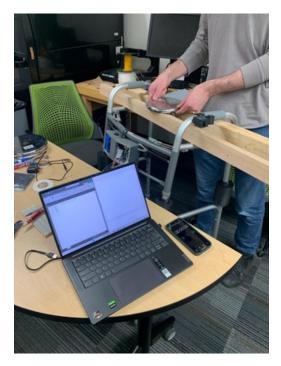
Content:

- · See "Calibration Protocol & Equation" page (Team Activities -> Fabrication) for more instruction on individual tests
- Weight of planks = 6.4 lbs (used to hold weights on walker)
- Went up to 200lbs applied to walker with no structural issues
- · Some noise in the measurements, so we averaged 50 samples for 3 different trials at each weight
- Solid fit for the calibration curve, with an Rsquared of 0.995, meaning that it should be good to go

Conclusions/action items:

Test calibration curve to see if it displays sensical weight values, then test further using force plates to find the error.

James Waldenberger - Apr 28, 2025, 11:40 PM CDT



Download

Calibrate.jpg (188 kB)

James Waldenberger - Apr 28, 2025, 11:11 PM CDT

Title: IR Issue Resolving

Date: 4/21/25

Content by: James Waldenberger

Present: Whole group

Goals: Resolve an issue we had with the IR sensor where the wires would prevent the walker from being adjusted in that leg.

Content:

- IR sensor wires bunching up below the load cell holder cause the walker to not be able to be adjusted below the 3rd/4th height setting
- · Unnecessary strain due to this bunching is all directly applied to the soldered pins of the IR sensor

Idea 1: Coiled wires inside the leg

- If the wires were connected directly to a spring or slinky-like object inside the leg, they wouldn't bunch up and instead follow the compression of the object.
- Difficult to fabricate, especially considering some pins go through the hollow leg
- Difficult to fix to the inside of the leg

Idea 2: Wrapped wires inside the leg

- Bunching wouldn't be as much of a problem if all the wires were combined using heat-shrink wrapping
- We would need to take out the wire and re-thread it through the leg
 - We attempted this, and the bigger wire still bunched, causing friction with the wall and continued difficulty adjusting

Idea 3: Bring the IR sensor wires outside the leg and around the load cell

- · Would alleviate all issues previously mentioned
- · Possible tripping hazard for the user
- Not as aesthetically pleasing

We ended up going with idea 3 for the final walker, where the wire was brought out externally, coiled, and wrapped with heat-shrink tubing to create a solid, dense wire on the outside. The walker is still only able to be brought down to the second height adjustment setting because the IR sensor itself causes a blockage internally (we need to explain this to Kutschera before handing it off). There is some slack when used on the lowest-possible setting, but we used an extra wire channel to help guide the extra wire to where it needs to go without creating a large tripping hazard.

Conclusions/action items:

Continue fabrication of walker, the IR fabrication is now complete.



James Waldenberger - Apr 28, 2025, 11:28 PM CDT

Title: Load Cell Issue Resolving

Date: 4/22/25

Content by: James Waldenberger

Present: Owen Kolnik, Eva Schiltz

Goals: We checked on the previous calibration from 4/16 and saw some issues happening, so now we need to resolve those before the final wiring of all the components.

Content:

- **Issue:** Weight displayed on screens was reading a fixed value that didn't change with applied pressure.
 - We took apart each leg, and found that one of the load sensors was orientated incorrectly
 - It was possible that there was an issue with sensors bottoming out or otherwise malfunctioning
 - This was corrected when we put it back together
 - The issue persisted, so we took a look at the wiring and found a short between the load cell circuit's power and ground
 - Fixed the short-term problem, but the reorientation of the load sensor meant that the calibration no longer held true
- We will re-calibrate the walker (using the same protocol as before) and see if all the issues are fixed.

Conclusions/action items:

Keep an eye on the calibration in the coming days, if it is still OK having not been adjusted then the problem is most-likely solved and testing can happen.



James Waldenberger - Apr 30, 2025, 4:53 PM CDT

Title: IR Testing

Date: 4/22/25

Content by: James Waldenberger

Present: Eva Schiltz, Owen Kolnik

Goals: Test the IR sensor to gauge values of average distance, average speed, and instantaneous velocity. Compare these with actual values for trial to get error

Content:

- See "Distance & Velocity Measurement Testing Protocol" page (Team Activities -> Testing and Results -> Protocols) for more instruction on individual tests
- · Issues when going high speed with 8-segment wheel, so we tried a 4-segment wheel instead
 - Resolved speed issues, gave more accurate readings all around
 - The IR sensor was skipping some tape markings, leading to lower-than-expected outcomes
 - Technically, it would be more optimal to get the 8-segment wheel working, since error intrinsic to the measuring method would be smaller
 - However, measured distances are well-within the allotted error
- · We had some issues with instantaneous velocity measurements
 - We tested with what is available to us, leading to significant error from testing method
 - Using a high-speed camera and microcontroller data storage the test could be much improved
 Not feasible for this semester
- · Error looks good, no concerns with distance or velocity measurement now

Conclusions/action items:

Finish up other avenues of testing and get ready for the poster presentation!



James Waldenberger - Apr 30, 2025, 8:37 PM CDT

Title: Load Cell Recalibration

Date: 4/23/25

Content by: James Waldenberger

Present: Whole group

Goals: Issues persisted with the load cell circuit calibration, and now there are inconsistencies in the displayed weight from day-to-day

Content:

- Issue: Once we re-calibrated the walker (using the same protocol as before), the given values using the same weights differed from dayto-day
 - The calibration issue was still not resolved, even once we made another calibration curve
 - Weights were not being displayed correctly to the actual weight applied
 - We took a look at the wiring and found a disconnected ground between proto-boards
 - The calibration was most-likely done while this issue persisted, so inconsistent values were still being displayed
 - · We had to re-calibrate again and it seems like everything is now okay

Conclusions/action items:

Go ahead and test the weight-measuring capability of the walker by comparing it to force plate data.



James Waldenberger - Apr 30, 2025, 4:53 PM CDT

Title: Load Cell Force Plate Testing

Date: 4/23/25

Content by: James Waldenberger

Present: Jacob Parsons, Owen Kolnik, Eva Schiltz

Goals: Use the in-ground force plates in the teaching lab to determine the accuracy of the walker's weight calibration.

Content:

- See "Force Plate Testing Protocol" page (Team Activities -> Testing and Results -> Protocols) for more instruction on individual tests
- Trials done with me and Eva applying varying loads to the walker over 5 trials each
- Timing inconsistencies due to "3, 2, 1" start method of syncing measurements
 - Only an issue when creating figures
 - Data is unaffected by this
- · Average force values were compared for walker data and force plate data
- Noise in walker data seems higher than usual, but the averages are pretty accurate

Conclusions/action items:

We're finished with the prototype!

2025/2/6-SLA&AnisotropicMaterialBehavior

OWEN KOLNIK - Feb 06, 2025, 12:55 PM CST

Title: SLA resin Anisotropicity

Date: 2/6/2025

Content by: Owen Kolnik

Present: N/A

Goals: To understand how to best model the electrical housing in SolidWorks for an FEM analysis.

Content:

Article:

K. K. Yang et al., "Experimental validation of 3D printed material behaviors and their influence on the structural topology design - computational mechanics," SpringerLink, https://link.springer.com/article/10.1007/s00466-018-1537-1 (accessed Feb. 6, 2025).

Conclusion:

• SLA Resins are Transversely Isotropic, having different elastic moduli based on printing direction.

Article:

G. Zhao, H. Xi, and J. Yang, "Transversely isotropic constitutive model of the polypropylene separator based on rich–hill elastoplastic constitutive theory," ASME Digital Collection, https://asmedigitalcollection.asme.org/electrochemical/article/18/2/020911/1091642/Transversely-Isotropic-Constitutive-Model-of-the (accessed Feb. 6, 2025).

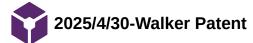
Conclusions:

Polypropylene (Transversely Anisotropic)

v11 = .2114 v22 = v33 = .1308 E11 = 1187 MPa E22 = e33 = 738 MPa

Conclusions/action items:

• Perform FEM analysis.



OWEN KOLNIK - Apr 30, 2025, 3:07 PM CDT

Title: Competing Designs

Date: 4/30/2025

Content by: N/A

Present: N/A

Goals: To find a load measuring walker patent. dissimilar from our design.

Content:

https://patents.google.com/patent/US5511571A/en

- This walker contains load sensing capabilities.
- Sensors are near the bottom of the legs.
- Additionally, this walker has no wheels, and thus cannot be rolled.

Conclusions/action items:

N/A



OWEN KOLNIK - Jan 30, 2025, 12:33 PM CST

Title: Electrical Housing Design Version 1

Date: 1/27/2025

Content by: Owen Kolnik

Present: N/A

Goals: To develop housing for the battery and internal circuitry supporting the accelerometer and load cells.

Content:

See attached File for Design

- Dimensions:
 - Angle: 13 deg from the horizontal
 - Height from base to top of middle mounting: 5.118"
 - Most dimensions are subject to change, depending on the dimensions of the circuitry and battery.
- Cost: ~29 cents per gram.
- Material: Formlabs Tough 1500 (Tough 1500 Resin | Formlabs)
 - Flexural Modulus: 1.4 GPa
 - Flexural Strength: 39 MPa
 - Material may change given the weight of the lithium battery.
- Tapered Heat-Set Inserts (inserts | McMaster-Carr)
- Size: TBD (3mm?)
- 8 screws
 - Size: TBD (3mm?)
- 3 Tube Clamps (See Example image)
 - Model: TBD
- Nuts and Bolts (Link & NutLink)
 - Size: 3/16"
- This design includes drilling holes into the walker tubing to run wire through the internals of the walker (to keep the wire out of the way).

Conclusions/action items:

- Adapt design as needed when the battery and circuitry dimensions are finalized.
- Share design with team members and advisor for feedback and design adjustments.



OWEN KOLNIK - Jan 30, 2025, 11:32 AM CST

ClampIDEA.jpg (24.9 kB)

OWEN KOLNIK - Jan 28, 2025, 5:48 PM CST



Download

ElectricalCircuitryHolder_V_.SLDPRT (365 kB)

OWEN KOLNIK - Jan 28, 2025, 5:48 PM CST



<u>Download</u>

ElectronicsHousingV1_1-25-2025.SLDASM (179 kB)

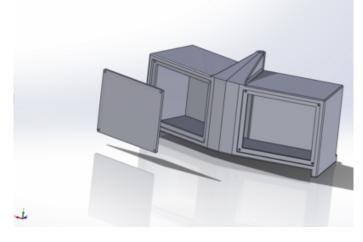
OWEN KOLNIK - Jan 28, 2025, 5:48 PM CST



<u>Download</u>

EntryPlate.SLDPRT (78.6 kB)

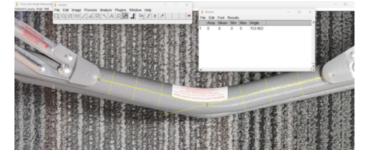
OWEN KOLNIK - Jan 28, 2025, 5:52 PM CST



Download

Screenshot_2025-01-28_175132.png (300 kB)

OWEN KOLNIK - Jan 28, 2025, 5:53 PM CST





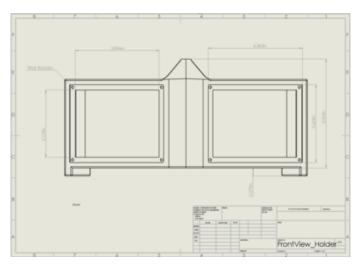
OWEN KOLNIK - Jan 30, 2025, 11:53 AM CST



Download

BackView_Holder.SLDDRW (179 kB)

OWEN KOLNIK - Jan 30, 2025, 11:53 AM CST



Download

FrontView.png (24.1 kB)

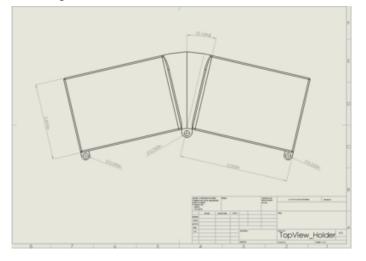
OWEN KOLNIK - Jan 30, 2025, 11:53 AM CST



<u>Download</u>

FrontView_Holder.SLDDRW (190 kB)

OWEN KOLNIK - Jan 30, 2025, 11:53 AM CST



<u>Download</u>

TopView.png (34.1 kB)

OWEN KOLNIK - Jan 30, 2025, 11:53 AM CST



Download

TopView_Holder.SLDDRW (193 kB)

BackView_Holder

OWEN KOLNIK - Jan 30, 2025, 11:54 AM CST

<u>Download</u>

BackView.png (30.7 kB)



2025/2/03-Electrical Housing Version 2

OWEN KOLNIK - Feb 17, 2025, 11:36 AM CST

Title: Electrical Housing Version 2

Date: 2/3/2025

Content by: Owen Kolnik

Present: N/A

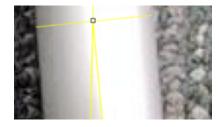
Goals: To finalize the electrical housing design ahead of preliminary presentation.

Content:

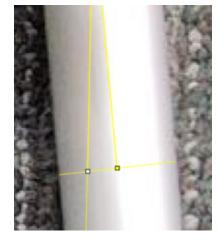
Components:

- Brass Heat Inserts:
 - Length: 2.92mm
 - For hole diameter: 3mm
 - $\circ~$ Thread Size: M1.6 x 0.35 mm ~
- Stainless Steel Screws:
 - Length: 6mm
 - Thread Size: M1.6 x 0.35 mm
 - Head Diameter: 3.2 mm
- Top Tube Clamp:
 - 1 inch
 - Hole: 6 mm
- Bottom Tube Clamp:
 - 0.5 Inch
 - Hole: 6.5 mm
- Large Attachment Bolts & Nuts:
 - M8
 - Coarse
 - Length: 30 mm
- Small Attachment Bolts & Nuts:
 - M6
 - Coarse
 - Length: 20 mm
- Velcro Strips
 - 1 X 4 inch
- Electrical Housing:
 - Mass: ~166.76g
- Housing Doors
 - Mass: ~11.54g (2x)
- Power Switch
- Protoboard

Conclusions/action items:



OWEN KOLNIK - Feb 04, 2025, 8:42 PM CST



Screenshot_2025-02-04_204152.png (128 kB)

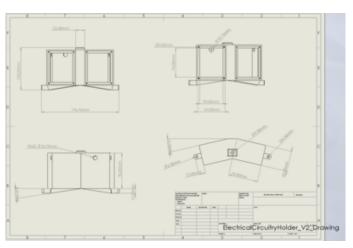
OWEN KOLNIK - Feb 04, 2025, 8:43 PM CST



Download

Screenshot_2025-02-04_204249.png (1.37 MB)

OWEN KOLNIK - Feb 05, 2025, 7:06 PM CST



173 of 233

Screenshot_2025-02-05_190620.png (127 kB)

OWEN KOLNIK - Feb 06, 2025, 4:26 PM CST



Download

Screenshot_2025-02-06_162610.png (328 kB)

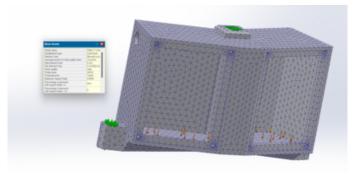
OWEN KOLNIK - Feb 06, 2025, 5:24 PM CST



<u>Download</u>

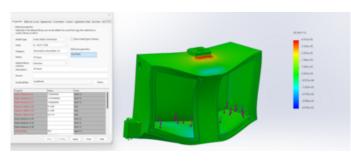
Screenshot_2025-02-06_172409.png (592 kB)

OWEN KOLNIK - Feb 06, 2025, 5:30 PM CST



Screenshot_2025-02-06_173011.png (359 kB)

OWEN KOLNIK - Feb 06, 2025, 5:37 PM CST



Download

Screenshot_2025-02-06_173720.png (390 kB)

OWEN KOLNIK - Mar 06, 2025, 5:19 PM CST



<u>Download</u>

Doors.STL (31.7 kB)

OWEN KOLNIK - Mar 06, 2025, 5:19 PM CST



Download

ElectricalCircuitryHolder_V2.STL (142 kB)



OWEN KOLNIK - Feb 12, 2025, 8:22 PM CST

OWEN KOLNIK - Feb 12, 2025, 8:22 PM CST

Title: Angle Measurements for the Walker Legs for design of load cell holders.

Date: 2/12/2025

Content by: Owen Kolnik

Present: N/A

Goals: To determine leg angles for load cell holder design

Content:

See images

Conclusions/action items:

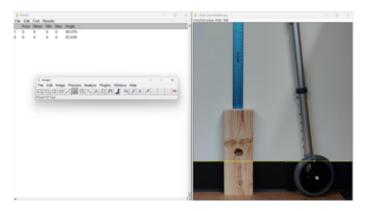
Implement in design.

0 0 90.079 0 0 83.636 0 0 88.490

Download

3.png (429 kB)

OWEN KOLNIK - Feb 12, 2025, 8:22 PM CST



Download

2.png (506 kB)

Fort Heads Mean Min Max Angle 90.079

OWEN KOLNIK - Feb 12, 2025, 8:22 PM CST





<u>Download</u>

1.png (425 kB)



OWEN KOLNIK - Feb 14, 2025, 2:23 PM CST

Title: Screen Holder V1

Date: 2/13/2025

Content by: Owen Kolnik

Present: N/A

Goals: To Design a component to house the OLED displays and mount them to the walker.

Content:

See attached images for dimensions, design, and assembly.

Additional Components:

- Top Clamp:
 - 6mm hole
 - 26 mm diameter tube
- Brass Heat Inserts:
 - Length: 2.92mm
 - For hole diameter: 3mm
 - Thread Size: M1.6 x 0.35 mm
- Stainless Steel Screws:
 - Length: 6mm
 - Thread Size: M1.6 x 0.35 mm
 - Head Diameter: 3.2 mm
- Large Attachment Bolts & Nuts:
 - M8
 - Coarse
 - Length: 30 mm
- Switch

Conclusions/action items:

Share with advisor and team.

OWEN KOLNIK - Feb 14, 2025, 2:22 PM CST



Download

1inch.SLDPRT (140 kB)

OWEN KOLNIK - Feb 14, 2025, 2:22 PM CST



Download

AccessDoor.SLDPRT (101 kB)



Assem1.SLDASM (156 kB)

OWEN KOLNIK - Feb 14, 2025, 2:22 PM CST



<u>Download</u>

DisplayHolder_V1.SLDPRT (435 kB)

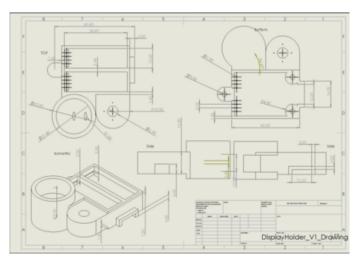
OWEN KOLNIK - Feb 14, 2025, 2:22 PM CST



Download

DisplayHolder_V1_Drawing.SLDDRW (249 kB)

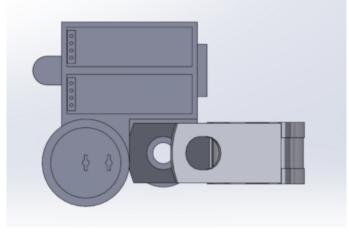
OWEN KOLNIK - Feb 14, 2025, 2:22 PM CST



Download

Screenshot_2025-02-14_122957.png (61.4 kB)

OWEN KOLNIK - Feb 14, 2025, 2:22 PM CST



Screenshot_2025-02-14_141956.png (93 kB)

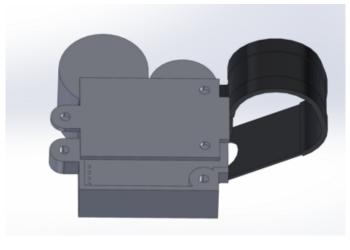
OWEN KOLNIK - Feb 14, 2025, 2:22 PM CST



Download

Screenshot_2025-02-14_142024.png (227 kB)

OWEN KOLNIK - Feb 14, 2025, 2:22 PM CST



Download

Screenshot_2025-02-14_142055.png (258 kB)



James Waldenberger - Mar 07, 2025, 1:55 PM CST

Title: Protoboard and Switch

Date: 2/21/2025

Content by: Owen Kolnik

Present: N/A

Goals: To have documentation for the protoboard and switch

Content:

- Board
- Switch

Conclusions/action items:

Order Items



OWEN KOLNIK - Feb 21, 2025, 4:10 PM CST

Title: First Assembly with Electrical Housing and Screen Holder

Date: 2/21/2025

Content by: Owen Kolnik

Present: N/A

Goals: To document images of the orignal assembly with the electrical housing and screen holder.

Content:

See Images

Conclusions/action items:

Discuss with advisor.

OWEN KOLNIK - Feb 21, 2025, 4:14 PM CST



Download

17401759992723620222097807447619.jpg (2.26 MB)

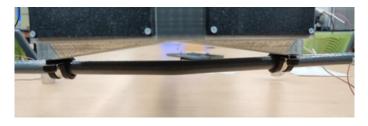
OWEN KOLNIK - Feb 21, 2025, 4:14 PM CST



Download

17401760322393599286385911605820.jpg (1.77 MB)

OWEN KOLNIK - Feb 21, 2025, 4:14 PM CST





Download

17401760416485915349845449406369.jpg (1.83 MB)

OWEN KOLNIK - Feb 21, 2025, 4:14 PM CST



<u>Download</u>

1740176059551478970055251701322.jpg (1.77 MB)

OWEN KOLNIK - Feb 21, 2025, 4:14 PM CST



Download

17401760713223325931093656807183.jpg (3.47 MB)



2025/2/28-System Block Diagram V1

OWEN KOLNIK - Feb 28, 2025, 9:07 AM CST

Title: System block diagram/flow chart

Date: 2/28/2025

Content by: James Waldenberger, Jacob Parsons, & Owen Kolnik

Present: N/A

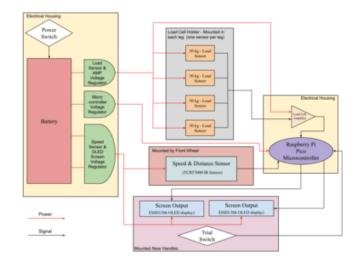
Goals: To design a block diagram of the overal device for our journal entry.

Content:

See attached drawing

Conclusions/action items:

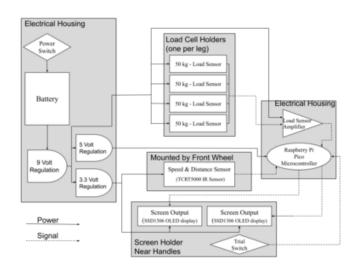
Finish report.



Download

Update_Component_Systems_Diagram.png (100 kB)

OWEN KOLNIK - Apr 30, 2025, 1:01 AM CDT



OWEN KOLNIK - Feb 28, 2025, 9:07 AM CST

<u>Download</u>

Component_Systems_Diagram_4_23_For_Report.png (95.4 kB)



OWEN KOLNIK - Mar 04, 2025, 4:50 PM CST

Title: Design Consultation

Date: 3/4/2025

Content by: Jesse

Present: Nolan & Owen

Goals: To fix the leg wobble

Content:

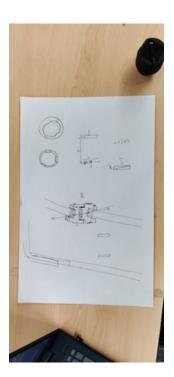
Main High-Level Takeaways:

- Redesign the load cell holders.
- · Add an additional verticle cross-bar to the front legs, curved if needed to avoid patients gait, for added structural integrity.

NEW DESIGN:

- · See Sketches Below
- Add nubs to the load cell holder, where the frame enters the component.
- Increase L in L/D to minimize wobble.
- Restrict to minimum number of degrees of freedom.
- Make sure planes of top and bottom pieces, where the load sensor will sit, are parrallel with the ground.
- Ensure the axis for which the top and bottom piece are concentric is normal to the ground.
 This allows tighter dimensions, so a tighter fit is enabled.
- Thus the holes into the frame will have to be a different angles, i.e. the one drilled in the top and the one drilled on the bottom of the cut.
- Could make the male and female profiles square.
- have the stem that enters the frame, and the portion the meets the other piece be at different angles, measured via imageJ, this may take iterations.

Conclusions/action items:

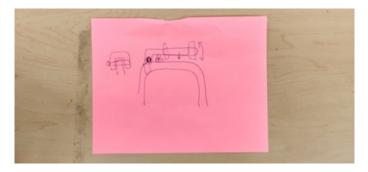


OWEN KOLNIK - Mar 04, 2025, 4:41 PM CST

Download

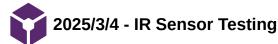
1741128028598341154976968665824.jpg (1.85 MB)

OWEN KOLNIK - Mar 04, 2025, 4:41 PM CST



Download

17411280504743436752777929161758.jpg (1.79 MB)



OWEN KOLNIK - Mar 06, 2025, 5:26 PM CST

Title: IR Sensor Testing

Date: 3/4/2025

Content by: N/A

Present: Nolan, Jacob, and Owen

Goals: To get testing data on the IR sensors distance accuracy and error.

Content:

- This is entry is mainly for reference for when testing was completed.
- See Jacob Parson's Entry for Data.

Procedure:

- · Known distances were measured out and marked on the floor using tape
- The IR sensor was then position by the right wheel.
- Power and signal wiring was attached to a breadboard with the rasberry pi microcontroller.
- Live distance data was outputted to Thonny micropython software.
- Time and distance information was recorded.
- Trials were as follows:
 - 5 30ft trials
 - 5 60ft trials
 - 5 100ft trials

Conclusions/action items:

Share with advisor.

OWEN KOLNIK - Mar 06, 2025, 5:28 PM CST



<u>Download</u>

IMG_20250303_175851.jpg (2.16 MB)

OWEN KOLNIK - Mar 06, 2025, 5:28 PM CST



Download

IMG_20250303_175845.jpg (1.53 MB)

OWEN KOLNIK - Mar 06, 2025, 5:28 PM CST



<u>Download</u>

IMG_20250303_175535.jpg (1.44 MB)



2025/3/6 - NO ROTATION OF THE LEGS OF THE WALKER

OWEN KOLNIK - Mar 06, 2025, 6:24 PM CST

Title: The walker cannot fold.

Date: 3/6/2025

Content by: Owen Kolnik

Present: N/A

Goals: To document a discovered design limitation

Content:

See Images

Conclusions/action items:

Share with team.

OWEN KOLNIK - Mar 06, 2025, 6:24 PM CST



Download

IMG_20250306_182200.jpg (1.42 MB)

OWEN KOLNIK - Mar 06, 2025, 6:24 PM CST



<u>Download</u> IMG_20250306_182154.jpg (3.51 MB)



OWEN KOLNIK - Mar 06, 2025, 6:27 PM CST

Title: V1 Components List

Date: 3/6/2025

Content by: Owen Kolnik

Present: N/A

Goals: To describe each part of the design and their quatities.

Content:

ITEM	QTY
Button Folding Walker with Wheels	1
Electrical Housing 3D print	1
Electrical Housing Access Door 3D Print	2
Brass Tapered Heat-Set Inserts For Plastic, M2 x 0.4 Mm Thread Size, 2.9 Mm Installed Length	12
1 inch Cable Clamp, M6	2
½ inch Cable Clamp, M6	2
M6 Coarse Bolt	3
M6 Coarse Bolt, Long	1
M6 Coarse Nut	4
M2 Coarse Phillips Screw	12
M2 Coarse Bolt, Long	1
M2 Coarse Nut	1
Display Holder 3D Print	1
Display Holder Access Door 3D Print	1
IR Sensor Securing Piece 3D Print	1
~3 degree Load Cell Holder, Top, 3D printed	2
~3 degree Load Cell Holder, bottom, 3D printed	2

~5 degree Load Cell Holder, Top, 3D printed	2
~5 degree Load Cell Holder, bottom, 3D printed	2
Load Cell Holder Washer 3D printed	4
#6 bolts, long	8
#6 nut	8
5/16 large washers	6
Brass Tapered Heat-Set Inserts For Plastic, M3 x 0.5 Mm Thread Size, 6.4 Mm Installed Length	16
IR Sensor	1
Black Electrical Tape	1 roll
White Electrical Tape	1 roll
OLED Display	2
Button Switch	2
Protoboard	1
Raspberry Pi Pico Microcontroller	1
Load Sensor (piezoelectric)	4
12V 2400mAh Rechargeable Li-ion Battery	1
12V to 5V Buck Converter	1
12V to 3.3V Buck Converter	1
LT1167 Instrumentation Amplifier	1
TL072 Operational Amplifier	1
TC962CPA DC go DC Converter	1
10 uF Capacitor	2
480 Ohm Resistor	1
10k ohm Resistor	2
20k ohm Resistor	2

194	of	233
-----	----	-----

3 colors of 22 gauge wiring	~50 ft total
Internal wires	?
Adhesive Velcro	3 strips
Wire conduit 3D printed	2

Conclusions/action items:

- Share with team/Client/Advisor
- Have Jacob and James add any further instrumentation components.



OWEN KOLNIK - Mar 06, 2025, 7:36 PM CST

Title: IR Sensor Holder V1

Date: 3/6/2025

Content by: Owen

Present: N/A

Goals: To design a piece to secure the IR sensor instead of zip ties.

Content:

See images and files

Conclusions/action items:

Share will team.

OWEN KOLNIK - Mar 06, 2025, 7:45 PM CST



Download

IR_Sensor_Holder_V1.SLDDRW (150 kB)

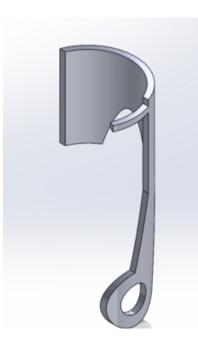
OWEN KOLNIK - Mar 06, 2025, 7:45 PM CST



Download

IR_Sensor_Holder_V1.SLDPRT (121 kB)

OWEN KOLNIK - Mar 06, 2025, 7:45 PM CST

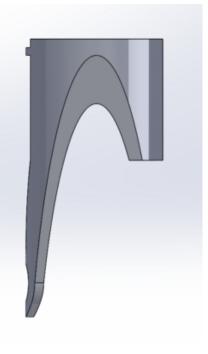




Download

Screenshot_2025-03-06_193631.png (68 kB)

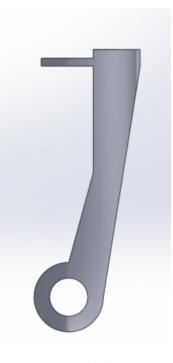
OWEN KOLNIK - Mar 06, 2025, 7:45 PM CST



Download

Screenshot_2025-03-06_193725.png (45.7 kB)

OWEN KOLNIK - Mar 06, 2025, 7:45 PM CST



Download

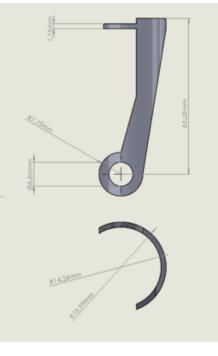
Screenshot_2025-03-06_193746.png (69 kB)



<u>Download</u>

Screenshot_2025-03-06_193813.png (119 kB)

OWEN KOLNIK - Mar 06, 2025, 7:45 PM CST



<u>Download</u>

Screenshot_2025-03-06_194456.png (22.7 kB)



OWEN KOLNIK - Mar 07, 2025, 5:22 PM CST

Title: IR Sensor Holder V2

Date: 3/7/2025

Content by: Owen

Present: N/A

Goals: To design a piece to secure the IR sensor instead of zip ties.

Content:

See images and files

Conclusions/action items:

Share will team.

OWEN KOLNIK - Mar 07, 2025, 5:22 PM CST



Download

IR_Sensor_Holder_V2.SLDDRW (171 kB)

OWEN KOLNIK - Mar 07, 2025, 5:22 PM CST



Download

IR_Sensor_Holder_V2.SLDPRT (151 kB)

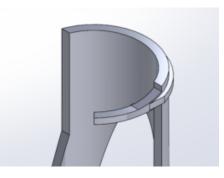
OWEN KOLNIK - Mar 07, 2025, 5:22 PM CST



Download

IR_Sensor_Holder_V2.STL (73.5 kB)

OWEN KOLNIK - Mar 07, 2025, 5:22 PM CST



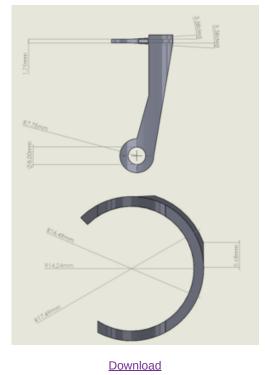


Download

Screenshot_2025-03-07_171459.png (146 kB)

Screenshot_2025-03-07_171530.png (125 kB)

OWEN KOLNIK - Mar 07, 2025, 5:22 PM CST



Screenshot_2025-03-07_172006.png (48 kB)



OWEN KOLNIK - Mar 15, 2025, 6:12 PM CDT

Title: Reworking Load Cell Holders

Date: 3/15/2025

Content by: Owen Kolnik & Eva Schiltz

Present: N/A

Goals: To address leg wobble.

Content:

See files and images.

***There is still minor errors, ~1.6 um (within tolerance).

• The error is the normal distance between the axis of the top tube and the top component load cell holder, the current tolerance for the tubing insertion is +/- 0.125 mm, so the tube should still fit. This error is likely due to trig rounding errors.

Conclusions/action items:

Discuss with team members.

OWEN KOLNIK - Mar 15, 2025, 6:09 PM CDT

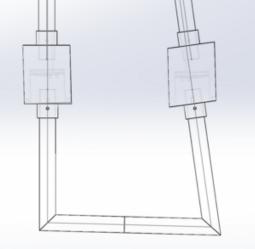


Download

Screenshot_2025-03-15_175516.png (213 kB)

OWEN KOLNIK - Mar 15, 2025, 6:09 PM CDT

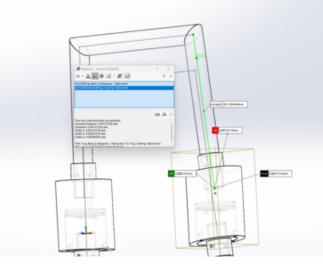




Download

Screenshot_2025-03-15_175542.png (171 kB)

OWEN KOLNIK - Mar 15, 2025, 6:09 PM CDT



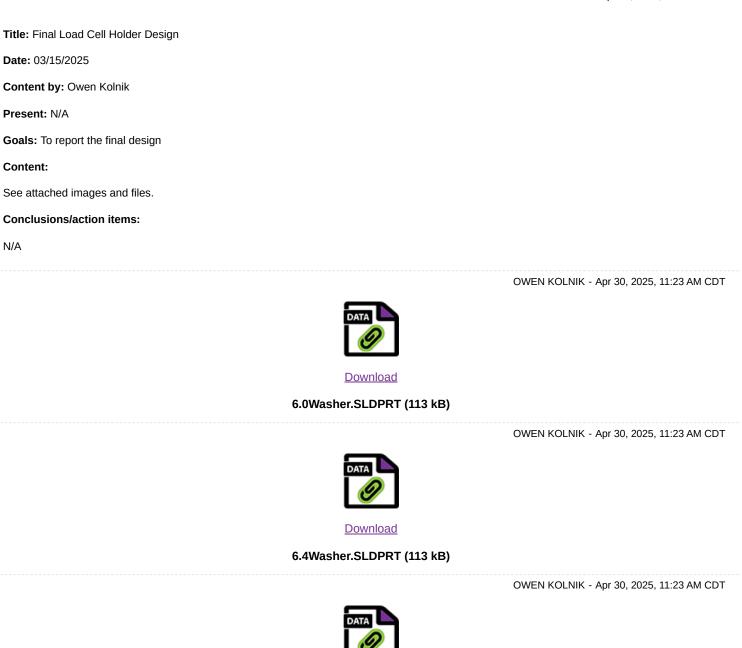
<u>Download</u>

Screenshot_2025-03-15_180841.png (252 kB)

2025/3/15-Final Load Cell Holder Design



OWEN KOLNIK - Apr 30, 2025, 1:05 AM CDT



Download

Bottom_Back_6.0degrees.SLDPRT (199 kB)

OWEN KOLNIK - Apr 30, 2025, 11:23 AM CDT



Download

Bottom_Back_6.4degrees.SLDPRT (243 kB)





Download

Top_Back_6.0degrees.SLDPRT (209 kB)

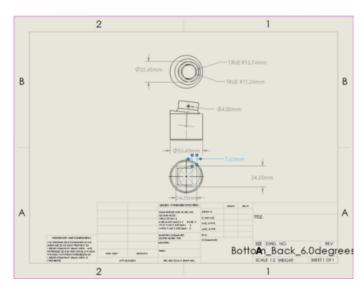
OWEN KOLNIK - Apr 30, 2025, 11:23 AM CDT



Download

Top_Back_6.4degrees_.SLDPRT (181 kB)

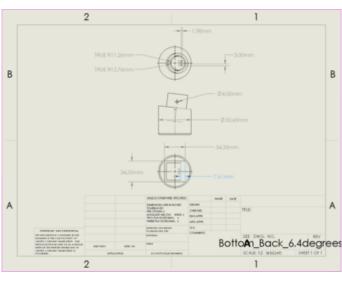
OWEN KOLNIK - Apr 30, 2025, 11:39 AM CDT



Download



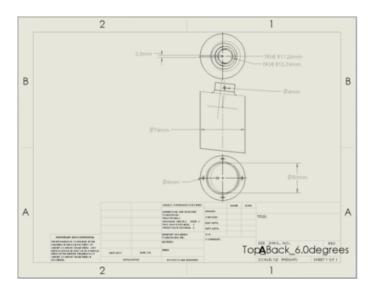
OWEN KOLNIK - Apr 30, 2025, 11:39 AM CDT



Download

Bottom_Back_6.4Degrees.png (38.4 kB)

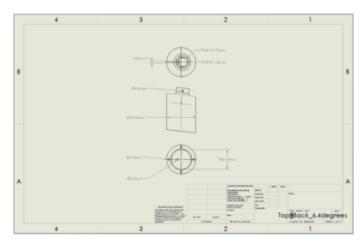
OWEN KOLNIK - Apr 30, 2025, 11:39 AM CDT



Download

Top_Back_6.0Degrees.png (38.3 kB)

OWEN KOLNIK - Apr 30, 2025, 11:39 AM CDT



Download

Top_Back_6.4Degrees.png (34.8 kB)



OWEN KOLNIK - Apr 30, 2025, 1:09 AM CDT

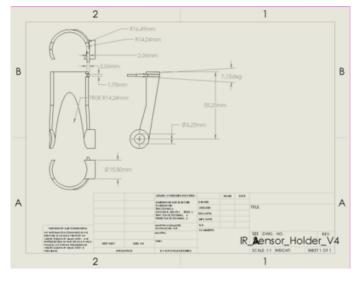
Title: IR Sensor Holder Version 4
Date: 3/15/2025
Content by: Owen Kolnik
Present: N/A
Goals: To document the final design.
Content:
See images and files.
Conclusions/action items:
N/A

OWEN KOLNIK - Apr 30, 2025, 11:47 AM CDT



IR_Sensor_Holder_V4.SLDPRT (194 kB)

OWEN KOLNIK - Apr 30, 2025, 11:47 AM CDT



Download

Drawing.png (25.3 kB)

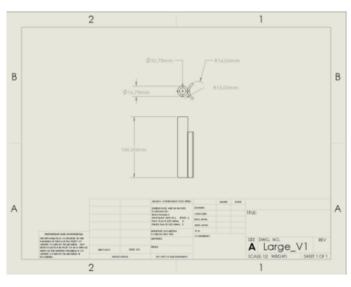


OWEN KOLNIK - Apr 30, 2025, 1:10 AM CDT

Title: Final Wire Conduit Design	
Date: 3/15/2025	
Content by: Owen Kolnik	
Present: N/A	
Goals: To document the wire conduit design.	
Content:	
See images and files.	
Conclusions/action items:	
N/A	
	OWEN KOLNIK - Apr 30, 2025, 11:50 AM CDT
Download	

Large_V1.SLDPRT (63.8 kB)

OWEN KOLNIK - Apr 30, 2025, 11:50 AM CDT



<u>Download</u>

Long.png (21.4 kB)



OWEN KOLNIK - Apr 30, 2025, 1:12 AM CDT

Title: Final Screen Holder Design

Date: 3/15/2025

Content by: Owen Kolnik

Present: N/A

Goals: To document the final screen holder design.

Content:

See files and images.

Conclusions/action items:

N/A

OWEN KOLNIK - Apr 30, 2025, 11:52 AM CDT



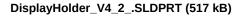
Download

AccessDoorV4.SLDPRT (167 kB)

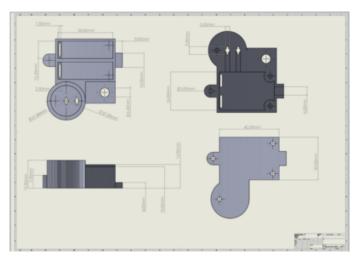
OWEN KOLNIK - Apr 30, 2025, 11:52 AM CDT



Download



OWEN KOLNIK - Apr 30, 2025, 11:52 AM CDT



Download

Screenshot_2025-04-30_115127.png (83.1 kB)



OWEN KOLNIK - Feb 26, 2025, 5:05 PM CST

Title: Fabrication for Load Cell Holder Attachment

Date: 2/26/2025

Content by: Nolan BlomWillis

Present: Nolan BlomWillis & Owen Kolnik

Goals: To drill holes for the attachment of the load cell holders.

Content:

See Images

Conclusions/action items:

• Use dremel to fix hole drilling inaccuracies.

OWEN KOLNIK - Feb 26, 2025, 5:12 PM CST



Download

IMG_20250226_160902.jpg (213 kB)

OWEN KOLNIK - Feb 26, 2025, 5:12 PM CST



Download

IMG_20250226_160858.jpg (159 kB)

2025/4/2-Final Load Cell Holder Fabriation and Leg Connection

OWEN KOLNIK - Apr 30, 2025, 11:57 AM CDT

Title: Final Fabrication of New Walker

Date: 4/2/2025

Content by: Owen Kolnik

Present: Owen Kolnik

Goals: To document the method of final fabrication.

Content:

See images.

Method:

1. Tape, a level, and calipers were used to determine location of cut to separate legs for load cell holder attachment.

2. Legs were sawed off using a hand saw, leaving 35 mm of clearance on both sides.

3. Next a Dremel was used to smooth the cuts.

- 4. The load cell holders were then attached, and the bolt hole position was marked on the walker frame.
- 5. Using a hand drill, .149" holes were made at these markings.
- 6. Load cell holders were attached and mounted via a bolt and nut (#6).

Conclusions/action items:

Begin integrating instrumentation.



Download

IMG_20250430_115516.jpg (75.8 kB)

OWEN KOLNIK - Apr 30, 2025, 11:58 AM CDT





<u>Download</u>

IMG_20250430_115539.jpg (127 kB)



OWEN KOLNIK - Apr 30, 2025, 12:04 PM CDT

Title: Wiring Fabrication

Date: 4/9/2025

Content by: Entire team

Present: Entire team

Goals: To document the team meeting where wiring was run throughout the walker frame.

Content:

Procedure:

1. Holes were cut into the front legs between the cross supports.

2. Using a weight and a guide wire, all wiring was pulled through the frame.

Conclusions/action items:

Test Sensors

OWEN KOLNIK - Apr 30, 2025, 12:07 PM CDT



Download

IMG_20250430_120557.jpg (125 kB)

OWEN KOLNIK - Apr 30, 2025, 12:07 PM CDT



Download

IMG_20250430_120603.jpg (101 kB)



OWEN KOLNIK - Apr 30, 2025, 12:15 PM CDT

Title: Calibration of Strain Gauge

Date: 4/17/2025

Content by: Entire Team

Present: Entire Team

Goals: To document the Calibration of the load sensors and the subsequent curve fitting.

Content:

Calibration procedure:

1. The microcontroller code was modified to display ADC voltage values.

2. Known weights were applied to the walker frame, and the resultant ADC voltage was recorded.

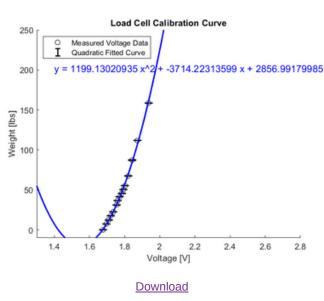
3. Ten trials, where 50 samples were collected, were performed for each weight applied.

4. Weight applied was incremented by 5 lbs from 0 to 60 lbs, beyond that the weight applied was incremented by 10 pounds.

4. Then using a MatLab script a calibration curve was created.

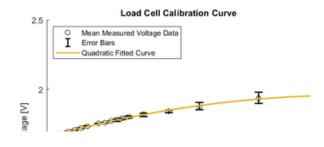
Conclusions/action items:

Perform Load Testing



cali2.png (29.1 kB)

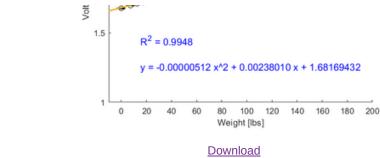
OWEN KOLNIK - Apr 30, 2025, 12:20 PM CDT



OWEN KOLNIK - Apr 30, 2025, 12:20 PM CDT

Owen Kolnik/Fabrication & Testing/2025/4/17-Load Calibration





Cali.png (28.4 kB)

OWEN KOLNIK - Apr 30, 2025, 12:20 PM CDT



<u>Download</u>

LoadCellCalibrationCurve.m (3 kB)

OWEN KOLNIK - Apr 30, 2025, 12:20 PM CDT



<u>Download</u>

cal2.xlsx (37.3 kB)

OWEN KOLNIK - Apr 30, 2025, 12:35 PM CDT



Download

IMG_5751.JPG (6.32 MB)



OWEN KOLNIK - Apr 30, 2025, 12:30 PM CDT

Title: In-ground force plate adaptor platform.

Date: 4/25/2025

Content by: Owen Kolnik

Present: N/A

Goals: To document the procedure to form a base to allow the use of in-ground force plates.

Content:

Used 1/2" boards and wood screws to connect 4 boards. This reduces the profile of the walker in order to place the walker on the force plates.

Conclusions/action items:

Perform Testing

OWEN KOLNIK - Apr 30, 2025, 12:31 PM CDT



Download

IMG_20250430_122712.jpg (196 kB)

OWEN KOLNIK - Apr 30, 2025, 12:31 PM CDT



Download

IMG_20250430_123036.jpg (166 kB)



OWEN KOLNIK - Apr 30, 2025, 2:04 PM CDT

Title: IR Sensor Final Code Date: 4/22/2025 Content by: Jacob Parsons and Owen Kolnik Present: N/A Goals: Get correct code to operate the IR sensor and collect data. from machine import Pin, I2C, ADC import ssd1306 import time import utime # ----- Display Setup -----i2c0 = I2C(0, scl=Pin(1), sda=Pin(0), freq=100000)i2c1 = I2C(1, scl=Pin(7), sda=Pin(6), freq=100000) oled_width = 128 $oled_height = 32$ oled0 = ssd1306.SSD1306_I2C(oled_width, oled_height, i2c0) oled1 = ssd1306.SSD1306_I2C(oled_width, oled_height, i2c1) def clear_displays():

oled0.fill(0)

Content:

Code:

oled0.show()

oled1.fill(0)

oled1.show()

clear_displays()

oled0.text("Not Running", 0, 0)

oled0.show()

----- Load Cell Setup ------

adc_load_cell = ADC(Pin(27))

----- IR Sensor Setup ------

sensor = ADC(Pin(26))

threshold = 10000

tape_width_m = 0.098

distance_m = 0

prev_state = sensor.read_u16() > threshold

last_ir_print = utime.ticks_ms()

----- Switch Setup -----

switch = Pin(16, Pin.IN, Pin.PULL_DOWN)

trial_running = False

start_time = 0

----- Queues for recent velocity ------

dist_queue = []

time_queue = []

MAX_QUEUE_LEN = 50

----- Main Loop ------

while True:

if switch.value() == 1:

if not trial_running:

trial_running = True

start_time = time.time()

distance_m = 0

dist_queue.clear()

time_queue.clear()

clear_displays()

oled0.text("Measuring", 0, 0)

oled0.show()

oled1.fill(0)

oled1.show()

print("\nTrial started...")

IR sensor logic

current_state = ir_value > threshold
if current_state != prev_state:
 distance_m += tape_width_m
 print(f"Transition detected! Distance: {distance_m:.3f} m")
 prev_state = current_state

Queue update for recent speed

Owen Kolnik/Fabrication & Testing/2025/4/22-IR sensor code

current_time = time.time()

dist_queue.append(distance_m)

time_queue.append(current_time)

if len(dist_queue) > MAX_QUEUE_LEN:

dist_queue.pop(0)

time_queue.pop(0)

Calculate recent speed over last N samples
delta_d = dist_queue[-1] - dist_queue[0]
delta_t = time_queue[-1] - time_queue[0]
recent_speed = delta_d / delta_t if delta_t > 0 else 0

OLED1 display
elapsed_time = current_time - start_time
oled1.fill(0)
oled1.text(f"Speed:{recent_speed:.2f}", 0, 0)
oled1.text(f"Time:{elapsed_time:.2f}s", 0, 16)
oled1.show()

Optional debug print

if utime.ticks_diff(utime.ticks_ms(), last_ir_print) >= 1000: print(f"Total distance: {distance_m:.3f} m") last_ir_print = utime.ticks_ms()

utime.sleep_ms(1)

else:

if trial_running:

trial_running = False

Owen Kolnik/Fabrication & Testing/2025/4/22-IR sensor code

total_time = time.time() - start_time

avg_speed = distance_m / total_time if total_time > 0 else 0

```
print("\nTrial ended.")
print(f"Distance: {distance_m:.3f} m")
print(f"Time: {total_time:.2f} sec")
print(f"Avg Speed: {avg_speed:.2f} m/sec")
```

clear_displays()

oled0.text("Trial Over", 0, 0) oled1.text(f"D:{distance_m:.2f}", 0, 0) oled1.text(f"T:{total_time:.2f}s", 0, 10) oled1.text(f"S:{avg_speed:.2f}m/s", 0, 20) oled0.show() oled1.show()

time.sleep(10) clear_displays() oled0.text("Not Running", 0, 0) oled0.show()

time.sleep(0.5)

Conclusions/action items:

Perform testing



2025/4/23-Distance and Speed Testing

OWEN KOLNIK - Apr 30, 2025, 12:50 PM CDT

Title: Velocity and Distance Testing

Date: 4/23/2025

Content by: Entire team

Present: Entire team

Goals: To document the testing procedure and results.

Content:

Distance Testing:

The walker was pushed know distances (50ft, 100ft, and 150ft) and devices measured distances were compared.

Velocity Testing:

Times of trials were also recorded, and average velocity was calculated with the distances traveled.

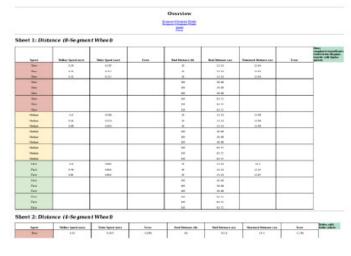
Instantaneous Velocity:

More frequent lap times and distances were used to calculate instantaneous velocity. This was then compared to the devices current speed readout.

Conclusions/action items:

N/A

OWEN KOLNIK - Apr 30, 2025, 12:50 PM CDT



Download

Testing_Results_ALL_TESTS_1_.xlsx (21.1 kB)

OWEN KOLNIK - Apr 30, 2025, 12:50 PM CDT

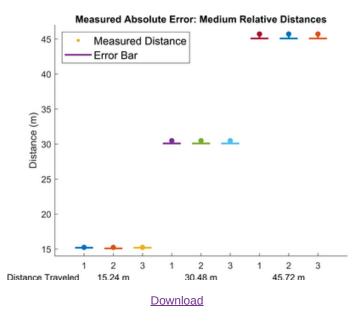
sheet dataTu Vallow Vider Freito Freito for i	;) WrB = "G'\USERS\GebruinLObertoald\Testing Results (ALL TESTS).etbr", Infers = 2; % Second sheet hable = readtable(fileFath, "Sheet", sheetlafex); wigned = distTable.Wignedpead.g.m.s.; Gened = distTable.Wignedpead.g.m.s.;
Wallow Wider RealD RealD	wipeed = dataTable.MalkerSpeed_m_s_;
For 1	
	bistance = dataTable.MealDistanCe.m.; #re#Distance = #ataTable.Measure#Distance.m.;
10	 = 1: (Jacqbi(An lar Speed)/2) (dx) = 3¹(-) + 1; (dx) = 3(dx) + 1; (dx) = 1(dx) + 1;(dx) = 1(dx) + 1(dx) + 1;(dx) = 1(dx) + 1(dx)



Download

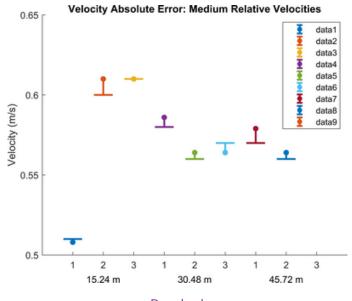
SpeedandDistanceProcessing.m (2.12 kB)

OWEN KOLNIK - Apr 30, 2025, 12:52 PM CDT

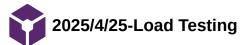




OWEN KOLNIK - Apr 30, 2025, 12:52 PM CDT



Download



OWEN KOLNIK - Apr 30, 2025, 12:39 PM CDT

Title: Load Testing

Date: 4/25/2025

Content by: Entire team

Present: Entire team

Goals: To document load testing an results.

Content:

1. In-ground force plates were used.

- 2. The devices load measurements were recorded.
- 3. Subjects applied load through the walker, which was on the force plates.
- 4. This led to two instantaneous force readings.

5. These readings were compared.

Conclusions/action items:

N/A



Download

IMG_5754.JPG (4.51 MB)



OWEN KOLNIK - Apr 30, 2025, 12:40 PM CDT

OWEN KOLNIK - Apr 30, 2025, 12:41 PM CDT

Download

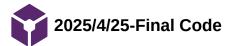
drive-download-20250430T174121Z-001.zip (2.56 MB)

OWEN KOLNIK - Apr 30, 2025, 12:43 PM CDT



Download

plot.png (40.4 kB)



OWEN KOLNIK - Apr 30, 2025, 2:06 PM CDT

Title: Final Microcontroller Code
Date: 4/25/2025
Content by: Jacob Parsons
Present: N/A
Goals: To document the final code.
Content:
from machine import Pin, I2C, ADC
import ssd1306
import time
import utime
Display Setup
i2c0 = I2C(0, scl=Pin(1), sda=Pin(0), freq=100000)
i2c1 = I2C(1, scl=Pin(7), sda=Pin(6), freq=100000)
oled_width = 128
oled_height = 32
oled0 = ssd1306.SSD1306_I2C(oled_width, oled_height, i2c0) # Status display
oled1 = ssd1306.SSD1306_I2C(oled_width, oled_height, i2c1) # Data display
def clear_displays():
oled0.fill(0)
oled0.show()
oled1.fill(0)
oled1.show()
Load Cell Setup
adc_load = ADC(Pin(27))
def read_voltage(adc, vref=3.3):
return (adc.read_u16() / 65535) * vref

def calculate_weight(voltage):

return (1199.13020935 * voltage**2) - (3714.22313599 * voltage) + 2856.99179985

----- IR Sensor Setup ------

sensor = ADC(Pin(26))

threshold = 10000

tape_width_m = 0.098

distance_m = 0

prev_state = sensor.read_u16() > threshold

----- Switch Setup -----

switch = Pin(16, Pin.IN, Pin.PULL_DOWN)

trial_running = False

 $start_time = 0$

----- Data Queues -----

speed_queue = []

weight_queue = []

time_queue = []

all_weights = [] # Stores ALL weights during trial for final averaging

----- Initialization -----

clear_displays()

oled0.text("Not Running", 0, 0)

oled0.show()

----- Main Loop -----while True:
if switch.value() == 1:
if not trial_running:
 trial_running = True
 start_time = time.time()
 distance_m = 0
 speed_queue.clear()
 weight_queue.clear()

time_queue.clear()

Owen Kolnik/Fabrication & Testing/2025/4/25-Final Code

all_weights.clear()

clear_displays()

oled0.text("Measuring", 0, 0)

oled0.show()

print("\nTrial started...")

IR Distance Detection

ir_val = sensor.read_u16()

current_state = ir_val > threshold

if current_state != prev_state:

distance_m += tape_width_m

prev_state = current_state

Weight Measurement

voltage = read_voltage(adc_load)
weight = calculate_weight(voltage)
all_weights.append(weight)

Queue Updates
current_time = time.time()
speed_queue.append((distance_m, current_time))
weight_queue.append(weight)
time_queue.append(current_time)

Trim old values (>1 second)
while current_time - time_queue[0] > 1 and len(time_queue) > 1:
 speed_queue.pop(0)
 weight_queue.pop(0)
 time_queue.pop(0)

Moving Averages
delta_d = speed_queue[-1][0] - speed_queue[0][0]
delta_t = speed_queue[-1][1] - speed_queue[0][1]
recent_speed_mps = delta_d / delta_t if delta_t > 0 else 0
recent_speed_mph = recent_speed_mps * 2.23694
avg_weight = sum(weight_queue) / len(weight_queue) if weight_queue else 0

OLED Display (Clamp negative weights for live display only)
display_weight = avg_weight if avg_weight > 0 else 0.0
oled1.fill(0)
oled1.text(f"Speed: {recent_speed_mph:.1f} mph", 0, 0)
oled1.text(f"Weight: {display_weight:.1f} lbs", 0, 16)
oled1.show()

```
utime.sleep_ms(50)
```

else:

if trial_running: trial_running = False total_time = time.time() - start_time avg_speed_mps = distance_m / total_time if total_time > 0 else 0 avg_speed_mph = avg_speed_mps * 2.23694 distance_ft = distance_m * 3.28084 total_avg_weight = sum(all_weights) / len(all_weights) if all_weights else 0

print("\nTrial ended.")
print(f"Distance: {distance_ft:.2f} ft")
print(f"Time: {total_time:.2f} sec")
print(f"Avg Speed: {avg_speed_mph:.2f} mph")
print(f"Avg Weight: {total_avg_weight:.1f} lbs")

clear_displays()

oled0.text("Trial Over", 0, 0)

oled1.text(f"W: {total_avg_weight:.1f} lbs", 0, 0)

oled1.text(f"S: {avg_speed_mph:.1f} mph", 0, 8)

oled1.text(f"D: {distance_ft:.1f} ft", 0, 16)

oled1.text(f"T: {total_time:.1f} s", 0, 24)

oled0.show()

oled1.show()

time.sleep(10)

Owen Kolnik/Fabrication & Testing/2025/4/25-Final Code

oled0.text("Not Running", 0, 0)

oled0.show()

time.sleep(0.25)

Conclusions/action items:



OWEN KOLNIK - Feb 28, 2025, 8:44 AM CST

Title: Journal Decision

Date: 2/26/2025

Content by: Owen Kolnik

Present: N/A

Goals: To choose a journal for our research paper.

Content:

https://www.asme.org/publications-submissions/journals/information-for-authors/journal-guidelines

Conclusions/action items:

Write preliminary report.



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.



John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: