BME Design-Fall 2023 - NIKHIL CHANDRA
Complete Notebook

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Jake Maisel

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Amara Monson - Sep 22, 2023, 12:03 PM CDT

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Project description

Amara Monson - Sep 22, 2023, 12:09 PM CDT

Course Number:

BME 300/200

Project Name:

Smart Walker

Short Name:

Smart Walker

Project description/problem statement:

The use of walkers in rehabilitation provides safety and confidence to patients as they redevelop full ambulation, and various measurements, such as gait speed and distance traveled, are recorded to assess patient progress as they use this tool. The current method of taking these measurements manually can be lengthy and takes time during sessions that could be used for further patient improvement, and does not allow for the measurement of pressure applied to the walker. The development of a Smart Walker that could measure and display these values in real time would return this time to the patient, and provide quantitative motivation for them in the process

About the client:

Mr. Danile Kutschera, PT is a physical therapist at the UW Rehabilitation Hospitals. He has identified a variety of areas for improvement in his work and created three projects for BME students looking to address these problems, including the Smart Walker.

Client Meeting - 9/12/2023

Amara Monson - Sep 21, 2023, 9:54 PM CDT

Title: Initial Client Meeting

Date: 9/12/2023

Content by: Team

Present: Amara, Lance, Nikhil

Goals: Gain a more in-depth understanding of the project and of client requirements

Content:

(Attached)

Conclusions/action items:

- Apply information from client meeting and individual research to the Product Design Specifications to outline the scope of the project

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Amara Monson - Oct 27, 2023, 1:16 PM CDT

How versatile should the design be, would you like it built for a specific brand or can be applicable to other brands as well?

Custom software or arduino?

What is the budget for this project?

How/when can we get access to a specific walker for testing, prototyping, ...?

What are the optimal values for a patient/how do you measure progress?

What are the accuracy specifications and also what units are they looking?

Is it intended for a short period in a clinical environment or for daily use?

What kind of interface and data visualization features would be most useful

- Real time data?
- Averages?
- Graphs as images, csv data?
-

Can you further elaborate on motivation, should the device give motivational cues or ...?

Used throughout the day

- Weight data in real time, distance and speed could be but don't need to be
- Display + upload to a server
- ~$400
- Doesn't need to be moved between devices
- Needs to be sanitized, waterproof, etc
- 2.2 mph (~3mph max)
- Pretty constant use throughout the day
- Don't want patients to be too focused on display
- Therapist could control start/stop
- Of these, weight most important

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Client_Questions.pdf (30.2 kB)

Poster Presentation Client Meeting - 12/8/2023

JOSEPH KOCH - Dec 10, 2023, 10:06 PM CST

Title: Poster Presentation Client Meeting

Date: 12/8/2023

Content by: Joseph Koch

Present: All group Members

Goals: show Mr. Kutschera our walker

Content:

We showed Mr. Kutschera the smart walker and the app. He was very excited and told us about his coworkers who were looking forward to seeing the smart walker. He explained how beneficial the smart walker will be in the clinic. We showed him the smart phone app and how it showed the pressure values when he pushed down on the walker. We told him that we would add a box and clean up the wiring, and we would let him know when it was ready for pickup

Conclusions/action items:

Finish the walker and arrange for pickup

Advisor Meeting - 9/15/2023

JOSEPH KOCH - Oct 13, 2023, 6:01 PM CDT

Title: Initial Advisor Meeting

Date: 9/15/2023

Content by: Joseph Koch

Present: All group members

Goals: Meet our advisor and discuss our project

Content:

We met with our advisor, Dr. Wille, and talked about past design projects that we had worked on. We discussed our client and project. We explained that we had already met with our client Danile Kutschera and explained his vision for the walker. We talked about different preliminary designs to help fulfill his requests

Conclusions/action items:

continue research and brainstorm design ideas

Advisor Meeting - 9/22/2023

JOSEPH KOCH - Oct 13, 2023, 5:57 PM CDT

Title: Advisor Meeting

Date: 9/22/2023

Content by: Joseph Koch

Present: All Group members and Advisor Christa Wille

Goals: Discuss client outreach and design plans

Content:

In this meeting we discussed preliminary design ideas with Dr. Wille. We also went through our preliminary design specifications. We reviewed what needed to be in the PDS and reviewed Dr. Wille's feedback on our initial draft of the PDS. We discussed potential designs and how they would fulfill the PDS.

Conclusions/action items:

Begin work on the preliminary designs and design matrix

Advisor Meeting - 9/29/2023

Amara Monson - Oct 13, 2023, 5:14 PM CDT

Title: Advisor Meeting

Date: 9/29/2023

Content by: Amara

Present: Full team

Goals: Meet with our advisor to talk about where we are at in the project

Content:

In this meeting with Dr. Wille we discussed our preliminary designs and design criteria with Dr. Wille. We did not yet have the design matrix filled out, but we had chosen final preliminary designs to move forward with. We discussed some things to consider, such as the sensitivity and accuracy of the hall effect sensor and the durability of placing the pressure sensor in the foot of the walker. In her final remarks during this meeting, Dr. Wille suggested we try to get our hands on a walker as soon as possible, and maybe even try to construct some simple prototypes of our designs to use during our preliminary presentation.

Conclusions/action items:

- Order a walker

- Fill out the design matrix and finish the presentation

Advisor Meeting - 10/13/2023

JOSEPH KOCH - Oct 13, 2023, 6:08 PM CDT

Title: Advisor Meeting

Date: 10/13/2023

Content by: Joseph Koch

Present: Baljinder, Nikhil, Joseph, Lance

Goals: Go through preliminary report and notebook requirements

Content:

We met with Dr. Wille to go through the preliminary report and notebook requirements. We also talked about reimbursement and ordering future materials. Dr. Wille suggested to reach out to our client about meeting to go through the preliminary presentation and talk about ordering materials

Conclusions/action items:

Reach out to Mr. Kutschera about meeting to go through preliminary designs.

Advisor Meeting - 10/20/2023

JOSEPH KOCH - Dec 10, 2023, 9:35 PM CST

Title: Advisor Meeting

Date: 10/20/2023

Content by: Joseph Koch

Present: All Group Members

Goals: Discuss current status of project

Content:

We discussed our plans for fabricating the hall effect sensor and how the different circuits would work. We also talked about how we would begin integrating the circuits into the walker by threading the wires through the legs of the walker. We also talked about the pressure sensors and the difficulties we were having finding force sensing resistors. We talked about ordering materials like the hall effect sensor.

Conclusions/action items:

Find force sensing resistors that will work for our smart walker and begin building the hall effect sensor circuit

Advisor Meeting - 10/27/2023

JOSEPH KOCH - Dec 10, 2023, 9:41 PM CST

Title: Joseph Koch

Date: 10/27/2023

Content by: Joseph Koch

Present: All group members

Goals: Discuss the pressure sensing circuit and show and tell with Dr. Wille

Content:

We talked with Dr. Wille about our revised plan for the pressure sensing aspect of the smart walker. We talked about switching from force sensing resistors to load cells. We continued to discuss how we were going to integrate the systems into the walker and the challenges that this might present especially with the larger load cells. We also talked about the upcoming show and tell what we were bringing and what we were hoping to get out of the show and tell. We hoped to get advice on how we would integrate the load cells into the feet of the walker.

Conclusions/action items:

Start building the load cell circuit when they arrive. Prepare for the show and tell

Advisor Meeting - 11/17/2023

JOSEPH KOCH - Dec 10, 2023, 9:46 PM CST

Title: Advisor Meeting

Date: 11/17/2023

Content by: Joseph Koch

Present: Nikhil Baljinder Joseph

Goals: Talk about the current status of the project and testing

Content:

We explained the current status of the project to Dr. Wille. We were still unable to get the pressure sensing circuit to work despite ordering a second set of load cells. We explained that we think the problem was with the connections or with the hx711 board. We all explained our testing plans. We were planning on calibrating the load cells with known weights to find the calibration factor then test the accuracy after that. For testing the speed/distance sensor we planned on travelling a set distance of 10m and manually recording the speed. Dr. Wille told us that we could use the force plates in the teaching lab in ECB and that would be a good way of testing the force sensors.

Conclusions/action items:

Get the force sensing circuit to work and test the circuits.

Advisor Meeting - 12/1/2023

JOSEPH KOCH - Dec 10, 2023, 10:02 PM CST

Title: Advisor Meeting

Date: 12/1/2023

Content by: Joseph Koch

Present: All group members

Goals: discuss the current status of the project, testing, and the poster presentation

Content:

We told Dr. Wille that the pressure and distance sensors were working and that we were planning on testing them this weekend. She asked us about our testing plans and we said we would either use the teaching lab force plates or known weights to test the force sensors. We also discussed the poster presentation and the expectations for the poster

Conclusions/action items:

print poster and finish testing

Group Brainstorming Session - 10/02/23

BALJINDER SINGH - Dec 13, 2023, 10:53 PM CST

Title: Group Brainstorming Session

Date: 10/2

Content by: Lance

Present: Entire Smart Walker Team

Goals: To come up with as many design ideas for measuring the speed, distance, and pressure distribution on the walker.

Content:

- Angular rotation of wheel: Exploring the use of the wheel's angular rotation data for movement analysis.
- GPS: Considering GPS integration to track the walker's location during mobility assessments, though precision might be an issue.
- Dial potentiometer: Thinking about using dial potentiometers to measure angles, but attachment and tangling could be tricky.
- Keeping measurement devices/electronics away from the wheel: Ensuring that electronic components are kept at a safe distance from moving parts for safety and reliability.
- Sonar: Investigating the potential of sonar technology for obstacle detection and distance measurement.
- Photogates (angular rotation): Considering the use of photogates to measure the angular rotation of the wheel.
- Pressure sensor on the wheel (measures pressure and speed): Exploring the installation of pressure sensors on the wheel to measure pressure distribution and speed.
- Pressure sensors on grips, bottom of feet: Looking into adding pressure sensors on hand grips and underfoot for balance and gait analysis.
- Compression force sensor: Exploring the use of compression force sensors to assess weight-bearing and stability.
- Software app & server - Bluetooth?, USB?: Planning to create a user-friendly app and a server for data collection and analysis, and debating whether to use Bluetooth or USB for connectivity.

Conclusion/Action items:

With many ideas for how we can measure the speed, distance, and pressure, moving forward we can now having deeper discussions as a team, narrow down these ideas, and begin creating out design matrices and initial drawings.

Proposed Final Design - 10/13/2023

Amara Monson - Nov 16, 2023, 10:25 PM CST

Title: Proposed Final Design

Date: 10/13/2023

Content by: Lance

Present: N/A

Goals: Summarize the final design

Content:

As decided in the speed and distance design matrix, the team will be moving forward with the magnetic sensor as the means for measuring the speed and distance traveled of the walker. The pressure design matrix determined the force sensing resistor placement on the handles to be most effective, and therefore will use the handle placement to record pressure and force data. In combination, these two sensors will provide the clients requested data of gait speed, distance, and pressure. The sensors will be hardwired to an Arduino microcontroller which will record and relay the live data to the server which will be accessible from the client's smartphone.

Speed/Distance magnet design

Pressure sensors in handle

Update: After looking into available pressure sensors, we have decided to use load cells in the non-wheel legs instead of pressure sensors in the handles. The load cells will be more durable than other options and will eliminate any error due to squeezing the handles.

Pressure sensors in the feet (update for load cells)

Conclusion/action items:

* Purchase magnets, hall effect sensor, pressure sensors and any other supplies need

* Find suggested circuits online for the sensors with the Arduino

* Design software and Arduino code

Design Matrixes - 10/13/2023

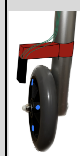
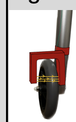
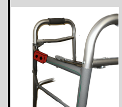
NIKHIL CHANDRA - Dec 15, 2023, 7:12 PM CST

Title: Design Matrixes

Date: 10/13/2023

Content:

Speed/Distance Design Matrix

Criteria	Weight	Magnetic Sensor 		Light Sensor 		Distance Sensor 	
Accuracy/precision	25	4/5	20	4/5	20	3/5	15
Ease of Use	20	5/5	20	5/5	20	5/5	20
Safety	20	5/5	20	3/5	12	5/5	20
Durability	15	4/5	12	3/5	9	5/5	15
Ease of Fabrication/Integration	10	4/5	8	4/5	8	2/5	4
Cost	10	5/5	10	2/5	4	3/5	6
Total:	100	Sum	90	Sum	73	Sum	80

The evaluation of three walker speed and distance designs—magnetic sensor, light sensor, and distance sensor—used six criteria: accuracy/precision, ease of use, safety, durability, ease of fabrication, and cost.

1. **Accuracy/Precision**: Magnetic and light sensors scored ⅘ for accurately measuring wheel rotation but struggled with turn calculations. The distance sensor scored ⅗ due to its reliance on a consistent reference surface.
2. **Ease of Use and Safety**: All designs scored 5/5 for ease of use, not hindering walker operation. For safety, the distance and magnetic sensors scored 5/5 for minimal interference, while the light sensor scored lower (⅗) due to its size.

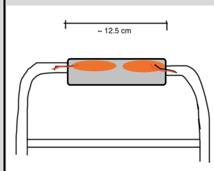
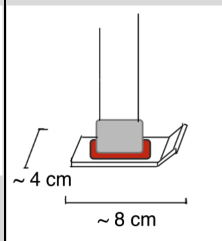
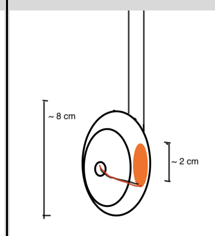
3. **Durability**: The magnetic sensor scored ⅘ for its simplicity; the light sensor ⅗ for being larger and complex; the distance sensor 5/5, being safely located.

4. **Ease of Fabrication**: Light and magnetic sensors scored ⅘, and the distance sensor ⅖ due to needing two units.

5. **Cost**: The magnetic sensor was the most cost-effective (5/5), followed by the distance sensor (⅗) and the light sensor (⅖).

Overall, the magnetic sensor emerged as the top choice for its accuracy, user-friendliness, safety, and cost-effectiveness.

Pressure Design Matrix

Criteria	Weight	Grip		Foot		Wheel	
							
Accuracy/Precision	25	3/5	15	4/5	20	4/5	20
Ease of Use	20	5/5	20	5/5	20	5/5	20
Safety	20	5/5	20	5/5	20	3/5	12
Durability	15	4/5	12	1/5	3	3/5	9
Ease of Fabrication/Integration	10	5/5	10	3/5	6	2/5	4
Cost	10	3/5	6	5/5	10	5/5	10
Total:	100	Sum	83	Sum	79	Sum	65

The evaluation of three pressure sensor placements for a walker—handle, foot, and wheel—focused on six criteria: accuracy/precision, ease of use, safety, durability, ease of fabrication/integration, and cost.

1. **Accuracy/Precision**: Foot and wheel placements scored high for their simple sensor integration. The handle design scored lower due to potential inaccuracies from grip force.

2. **Ease of Use**: All designs scored equally well, indicating no significant impact on walker use.

3. **Safety**: Handle and foot placements rated high for safety, while the wheel design was lower due to possible instability from moving parts.

4. **Durability**: The handle placement was most durable, with the foot and wheel placements scoring lower due to constant ground contact and pressure.

5. **Ease of Fabrication/Integration**: The handle design scored highest for its straightforward sensor integration, with foot and wheel placements scoring lower due to more complex wiring.

6. **Cost**: Foot and wheel were more cost-effective, needing fewer sensors, while the handle design was pricier due to more sensors and a protective cover.

Overall, the handle placement was the best choice with a score of 83/100, excelling in most criteria. The foot and wheel placements scored 79/100 and 65/100, respectively.

Conclusions/action items:

present design matrix in preliminary presentation

begin fabrication of chosen designs

Preliminary design Drawings - 10/13/2023

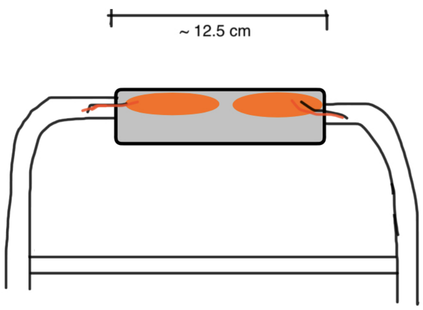
BALJINDER SINGH - Dec 13, 2023, 10:50 PM CST

Title: Preliminary Design Drawings

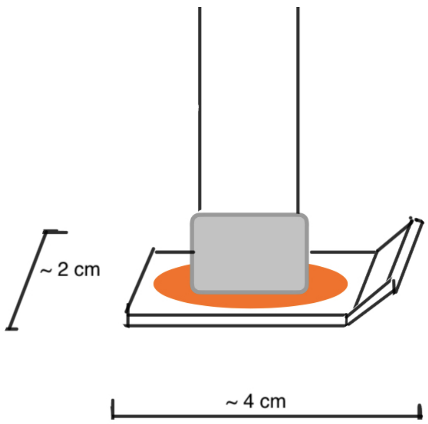
Date: 10/13/2023

Content:

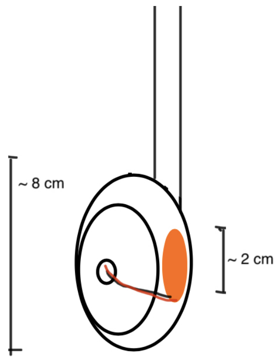
Pressure drawings



hand grip design - places pressure sensors in the handgrip of the walker

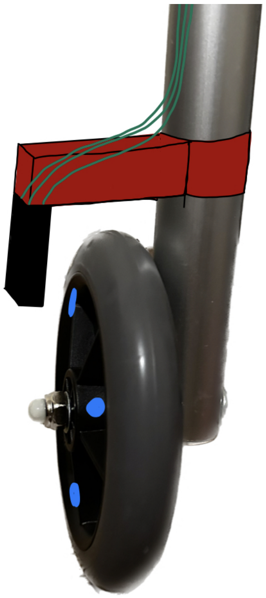


foot placement design - places pressure sensors in between the slider and the leg of the walker

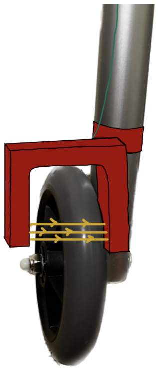


wheel design - places the pressure sensors on the wheels of the walker

Speed/Distance Designs



Magnetic sensor - uses a hall sensor and magnets on the wheel to track the rotation of the wheel



light sensor - uses a photogate sensor which is interrupted by the spokes of the wheel. These interruptions can be use to track the rotation of the wheel

Distance sensor - uses an ultrasonic distance sensor which sends out ultrasonic waves which bounce off a surface and returns to the walker. The sensor tracks the distance from the wall to the sensor.

Conclusions/action items:

Evaluate the different designs using the design matrix and present them in the preliminary design presentation.

Hall Effect Sensor Design - 10/22/2023

JOSEPH KOCH - Dec 10, 2023, 6:22 PM CST

Title: Hall Effect Sensor Design

Date: 10/22/2023

Content by: Joseph Koch

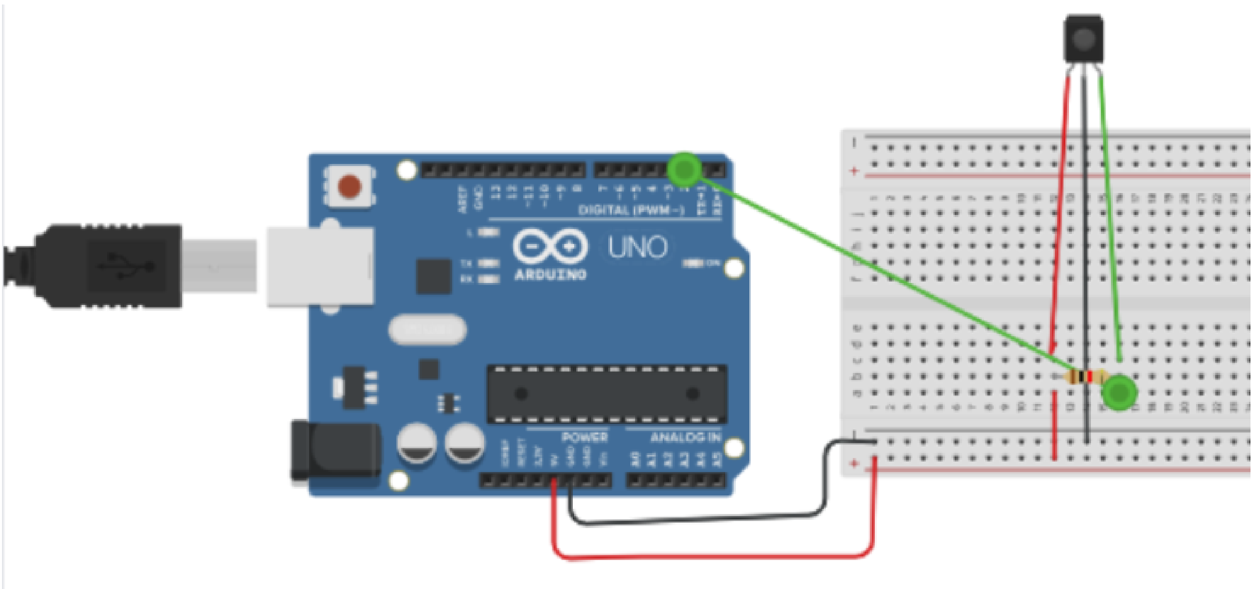
Present: All members

Goals: Complete hall effect sensor design and have proof of concept testing

Content:

In this meeting, we worked on a preliminary circuit for tracking speed and distance using a hall effect sensor. We constructed the circuit and tested it by putting magnets near the sensor.

Preliminary circuit



Preliminary code for Testing concept

```
int sensor = 10; //sensor pin
int val; //numeric variable

void setup()
{
  pinMode(led, OUTPUT);
  pinMode(sensor, INPUT); //set sensor pin as input
}

void loop()
{
  val = digitalRead(sensor); //Read the sensor
  if(val == HIGH) //when magnetic field is detected, turn led on
  {
    digitalWrite("magnet");
  }
```

Conclusions:

The hall effect sensor should work for testing speed and distance. We need to figure out how to integrate it into the walker and if we will need to use strong magnets and where the magnets will be placed.

Action items:

Continue to refine the idea by testing it with the actual wheel of the walker. Also doing the calculations to find the distance from the sensor. Continue work on pressure circuit.

Force Sensor Reevaluation - 10/22/2023

JOSEPH KOCH - Dec 10, 2023, 6:35 PM CST

Title: 10/22/2023 Force Sensor Reevaluation

Date: 10/22/2023

Content by: Joseph Koch

Present: All group members

Goals: Reevaluate our preliminary design for sensing force

Content: In our preliminary design presentation we initially planned to use force sensing resistors in the handles of the walker. As we began to look for force sensing resistors we found it hard to find a sensor that would be malleable to wrap around the handles, small enough to fit under the handle, and be able to sense enough pressure. We then decided to change where we were going to place the force sensors choosing to put them in the feet of the walker instead of the handles because they would be easier to integrate there. However the force sensing resistors would not be durable enough to withstand the hard leg bottoms. We decided to forgo the FSR entirely and opted for a larger more durable load cell. The load cell could measure larger forces and was commonly used in at home scales.

Load cell we ended up selecting

Conclusions:

we ultimately decided to change our force sensing preliminary design because it was too difficult to integrate the force sensing resistors and find a suitable sensor in our budget. Instead, we choose to place the sensors in the feet of the walker and use load cells.

Action items:

Purchase load cells

Figure out circuit and details about output of sensors

build circuit

Load Cell Research - 10/23/2023

JOSEPH KOCH - Dec 10, 2023, 6:49 PM CST

Title: Load Cell research

Date: 10/23/2023

Content by: Joseph Koch

Goals: Research different load cell designs and find a suitable option for the smart walker

Content:

There are 3 different types of load cell configurations with strain gauges. When force is applied to the load cell the internal strain gauge will convert the force into an electrical signal in the form of resistance. The resistance is very small so they are often used in tandem with an hx711 amplifier board which amplifies the output. Strain gauge load cells are often configured in a wheatstone bridge circuit with four load cells. The three most common configurations are

1. A flat metal pad

2. Bar shaped

3. Disc shaped

The disc shaped would be ideal for the smart walker because it would be easy to integrate into the walker legs with minimal disruption. Unfortunately, the disc shaped sensors are much more expensive $60-$100 per a sensor and to form the wheatstone bridge we would need four eating up a substantial portion of the budget.

The bar shaped load cell would be incredibly difficult to integrate leaving the flat pad sensor as the best option.

Conclusions/action items:

Purchase flat pad shaped load cells

build circuit

test circuit

Fabrication Materials - 10/13/2023

Amara Monson - Nov 16, 2023, 10:27 PM CST

Title: Fabrication Materials

Date: 10/13/2023

Content by: Lance

Present: N/A

Goals: Outline the required materials for the smart walker design

Content:

In order to begin fabrication of the smart walker, the team will need to purchase some components and fabricate some additional parts. Specifically, at least 4 force sensing resistors will need to be purchased in order to complete the pressure-sensing aspect of the design. The pressure design also requires some sort of cover for the sensors, so a lightweight yet durable fabric or foam will also need to be acquired. Additionally, the magnetic sensor for the wheel will need to be purchased, and perhaps larger or smaller magnets may also need to be purchased to better suit the small size of the walker wheels. The magnetic sensor magnet will also need to be secured to the wheel using high-strength glue or other method of attachment. Low-voltage wiring and methods for attaching the wiring(zip ties, glue, velcro, cable routing tubes, etc.) will need to be obtained in order to connect the sensor components to the Arduino UNO microcontroller, which will also need to be purchased. A power source will also be necessary for the Arduino so a battery will need to be purchased. The backbone of the entire design, the aluminum two-wheel walker, has already been purchased and will be modified to accommodate the sensors, their mounts, and the wiring.

Conclusion/Action Items:

Moving forward now that we have a more general understanding of the materials that can be ordered for the initial

Action item --> purchase magnets, hall effect sensors, and pressure sensors

Load Cell - 10/23/2023

JOSEPH KOCH - Dec 10, 2023, 6:59 PM CST

Title: Load Cell

Date: 10/23/2023

Content by: Joseph Koch

Goals: Purchase Load Cells

Content:

We decided to purchase flat strain gauge load cells because they were cheaper than the alternative disc shaped strain gauge load cells and were easier to integrate than the bar shaped load cells.

Conclusions/action items:

Research wheatstone bridge circuit and build circuit

Final Design Budget - 12/11/23

BALJINDER SINGH - Dec 11, 2023, 6:10 PM CST

Title: Final Design Budget

Date: 12/11/23

Content by: Baljinder

Present: Baljinder

Goals: Record all purchases made for the Final SMART Walker.

Content:

Budget Calculations

Item	Price	Quantity	Total Price	Buying Information	Person	Total	Remaining Budget
Walker	$43.53	1	$43.53	Link (Amazon)	Amara	$276.48	$123.52
Gliders	$11.04	1	$11.04	Link (Amazon)	Amara		
Apple Developer Account	$99.00	1	$99.00	Link (Apple)	Nikhil		
ARDUINO							
Microcontrollers	$48.53	1	$48.53	Makerspace	Nikhil		
Hall Effect Sensor	$1.00	1	$1.00	Makerspace	Amara		
Load Cells (First Prototype)	$2.25	4	$9.00	Link (Amazon)	Amara		
Load Cells (Second Prototype, first did not work)	$4.50	4	$18.00	Link (Sparkfun Electronics)	Joseph		
Amplifier Boards	$1.80	5	$8.98	Link (Amazon)	Joseph		
Hall Effect Sensors - Time Contraint	$1.10	2	$2.20	Makerspace	Amara		
3D PRINT							
3D Printed Glider - PLA (Prototype)	$3.28	1	$3.28	Makerspace	Lance		
3D Printed Gliders - PLA	$8.00	1	$8.00	Makerspace	Lance		
3D Printed Box - PLA(Protytype)	$4.58	1	$4.58	Makerspace	Jake		
MISC							
Screws	$0.03	9	$0.30	Makerspace	Lance		
Nuts	$0.15	8	$1.20	Makerspace	Lance		
Zipties	$0.05	10	$0.50	Makerspace	Baljinder		
Big Magnets	$0.25	3	$0.75	Makerspace	Amara		
Medium Magnets	$0.11	4	$0.44	Makerspace	Amara		
Powerblock	$11.50	1	$11.50	Makerspace	Amara		
Electric Tape	$3.50	1	$3.50	Makerspace	Amara		
Super Glue	$1.15	1	$1.15	Makerspace	Amara		

Conclusions/action items:

We ended up using $276.43 of our $400 budget. We were left with $123.52

Initial Fabrication Outline/Steps - 10/13/2023

NIKHIL CHANDRA - Dec 15, 2023, 7:13 PM CST

Title: Initial Fabrication Outline/Steps

Date: 10/13/2023

Content by: Lance

Present: N/A

Goals: Outline the initial fabrication steps

Content:

Once the materials have been acquired, the team will divide to fabricate the design in three general groups. One group will work with the force sensing resistors to assemble the handles using adhesive to secure the sensors in optimal positions and route the wires safely out of the way so that the patients will not damage the circuitry during use. The team will also need to figure out how to fabricate and attach the handle covers in a way that doesn't have too great an impact on the use and feel of the walker. Another group will work with the magnetic sensor to integrate the sensor and the magnet onto the wheel assembly, which will likely require some 3D printing to mount the sensor in the perfect position. A similar fabrication process will be used by the third team to secure the Arduino microcontroller to the frame of the walker. This will likely best be accomplished using 3D printing to make a secure box that can contain both the Arduino and its power source and the incoming wires from the sensor. Soldering techniques will likely also need to be used to fabricate the circuitry.

Conclusion/Action Items:

Begin acquiring materials and fabrication pressure and speed sensor circuits along with software app.

Pressure Sensor reassembly 11/11/2023

BALJINDER SINGH - Dec 11, 2023, 11:22 AM CST

Title: Pressure Sensor Reassembly

Date: 11/11/2023

Content by: Joseph Koch

Present: Nikhil, Amara, Lance, Baljinder

Goals: Reassemble the pressure circuit using different tutorials

Content:

In a previous meeting, we attempted to use the circuit diagrams on the Amazon page for the load cells. We tried this circuit again with different codes from different online tutorials. This was not successful because the pressure readings still did not change when force was applied. We deconstructed the circuit and reassembled it using a bread board in hopes of fixing any poor connections. The load cells used threaded wire instead of solid core and the wires are very thing which makes using a bread board very difficult. We concluded that the problem is either with the connections or the load cells themselves because they were very cheap. There are a lot of connections within the circuit because it used 4 load cells each with 3 wires and 4 wires from the board to the arduino, so we decided to look into buying new sensors.

Conclusions/action items:

We decided that the current pressure sensors weren't working and we should look into buying new pressure sensors.

New pressure sensors 11/12/2023

JOSEPH KOCH - Dec 10, 2023, 7:45 PM CST

Title: New pressure Sensors

Date: 11/12/2023

Content by: Joseph Koch

Present: Nikhil Jake Baljinder

Goals: Work with new pressure sensors and get these to work

Content:

In our previous meeting we concluded that the old pressure sensors were not working so we decided to purchase new sensors. I soldered the circuit together following the circuit diagram on the web page for the sensors. I soldered them to a new hx711 board. The circuit still did not produce values when force was applied. The probability that these sensors also did not work was very unlikely so we concluded that it was likely the solder connections that were the problem. To ensure this we tested the resistance across the wires of each load cell they all aligned with their expected values. Because the load cells had thin threaded wires we decided to solder thicker solid core wiring to each wire to be more suitable for prototyping with a breadboard. After soldering the solid core wire we reconstructed the circuit and it still didn't work. We think that the hx711 amplifier board might be part of the problem.

Conclusions/action items:

Continue to work on the pressure circuit and try to get it to work. Order new hx711 boards

HX711 Soldering - 11/12/22

BALJINDER SINGH - Dec 11, 2023, 11:35 AM CST

Title: Soldering HX711 Board

Date: 11-12

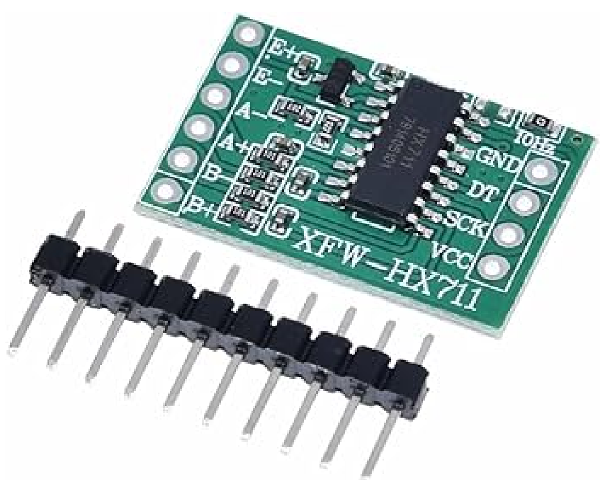
Content by: Baljinder

Present: Baljinder, Nikhil

Goals: The goal for this meeting is to solder the pins onto the HX711 board so that we can successfully attach the Load Cells and complete the circuit.

Content:

Previously, we ordered 4 load cells and they came with HX711 board. While some of us stayed back to work on the circuit, Nikhil and I went up to the Makerspace to solder the pins onto the board. We used smaller solder feed because the breadboard was very small. I haven't used the soldering iron ever, while Nikhil last used it a while ago. I spent majority of the time learning how to solder, and then helped solder a few pins towards the end.



Conclusions/action items:

Towards the end of our meeting, we checked the board out, and all the connections seemed connected. We were now ready to attach the circuit to the board, and test the load cells.

Notes for Pressure Sensor Circuits - 11/14/23

BALJINDER SINGH - Dec 11, 2023, 5:58 PM CST

Title: Notes for Pressure Sensor Circuits

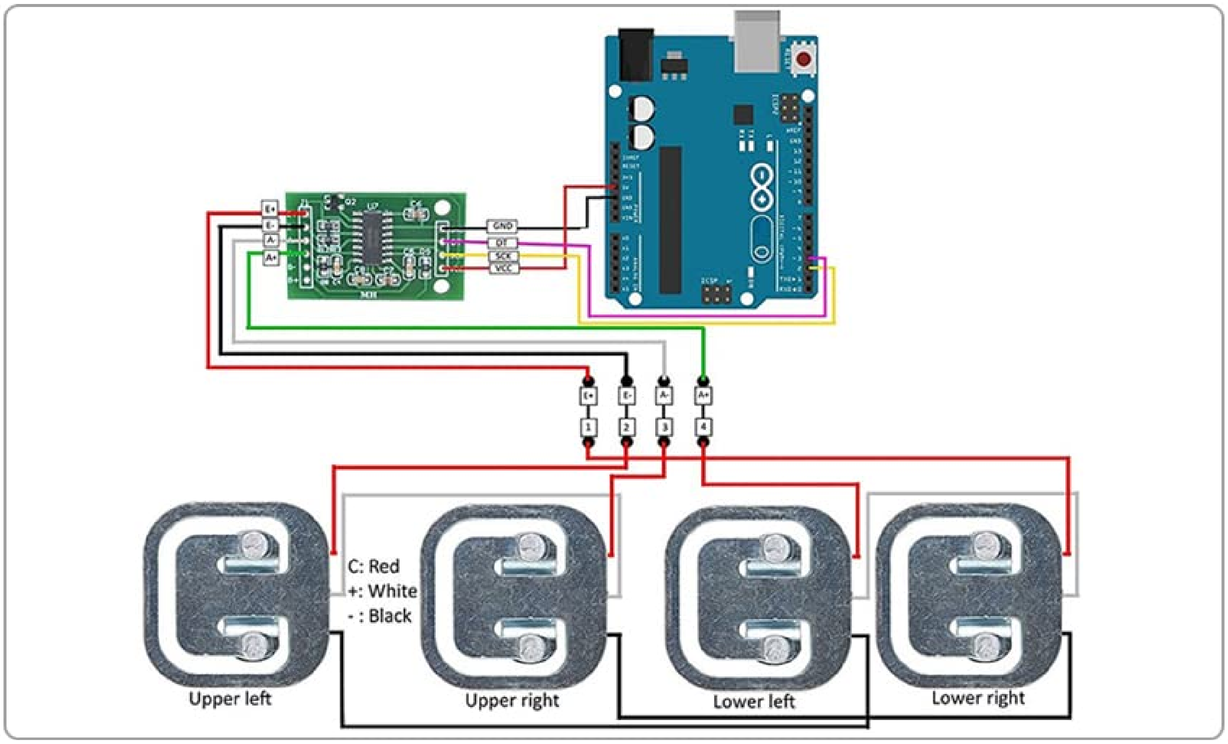
Date: 11/14/2023

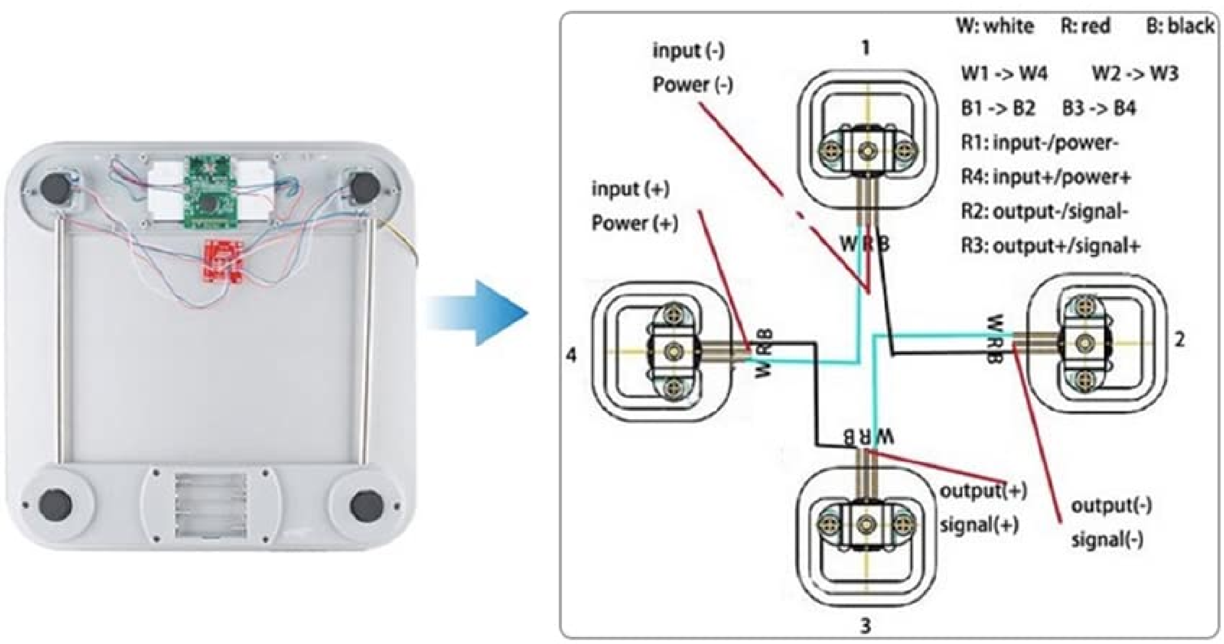
Content by: Baljinder Singh

Present: Baljinder Singh

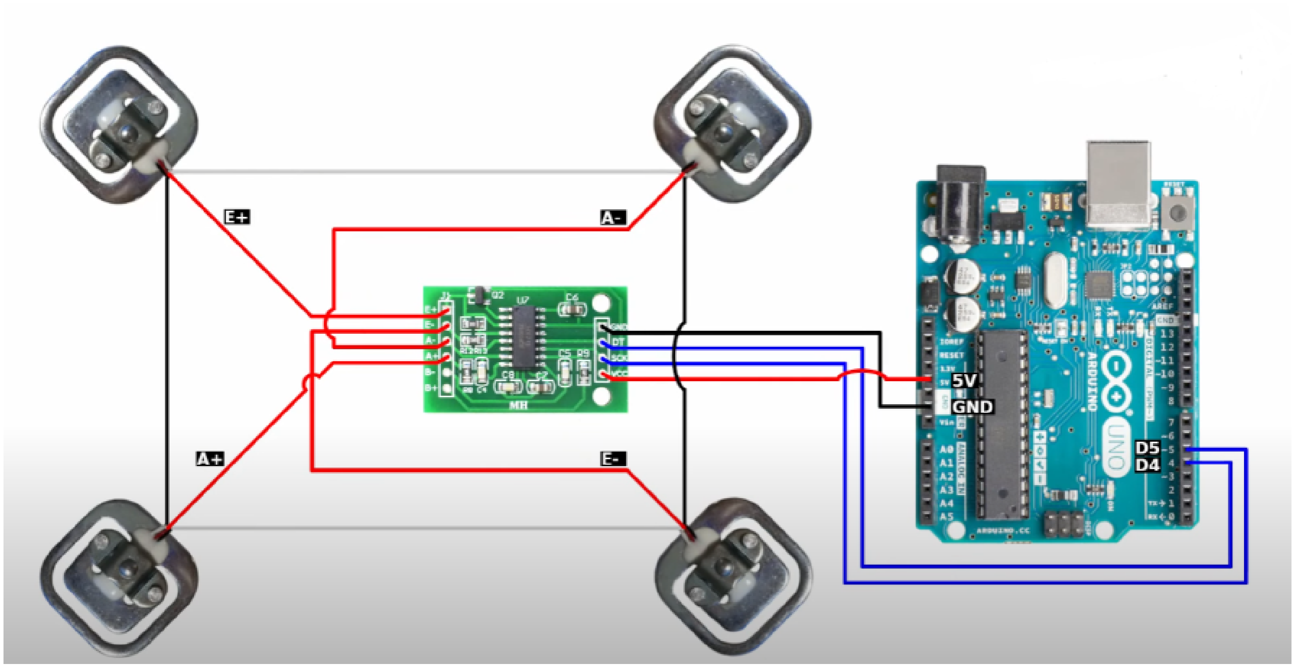
Goals: Find different tutorials that can help circuit the pressure sensors.

Content:





This circuit comes straight from the Amazon listing that we used to purchase the load cells.



This is another circuit for the loadcells.

When using the voltmeter,

The input voltage is typically 3 to 5 volts, but can be 1 to 10 volts or so. Normally, all four strain gauges (2 or 3 could be resistors) are all the same resistance. Typical resistances are 120, 350, or 1000 ohms.

Reference: https://www.physicsforums.com/threads/load-cell-wiring-length-question.1049663/

Conclusions/action items:

Reference the pictures above to help with the circuit for the load cells.

Pressure Sensor Reassembly 2 11/19/2023

JOSEPH KOCH - Dec 10, 2023, 9:22 PM CST

Title: Pressure Sensor Reassembly 2

Date: 11/19/2023

Content by: Joseph Koch

Present: Amara Joseph Nikhil

Goals: Reconfigure the pressure sensor circuit and try different ways of triggering the sensors

Content:

Because the new pressure sensors still didn't work from the last meeting we tried different configurations using 4 sensors in a wheatstone bridge, 2 sensors, and 1 sensor. We tried the 2 sensor configuration and 1 sensor configuration and neither of those would produce values. Then we tried different ways of triggering the sensors because we thought that we weren't putting pressure in the right spot or putting enough pressure. After pushing on all sensors at once and on different places on the sensors, we tried standing on them and it still didn't work. We then set the sensor up so the middle part would be able to bend down inside of the surrounding supports and it still didn't work so we concluded the connections or the board must be the problem.

Conclusions/action items:

redo all of the connections on the circuit and look into getting new hx711 boards.

Pressure Circuit Soldering and Setup - 11/21/23

NIKHIL CHANDRA - Dec 10, 2023, 5:04 PM CST

Title: Pressure Circuit Soldering and Setup - 11/21/23

Date: 11/21/23

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To resolder every one of the connections from the load cells to thicker wires and to resolder the Hx711 board, then to put the load cell circuit together and do initial testing to see if the problem is solved.

Content:

In the previous meeting we are still unsure why the pressure sensor circuit is not working but we believe it could potentially be due to loose connections.

To begin, I am going to resolder the entire hx711 board to the headers and double check the soldering to make sure every connection is perfect. The soldering turned out well and every connection seemed reinforced.

I then moved on to stripping new thicker wires that I soldered to the relatively thin wires of the load cells to create a more reinforced connection. It was a long process since stripping the thin wires was incredibly fragile and kept leading to the wires simply cutting, but eventually the soldering job was done.

I then followed the bathroom scale tutorial showing how to connect one load cell in a circuit with two other 1k resistors to form a wheatstone bridge into the hx711 amplifier. I then connected the arduino to my computer and ran the same code as before to calibrate the amplifier. When I pressed the load cell using my fingers, it finally read values that would change accordingly to the pressure I placed with my fingers. Some videos and pictures are attached.

Conclusions/action items:

Having successfully created the pressure sensor circuit to read appropriate values for changing applied forces after many unsuccessful attempts over the past few weeks, we can now proceed with creating a more solidified circuit diagram involving two load cells and an overall fabrication protocol for how we can calibrate and integrate the pressure sensor circuit into the walker.

NIKHIL CHANDRA - Dec 10, 2023, 5:05 PM CST

Download

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NIKHIL CHANDRA - Dec 10, 2023, 5:05 PM CST

Download

IMG_0353.heic (1.18 MB)

Fabrication Protocol of Final Pressure Sensor Circuit - 11/24/23

NIKHIL CHANDRA - Dec 10, 2023, 5:25 PM CST

Title: Fabrication Protocol of Final Pressure Sensor Circuit - 11/24/23

Date: 11/24/23

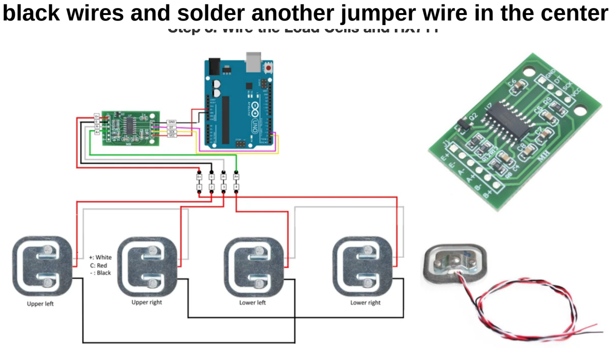
Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To write out and execute a fabrication protocol for the pressure sensor circuit that will be integrated into the walker with two load cells wired into an hx711 amplifier board.

Content:

1. **Measure and strip 6 wires the length from the bottom of the gliders of the walker to the middle horizontal bracket of the walker. Use different colors**
2. **For each wire stripped on both ends, solder each one to each wire of the load cells for all 6 wires.**
3. **Take the protoboard and solder a 5V(outside) and GND(inside) long line**
4. **Similar to the breadboard setup in the bathroom scale tutorial, solder the white wire and black wire of separate load cells into one connected line, and between them solder a jumper wire. Then do the same for the remaining white and black wires and solder another jumper wire in the center of the connection line**



   a. **Reference:**
      i. **DegrawSt, and Instructables. "Arduino Bathroom Scale with 50 Kg Load Cells and HX711 Amplifier."** ***Instructables*****, Instructables, 22 Oct. 2020, www.instructables.com/Arduino-Bathroom-Scale-With-50-Kg-Load-Cells-and-H/.**
5. **Then connect the red wires of the load cells and the jumper wires and appropriately plug them into the hx711 board into E-, E+, A-, A+ as in the above diagram**
6. **Then connect the jumper wires of the hx711 board to the arduino including the power/VCC, GND, DT and SCK to the arduino**
7. **Test to check if the load cells output values.**

Images are attached of the fully soldered pressure sensor circuit after successfully following the above fabrication protocol.

Conclusions/action items:

After completing the above fabrication protocol for the full pressure sensor circuit, the next task as a team is to integrate the pressure sensor circuit into the walker and to do some initial testing to see if the circuit successfully works and if not to see how we can debug and decipher the issue.

NIKHIL CHANDRA - Dec 10, 2023, 6:09 PM CST

Download

IMG_0363.heic (835 kB)

Pressure Sensor Circuit Integrated into Walker Troubleshooting - 12/2/23

NIKHIL CHANDRA - Dec 10, 2023, 6:13 PM CST

Title: Pressure Sensor Circuit Integrated into Walker Troubleshooting - 12/2/23

Date: 12/2/23

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To troubleshoot and diagnose the issue for why the pressure sensor circuit continuous prints out zero pressure regardless of the applied force on the walker.

Content:

To troubleshoot the walker, my strategy was to isolate in on different components of the pressure sensor circuit, replace parts as necessary and slowly narrow it down to a potential problem.

I began by inspecting every connection to make sure there was no soldered connection that broke or if there was any loose connection. I added soldered to what I believed were loose connections and I inspected the soldering of the protobard to ensure there was no solder that leaked between lines. I then used a multimeter to make sure current traveled through the circuit as expected and everything checked out for both load cells and the protobard.

If the load cells nor the soldering was the problem since current was being recorded as expected and there was appropriate resistances measured between wires of the load cells, then the potential problem might either have been the arduino or the hx711 amplifier.

I replaced the arduino with another spare arduino uno and that still did not solve the problem. I then detached the hx711 board completely from the circuit and used an entirely different load cell and a breadboard as opposed to the soldered protoboard, and the circuit still did not work indicating that the most likely issue was the the amplifier had somehow short circuited and was the defective component of the circuit.

I then soldered a new hx711 board to headers and tried the circuit again with the new hx711 board and the arduino successfully was printing changing values again given an applied force. Images of the circuit are attached.

Conclusions/action items:

Now that the pressure sensor circuit is successfully working, we now can calibrate the pressure circuit and conduct our testing protocol as a team of the entire walker before the final presentation in a week.

NIKHIL CHANDRA - Dec 10, 2023, 6:13 PM CST

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IMG_0441.heic (916 kB)

3d Foot Modeling - 12/5/23

Lance Johnson - Dec 11, 2023, 4:50 PM CST

Title: Walker 3d Foot Modeling

Date: 12/5/23

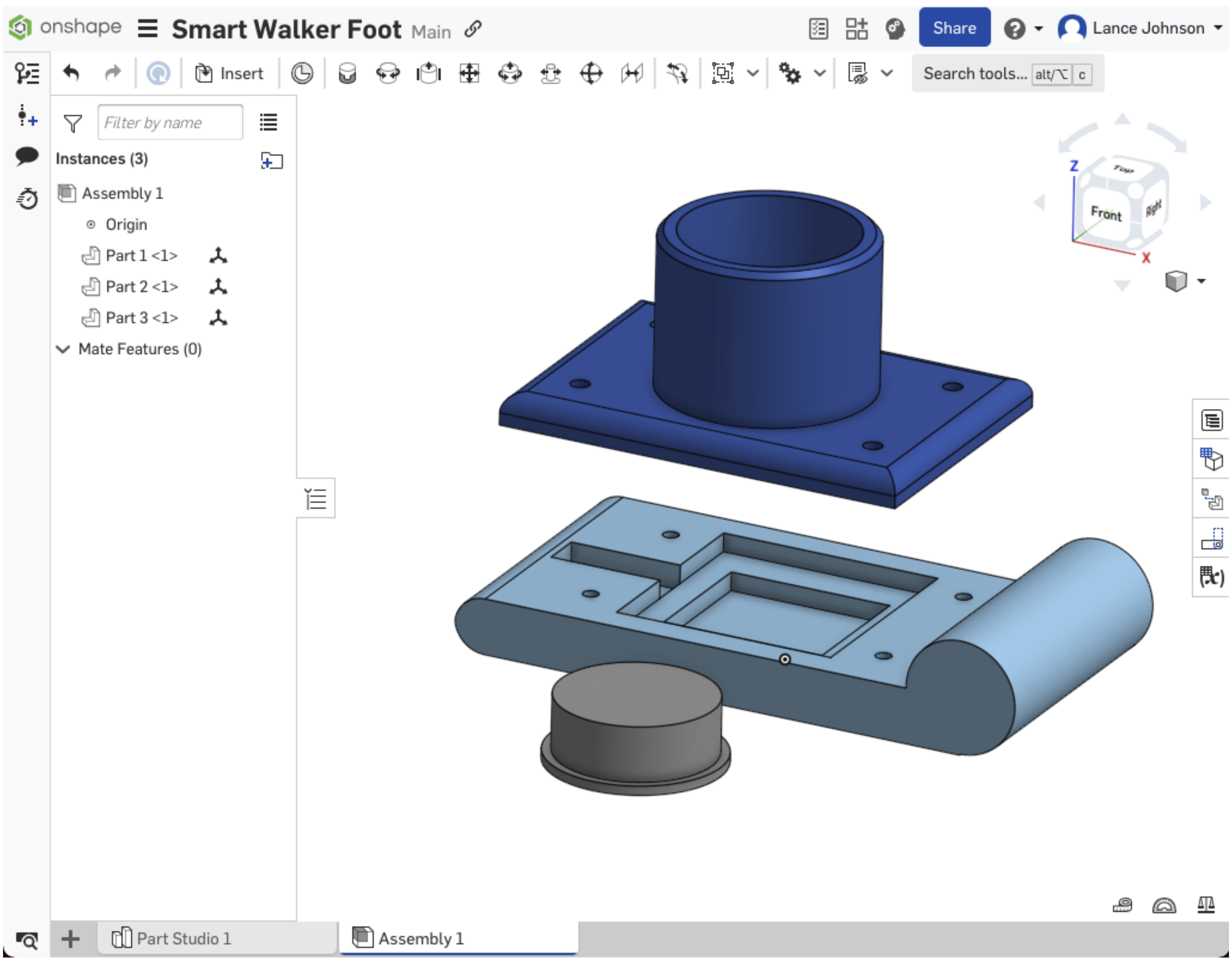
Content by: Lance

Present: N/A

Goals: To model a new walker glider that can house the load cell and direct force from the legs to the load cell.

Content:

A preliminary model was created and printed out of normal PLA with minimal infill(20%) in order to keep the first prototype cheap and keep the print time down.



The initial prototype needed refining after printing, but the general concept seemed to work very well for the walker. Therefore, after necessary adjustments were made to the dimensions of the cuff radius, load cell recess, and screw holes, a second prototype was printed. This time, the infill was increased to 40% in order to provide a more robust product. Once the second foot model was printed, it was tested and once all the dimensions were confirmed, the last walker foot was printed.

Conclusions/action items: The walker feet seem to work very well in the initial testing of durability and fit, but only when the actual output of the load cell is measured will their effectiveness be determined.

Final Prototype Assembly - 12/10/23

Lance Johnson - Dec 11, 2023, 3:51 PM CST

Title: Final Prototype Assembly

Date: 12/10/23

Content by: Lance

Present: All members

Goals: To complete the final prototype by installing and securing all sensor systems on the walker.

Content:

The team began the final fabrication process by assembling the sensor systems on the walker. This was done first by loosely taping the circuitry to the walker frame, making sure to maintain ample slack in the wires for rearrangements. The hall effect sensor was taped to the outside of the front-left leg, and the wheel was detached and five magnets were glued to the inside surface of the wheel at equal distances. The wires leading to the Arduino were routed up the leg to the middle of the walker where the Arduino was taped to the walker crossbar. A similar process was done with the load cell circuit, taping the wires up the two back legs and connecting the circuit to the Arduino. Once the circuits were installed, the 3d-printed walker gliders were assembled on the bottom of the walker legs. This was done by inserting the leg cap, placing the load cell in the glider, and screwing the leg attachment piece to the glider. This was done carefully as to not break a wire or undo a wire connection.

Conclusions/action items:

While the final prototype is completely assembled, the design could use some refining. The wiring is very loosely taped around the legs and frame of the walker, which is not ideal for durability and aesthetics, but allows for alterations during the testing processes and finer refining of the design. Additionally, we hope to house the Arduino, protoboard, and extra wire slack in a 3d-printed housing.

Initial Design of Software App UI - 11/03/23

NIKHIL CHANDRA - Dec 11, 2023, 1:57 PM CST

Title: Initial Design of Software App UI

Date: 11/3/23

Content by: Nikhil Chandra

Present: All Team Members

Goals: To describe the software app UI that was developed in XCode then to have Nikhil present the UI to the team to receive feedback to further refine the UI moving forward.

Content:

In the below images of the programmed software UI using SwiftUI in Xcode that we will be presenting at show and tell to other teams we can see some of the main features of the software app being its ability to display speed, distance traveled, and left and right pressure in real time. This is only the user interface design, and currently the software app does not connect to the firebase server just yet.

The team discussed that the design looks great and that the color scheme and styling is professional and user friendly. There were no points for improvement as of this point.

Note that the software code and iterations of the software code are linked and further described in Nikhil's individual notebook.

Conclusions/action items:

Moving forward, I can now design the rest of the User interface including the ability to choose patients from an existing list and create new patients. Afterwards we can then connect all these UI components to the backend.

Draft of Software App Features - 11/9/23

NIKHIL CHANDRA - Dec 10, 2023, 6:57 PM CST

Title: Draft of Software App Features

Date: 11/9/23

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To draft a list of features for the design of the software application before designing the software flow or user interface.

Content:

Below is a list of features we can integrate into the application and what the firebase backend might look like given these features.

UI:

- Pressure
- Speed
- Distance
    - All of these being shown in real time every x s
    - We will have to create a snapshot listener that listens to changes

Patient ID

- Interface for choosing a patient ID
    - List of patient IDs stored in firebase or we can retrieve that from retrieve document names
- Creating a new patient ID
    - When you create a new patient

Start and stop button

- When you click the start button
    - it resets distance to zero
    - It starts recording pressure, speed, distance locally
- When you click the stop button
    - It gets the average of these values and appends them with the current date to firebase given the patient ID

Firebase structure

Collection of users

- Patient Document
    - Subcollection of average values
        - Document with date and time

        - Average pressure
        - Distance traveled
        - Speed
- Real time Data document
    - Real time pressure
    - Real time distance
    - Real time speed

Store all real time values, and fetch them in real time using snapshot listener

Configure start stop button to collect data every n seconds, append to a list then append the averages to firebase

Conclusions/action items:

Given a solidified list of the different features in the software app, we can now move forward with designing the general structure of the software for the software app including how the frontend will interact with the backend.

Patient Selection UI Design and Discussion - 11/15/23

NIKHIL CHANDRA - Dec 11, 2023, 2:20 PM CST

Title: Patient Selection UI Design and Discussion

Date: 11/15/23

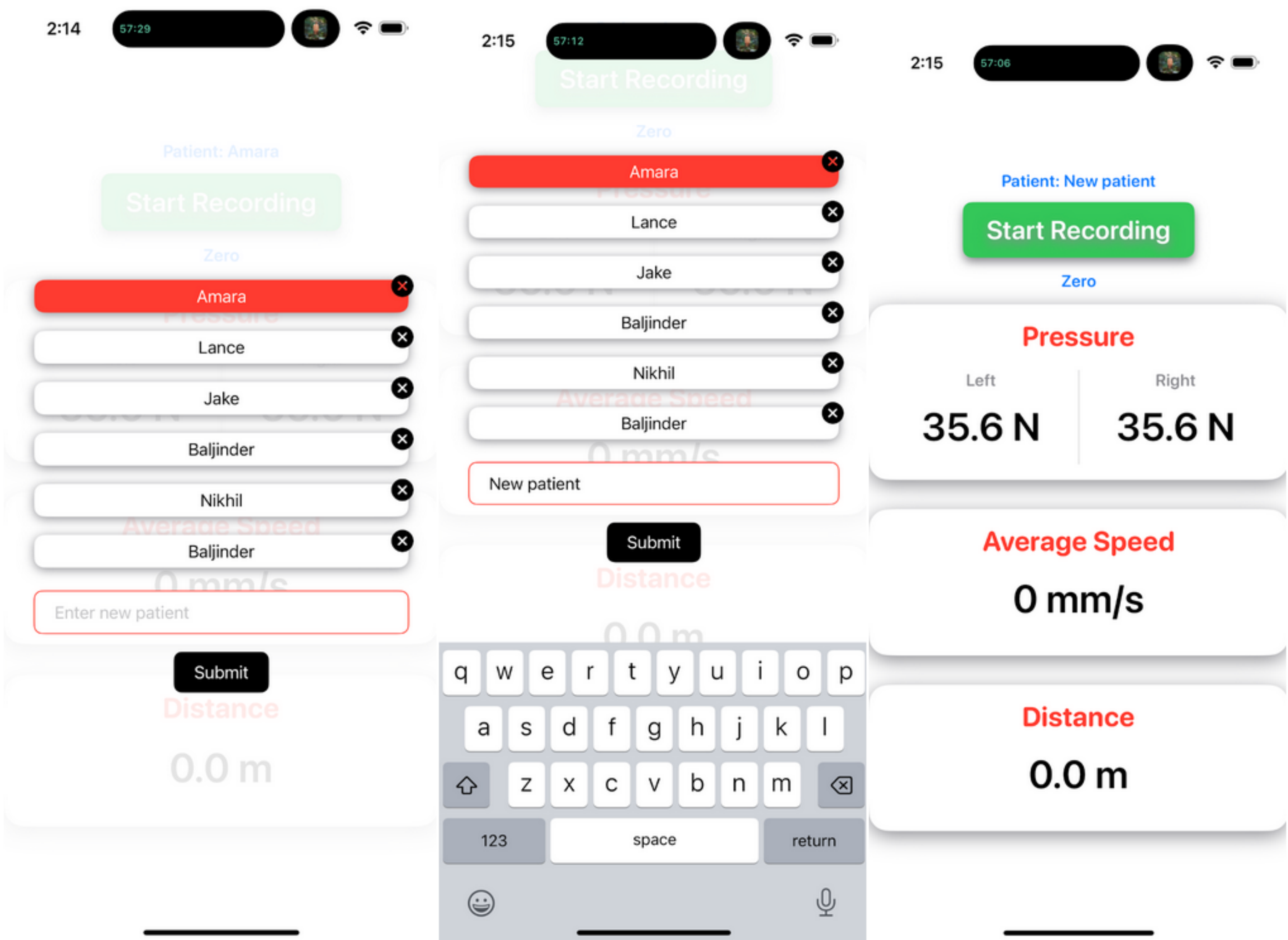
Content by: Nikhil Chandra

Present: All Members

Goals: To describe the patient selection and creation user interface for the software application and discuss the UI with the team to receive feedback

Content:

In the below images we can see the UI components that were programmed using XCode in SwiftUI that will allow the physical therapist to create a new patient upon typing it in the text field and clicking submit. They can also choose from an existing list of patients to change the selected patient.



The team likes the design for creating and selecting patients and does not have any points of improvement as of now. Again, further discussion of the code is outlined in Nikhil's individual notebook.

Conclusions/action items:

With the patient selection feature of the UI designed, we can now move forward with the programming of the backend using the firebase server.

Firebase Server Backend Design and Discussion - 11/25/23

NIKHIL CHANDRA - Dec 11, 2023, 3:00 PM CST

Title: Firebase Server Backend Design and Discussion

Date: 11/25/23

Content by: Nikhil Chandra

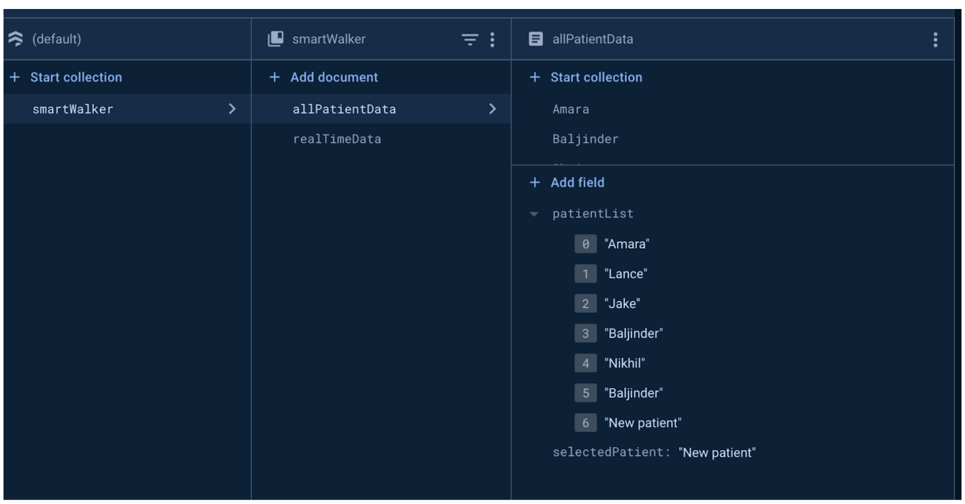
Present: All Members

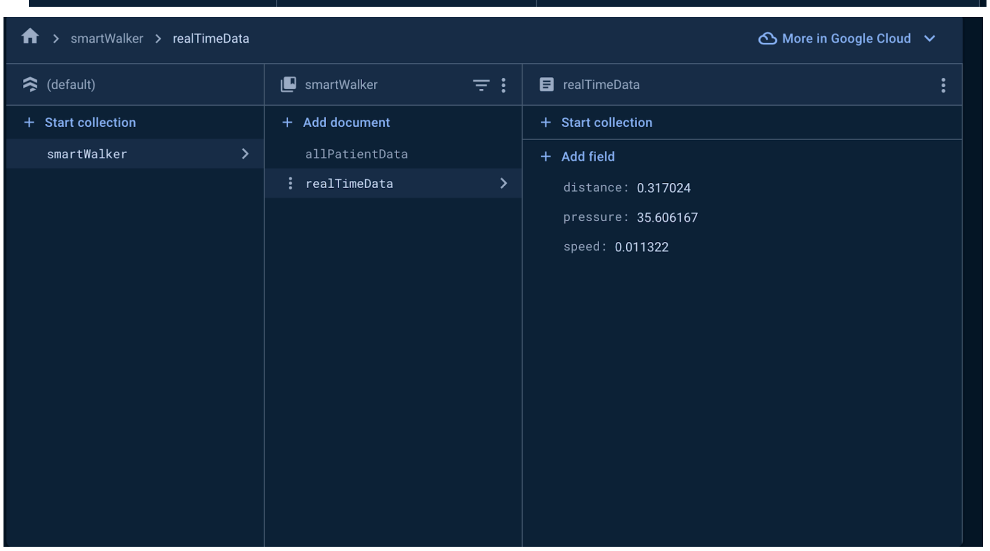
Goals: To describe how the software app connects to the firebase server and to discuss the progress with the team to receive feedback

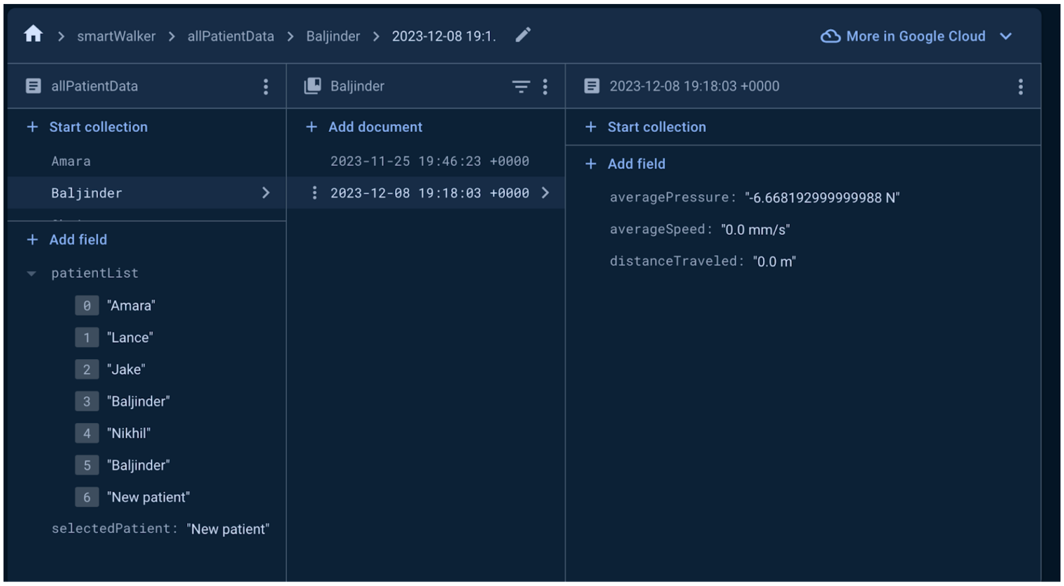
Content:

For realtime data retrieval, the software app utilized a firebase function called a snapshot listener, where everytime data in the server changes, the software app gets notified and can then update the UI with the new data. In addition, for patient selection, when a new patient is entered, the setDocument() function is used to set a document that contains a list of patients in the server with the new patient. When a patient gets deleted or the selected patient gets updated, the same function is used to update the corresponding variables in firebase.

The google firebase server stores data in key value pairs in objects called documents, and these documents are stored in a higher order object called a collection. The hierarchy and design of the server is shown below:







The team discussed the firebase backend and agrees that the data storage organization is intuitive such that the client/physical therapist will be able to access and easily sort through and analyze the data in the server at any time.

Again details of the code are further described in Nikhil's individual notebook.

Conclusions/action items:

With the software app completed including its connection to the server we now have to finish off the walker prototype, initially test and verify its ability to work with the arduino and the server in real time, then properly test it using an outlined testing protocol.

Arduino Software Flow Design - 12/3/2023

NIKHIL CHANDRA - Dec 10, 2023, 6:37 PM CST

Title: Arduino Software Flow Design - 12/3

Date: 12/3

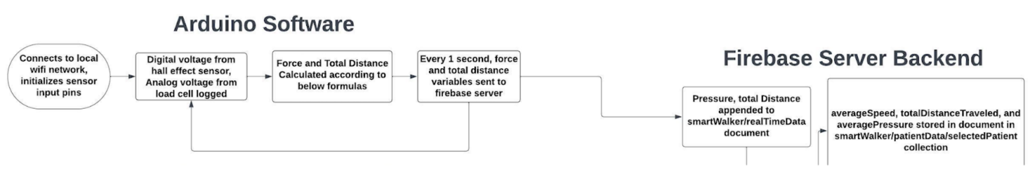
Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To design a flowchart for the arduino software design for measuring force and distance traveled then relaying this data to firebase firestore.

Content:

In addition to this flowchart, its important to note that the distance as of right now is calculated on the arduino, and the speed is calculated on the software app using a built in timer in the software app that gets started upon the start recording button, which is further described in the software flow entry for the software application. This was done for efficiency since if we ever want to change units or troubleshoot, it is easier to alter the code of the software app than it is to alter the code of the hardware.



Conclusions/action items:

Given this general software flowchart, I can now begin writing the software code in the arduino which will be shown in another lab archives entry.

Complete Software Flowchart and Discussion - 12/3/23

NIKHIL CHANDRA - Dec 11, 2023, 3:10 PM CST

Title: Complete Software Flowchart and Discussion

Date: 12/3/23

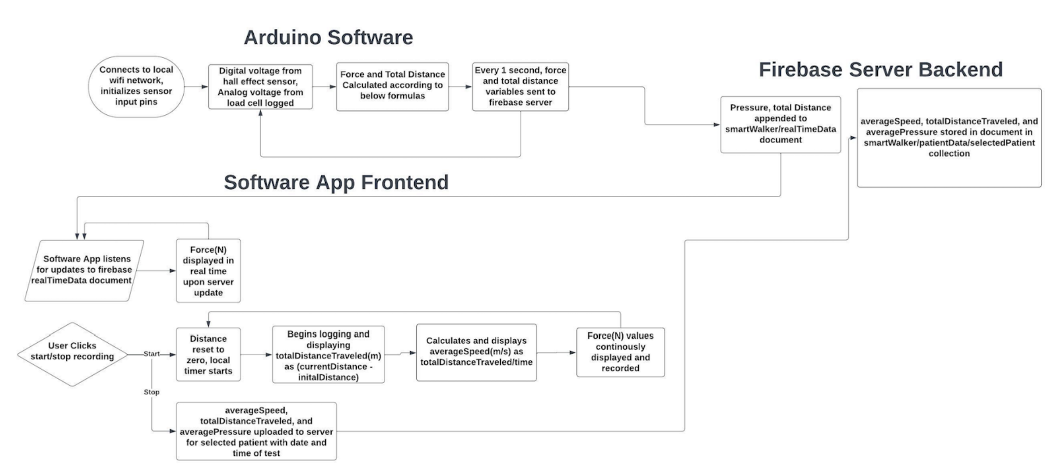
Content by: Nikhil Chandra

Present: All Members

Goals: To present and discuss a flowchart outlining the overall logic of the software components of the arduino mkr wifi 1010, the firebase server backend, and the frontend software app and how these devices interact with one another.

Content:

Below is a flowchart describing the interplay between the different software components of the project overall. After looking over it as a team, we agree that it encompasses the most important software components for someone to potentially generally replicate the software if they had an understanding of programming in SwiftUI, C++/Arduino, and how firebase works. Further details and iterations of the software code is in Nikhil's individual notebook.



Conclusions/action items:

Having completed the software app and verified there are no major bugs, the above software flowchart effectively and accurately describes our final software flow and it is something we could potentially add to the final poster although we may have to condense it down.

Troubleshooting Arduino Firebase Data Storage - 12/5/2023

NIKHIL CHANDRA - Dec 10, 2023, 6:46 PM CST

Title: Troubleshooting Arduino Firebase Data Storage

Date: 12/5

Content by: Nikhil Chandra

Present: Nikhil, Amara, Baljnder

Goals: To troubleshoot why the arduino is not sending data to the firebase firestore server and potentially solve the problem.

Content:

Referring to the github arduino library which offers functionality for sending data from arduino to firebase realtime database we need to do a deeper dive into the documentation to figure out how our implementation is incorrect. To refer to the iterations of code, refer to the arduino code in Nikhil's individual notebook entries.

After looking at the example with the code below, we were able to successfully get data to be sent to firebase firestore. The issue was that we were trying to send data to firebase realtime database which is actually different than firestore and is an outdated version that offers similar yet more limited database functionality. The code that allowed data storage in firestore to work as in the github:

Reference:

***GitHub*,github.com/mobizt/Firebase-ESP-Client/blob/main/examples/Firestore/DeleteDocument/DeleteDocument.ino. Accessed 10 Dec. 2023.**

```
/**

 * Created by K. Suwatchai (Mobizt)

 *

 * Email: k_suwatchai@hotmail.com

 *

 * Github: https://github.com/mobizt/Firebase-ESP-Client

 *

 * Copyright (c) 2023 mobizt

 *

 */


// This example shows how to delete a document from a document collection. This operation required Email/password, custom or OAUth2.0 authentication.


#include <Arduino.h>
```

```
#if defined(ESP32) || defined(ARDUINO_RASPBERRY_PI_PICO_W)

#include <WiFi.h>

#elif defined(ESP8266)

#include <ESP8266WiFi.h>

#elif __has_include(<WiFiNINA.h>)

#include <WiFiNINA.h>

#elif __has_include(<WiFi101.h>)

#include <WiFi101.h>

#elif __has_include(<WiFiS3.h>)

#include <WiFiS3.h>

#endif



#include <Firebase_ESP_Client.h>



// Provide the token generation process info.

#include <addons/TokenHelper.h>



/* 1. Define the WiFi credentials */

#define WIFI_SSID "WIFI_AP"

#define WIFI_PASSWORD "WIFI_PASSWORD"



/* 2. Define the API Key */

#define API_KEY "API_KEY"



/* 3. Define the project ID */

#define FIREBASE_PROJECT_ID "PROJECT_ID"



/* 4. Define the user Email and password that alreadey registerd or added in your project */

#define USER_EMAIL "USER_EMAIL"

#define USER_PASSWORD "USER_PASSWORD"
```

```
// Define Firebase Data object

FirebaseData fbdo;


FirebaseAuth auth;

FirebaseConfig config;


bool taskCompleted = false;


#if defined(ARDUINO_RASPBERRY_PI_PICO_W)

WiFiMulti multi;

#endif


void setup()

{


   Serial.begin(115200);


#if defined(ARDUINO_RASPBERRY_PI_PICO_W)

   multi.addAP(WIFI_SSID, WIFI_PASSWORD);

   multi.run();

#else

   WiFi.begin(WIFI_SSID, WIFI_PASSWORD);

#endif


   Serial.print("Connecting to Wi-Fi");

   unsigned long ms = millis();

   while (WiFi.status() != WL_CONNECTED)

   {

      Serial.print(".");
```

```
        delay(300);
#if defined(ARDUINO_RASPBERRY_PI_PICO_W)
        if (millis() - ms > 10000)
            break;
#endif
    }
    Serial.println();
    Serial.print("Connected with IP: ");
    Serial.println(WiFi.localIP());
    Serial.println();

    Serial.printf("Firebase Client v%s\n\n", FIREBASE_CLIENT_VERSION);

    /* Assign the api key (required) */
    config.api_key = API_KEY;

    /* Assign the user sign in credentials */
    auth.user.email = USER_EMAIL;
    auth.user.password = USER_PASSWORD;

    // The WiFi credentials are required for Pico W
    // due to it does not have reconnect feature.
#if defined(ARDUINO_RASPBERRY_PI_PICO_W)
    config.wifi.clearAP();
    config.wifi.addAP(WIFI_SSID, WIFI_PASSWORD);
#endif

    /* Assign the callback function for the long running token generation task */
    config.token_status_callback = tokenStatusCallback; // see addons/TokenHelper.h
```

```
    // Comment or pass false value when WiFi reconnection will control by your code or third party library e.g. WiFiManager

    Firebase.reconnectNetwork(true);



    // Since v4.4.x, BearSSL engine was used, the SSL buffer need to be set.

    // Large data transmission may require larger RX buffer, otherwise connection issue or data read time out can be occurred.

    fbdo.setBSSLBufferSize(4096 /* Rx buffer size in bytes from 512 - 16384 */, 1024 /* Tx buffer size in bytes from 512 - 16384
*/);



    // Limit the size of response payload to be collected in FirebaseData

    fbdo.setResponseSize(2048);



    Firebase.begin(&config, &auth);



    // You can use TCP KeepAlive in FirebaseData object and tracking the server connection status, please read this for detail.

    // https://github.com/mobizt/Firebase-ESP-Client#about-firebasedata-object

    // fbdo.keepAlive(5, 5, 1);

  }



  void loop()

  {



    // Firebase.ready() should be called repeatedly to handle authentication tasks.



    if (Firebase.ready() && !taskCompleted)

    {

      taskCompleted = true;



      // For the usage of FirebaseJson, see examples/FirebaseJson/BasicUsage/Create_Edit_Parse/Create_Edit_Parse.ino

      FirebaseJson content;
```

```
        // aa is the collection id, bb is the document id in collection aa.

        String documentPath = "aa/bb";



        // If the document path contains space e.g. "a b c/d e f"

        // It should encode the space as %20 then the path will be "a%20b%20c/d%20e%20f"



        content.set("fields/v1/integerValue", "12345");

        content.set("fields/v2/doubleValue", 123.456);



        Serial.print("Create a document... ");



        if (Firebase.Firestore.createDocument(&fbdo, FIREBASE_PROJECT_ID, "" /* databaseId can be (default) or empty */,
documentPath.c_str(), content.raw()))

          Serial.printf("ok\n%s\n\n", fbdo.payload().c_str());

        else

          Serial.println(fbdo.errorReason());



        Serial.print("Delete a document... ");



        if (Firebase.Firestore.deleteDocument(&fbdo, FIREBASE_PROJECT_ID, "" /* databaseId can be (default) or empty */,
documentPath.c_str()))

          Serial.printf("ok\n%s\n\n", fbdo.payload().c_str());

        else

          Serial.println(fbdo.errorReason());

      }

    }
```

Conclusions/action items: Having successfully sent data from the arduino to firebase firestore, we now need to integrate and refine this code into the overall arduino software flow then do testing with the walker prototype to see if load cell and speed data can be sent in real time to firestore.

Attaching Hall Effect Sensor - 11/27/2023

Amara Monson - Dec 11, 2023, 6:40 PM CST

Title: Attaching Hall Effect Sensor

Date: 11/21/2023

Content by: Amara

Present: Amara, Nikhil, Baljinder, Lance, Jake, Joseph

Goals: Solder the hall effect sensor circuit

Content:

The legs of the hall effect sensor were soldered to wires long enough to reach from the wheel to the crossbar of the walker when the legs are fully extended. When facing the front (rounded side) of the sensor, the left leg was soldered to the input wire, the middle to the ground wire, and the right leg to the output wire. A 10k resistor was soldered to the outside legs of the sensor. A ground line and a 5V input line were soldered on a protoboard, and the input and output wires were soldered to their respective positions. When the 5V and ground was attached to the Arduino, the hall effect sensor successfully detected the presence of a magnet.

Conclusions/action items:

- Attach the hall effect sensor to the leg of the walker and the magnets to the wheel for testing.

Re-solder new hall effect sensor - 12/4/2023

Amara Monson - Dec 11, 2023, 8:44 PM CST

Title: Re-soldering hall effect sensor

Date: 12/4/2023

Content by: Amara

Present: Amara, Nikhil, Joseph

Goals: Re-solder and reattach hall effect sensor and new HX711 board

Content:

The hall effect sensor was attached to the outside of the walker leg with tape on Wednesday, Nov. 29 and successful detection of magnets was observed. Unfortunately, on Thursday, the sensor stopped working. It was believed to be a failure of the sensor itself, so a new sensor was purchased. Today, we re-soldered the hall effect sensor to the existing 5V, ground, and output wires. Instead of soldering the 10k resistor to the legs of the sensor, small sections of the 5V and output wires were stripped near the sensor and the resistor was soldered there. Then, the resistor and the legs of the hall effect sensor were insulated with electrical tape to prevent any unwanted connections. This circuit successfully detected magnets again and was reattached to the leg of the walker.

We also had to order more HX711 boards because this stopped working as well. Nikhil suggested static electricity might have caused problems. This same meeting, we soldered wires to a new HX711 board and reassembled the load cell circuit, and were able to read values again.

Conclusions/action items:

- test speed, distance, and pressure functionality tomorrow, Dec 5

Hall Effect Sensor Fabrication Protocol - 12/11/2023

Amara Monson - Dec 11, 2023, 8:58 PM CST

Title: Hall Effect Sensor Fabrication Protocol

Date: 12/11/2023

Content by: Amara

Present: n/a

Goals: Outline the steps of assembling the final hall effect sensor circuit so they can be successfully repeated

Content:

1. Measure and cut 3 wires, long enough to reach from the bottom of a wheeled leg to the middle of the lower crossbar of the walker. Use 3 different colors.

2. Strip the ends of the wire for soldering.

3. Solder each of the 3 wires to a leg of the hall effect sensor.

4. On the wires connected to the outer legs of the hall effect sensor, strip a section of the wire close to the sensor.

5. Solder a 10 kOhm resistor between these two sections of stripped wire.

If step 6 has already been done, skip to step 7...

6. On a protoboard, solder a line (outside) for a 5V connection and a line (inside) for a ground connection. Make sure that there is a connection to the 5V and GND pins of the Arduino.

7. When facing the round face of the hall effect sensor, solder the leftmost wire to the 5V line on the protoboard.

8. When facing the round face of the hall effect sensor, solder the middle wire to the ground line on the protoboard.

9. When facing the round face of the hall effect sensor, attach the rightmost wire to digital pin 3 on the Arduino.

10. Test the finished circuit to make sure that the hall effect sensor accurately detects the presence of a magnet.

Conclusions/action items:

After the circuit is completed, attach the hall effect sensor to a wheeled leg of the walker facing the wheel and attach equally spaced magnets at the height of the sensor to the face of the wheel facing the sensor.

Preliminary Mechanical Box Design - 11/20/2023

Jake Maisel - Dec 12, 2023, 1:09 AM CST

Title: Preliminary Mechanical Box Design

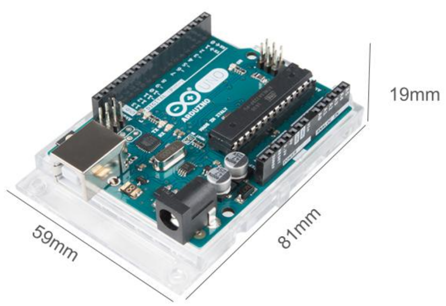
Date: 11/20/2023

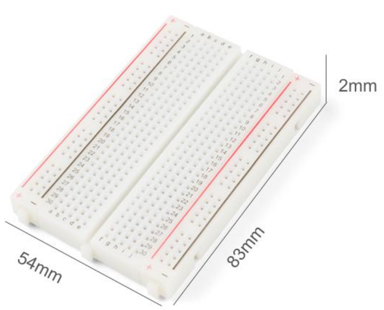
Content by: Jake

Present: NA

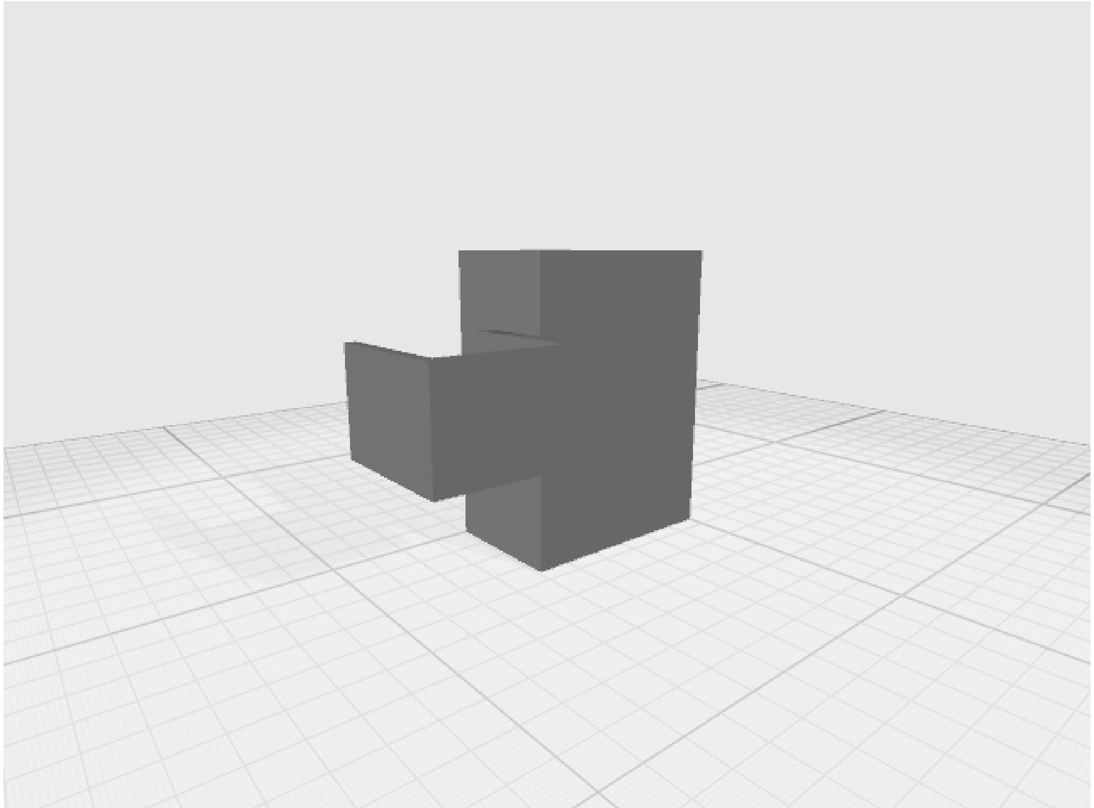
Goals: To create a 3D printed box that can fit all of the electronic devices.

Content:





These are the main three components that have to fit in the 3D printed box along with the wiring connecting these components to the sensors on the walker.



Initial 3D printed design.

Conclusions/action items:

This was a very simple design that would allow the box to fit the components. This box was designed to connect to the walker by screwing holes into the three sides extended from the walker. Then screw holes into the walker frame, this would allow for the box to stay in place on the walker. There were some issues with this design, the first being the frame. The frame of the walker does not detach which would make drilling into it very difficult. Additionally, most of the walker is made of aluminon which is a soft metal however the frame of the walker was made of a hard metal. Moreover, the box fit all the components, but the wiring would have to be bent a ton to fit. All these problems ultimately show that this box is a good start, but has to be renovated to work for the walker.

Final Mechanical Box Design - 12/6/2023

Jake Maisel - Dec 12, 2023, 1:10 AM CST

Title: Final Mechanical Box Design

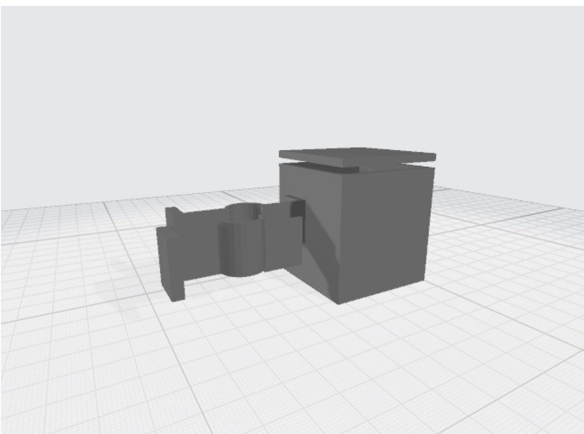
Date: 12/6/2023

Content by: Jake

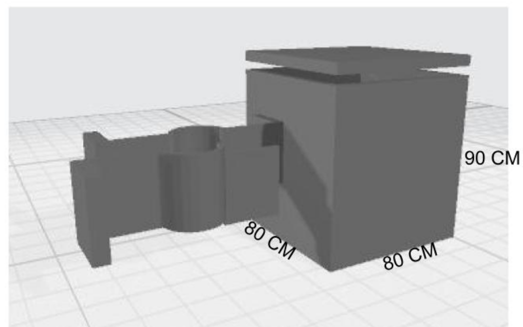
Present: NA

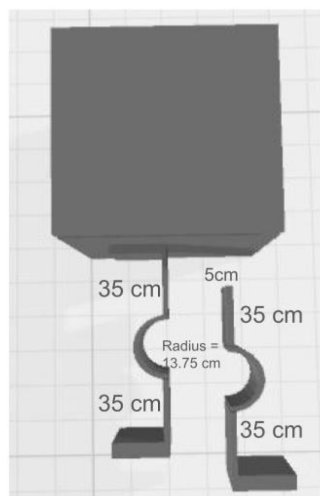
Goals: To create a box that can easily be attached to the walker and can hold all the electronic components without causing the wiring to break

Content:



Final Design





Final Design with Dimensions

Conclusions/action items:

This design works by attaching a box to one of the two same dimensions, outer structures. The half circle then attaches to the frame of the walker. The other outer structure that's not connected to the box is screwed into the outer structure that is attached to the box to keep the box attached to the frame of the walker. This box can be installed without screwing into the frame of the walker which would become very difficult. The infill was set to 30 percent, which is more than enough to drill through and be able to put a screw in. Additionally, because we need this box to last and protect the electric components, I used a hard PLA material.

12/5/2023 Testing Protocol

Amara Monson - Dec 11, 2023, 9:03 PM CST

Title: Testing Protocol

Date: 12/5/2023

Content by: Amara

Present: Amara, Nikhil, Joseph, Lance, Baljinder, Jake

Goals: Test the functionality of our final design

Content:

Calibration (before pressure testing):

1. Measure the weight of an object using a bathroom scale

2. Apply the object to the handles of the walker with the weight evenly distributed

3. Using the calibration code, input the expected weight applied to the load cells and record the calibration value.

4. Use this calibration value with the main code for testing.

Pressure Testing:

Note: Make sure that the bathroom scale and the walker are on a flat, solid surface

1. Place an object on a bathroom scale and record the value on the screen once it starts flashing.

2. Place this object on the handles of the walker with the weight evenly distributed between handles.

3. Record the force value shown in the smartphone app after 5 seconds, and remove the object.

4. Repeat step 3 for two more trials.

5. Repeat steps 1-4 with two more objects.

Speed/Distance Testing:

1. Place an tape measurer, extended to 10ft, on the ground (alternatively, measure a 10ft length of string and place that on the ground)

2. Place the walker at one end of the string and have a stopwatch prepared.

3. Walk the walker along the 10ft path and measure how long it takes using the stopwatch.

4. Record the time value on the stopwatch, and the speed and distance values shown in the smartphone.

5. Repeat steps 1-4 for three more trials.

Note: For data analysis, use the manually recorded time and a distance of 10ft to calculate the speed.

Conclusions/action items:

Analyze the data recorded during testing

Initial Prototype Testing - 12/6/23

Lance Johnson - Dec 11, 2023, 4:26 PM CST

Title: Initial Prototype Testing

Date: 12/6/23

Content by: Lance

Present: All members

Goals: To design and perform initial tests for the load cell and hall effect sensor circuits, and determine calibrating coefficients to input into the software script.

Content:

The team planned to meet up in the BME teaching lab, but due to time conflicts, had to meet elsewhere and were therefore unable to use the force plates for testing the load cell circuit.

Two tests were performed to diagnose any technical issues and determine calibrating coefficients. The first involved measuring an object's weight using a bathroom scale, then placing the object in a box that sat on the walker and recording the output of the software. Each weight was measured three times on the walker to increase accuracy of the calibrating coefficient, which would be calculated using the output value and the known mass value. Some success was had in these initial tests, as the load cell circuit seemed to integrate well into the software app and data was easily available on the iPhone app. However, the force reading quickly became very unreliable, as the output force would fluctuate greatly even when no weight was being placed on the walker. This continued when a weight would be removed from the walker, the output force would not return to a zero reading/baseline value which was concerning. The team hypothesized that there was either an error in the actual load cell where the walker leg may not be fully retracting from the load cell after weight was placed on the walker, or that there was a coding error or wire damage. To combat this, Nikhil coded a zero button into the app which we hoped would fix the presumed sensor drift. This had some success, but the force readings remained fairly sporadic and unpredictable.

The other test performed to assess the hall effect sensor circuit was a simple distance test. The team measured out and marked a straight, 10-ft path. Then the walker was walked down the line, and the software output of speed and distance was recorded. Time was also recorded manually using stopwatches. This process was repeated multiple teams, testing how the accuracy of the sensor would vary at different speeds. The team discovered that the walker tended to always underreport the actual distance value, and that the speed values were also fairly inaccurate. After multiple trials, the team hypothesized that when the walker sent data to the server, the sensors did not record incoming data. This seemed to be true because the walker's underreporting of speed increased as the actual speed increased. The team tried to combat this by dramatically increasing the update speed from a few milliseconds to a few seconds. We hope that this change would result in less "missed" interactions between the magnets on the wheel and the hall effect sensor. However, just like the force readings, these output values remained pretty inaccurate and unreliable.

Conclusions/action items:

Based on these initial results, the team figured that there was a fundamental flaw in the hall effect sensor circuit with the update speeds, or that there was a coding error in the software. Additionally, the team figured that there may have been some mechanical flaws with the load cell circuit. However, because not many physical alterations could be done in the time remaining, the team chose to try and fix the load cell circuit because the pressure readings were of highest priority to the client. The team planned to re-solder all the connections to a new protoboard, inspect the walker feet, and review the code in the software app.

Results and Discussion - 12/6/2023

Amara Monson - Dec 11, 2023, 9:22 PM CST

Title: Testing Results and Discussion

Date: 12/6/2023

Content by: Amara

Present: All team members

Goals: Analyze the results of the testing performed

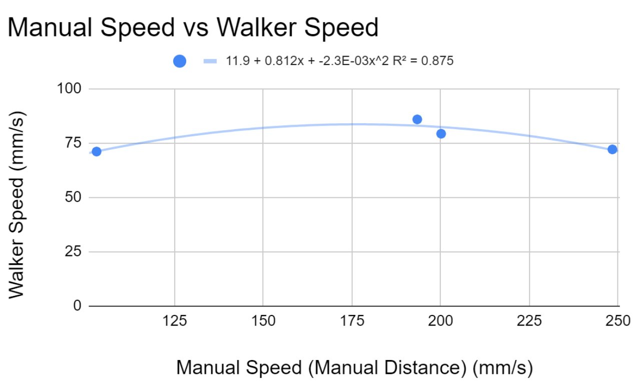
Content:

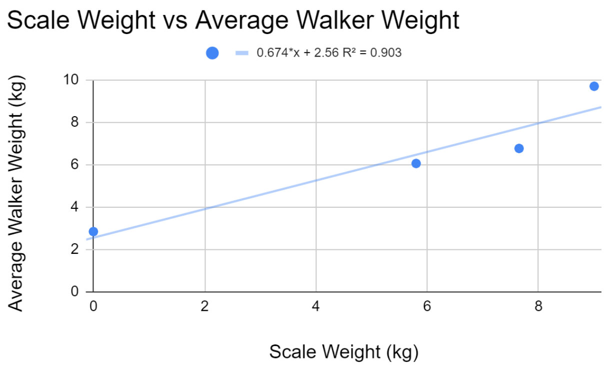
Scale Weight (kg)	Walker Weight (kg)	% Difference	% Error
0	2.846	n/a	n/a
5.8	6.058	0.04358	0.04455
7.65	6.767	0.1224	0.1154
9	9.699	0.0748	0.07771

A paired t-test was performed on this data and got a p-value of 0.418. This is greater than alpha = 0.05 at 95% significance, so the expected and actual values are not statistically different. The average error was 7.97% and the confidence interval of 95% was 8.39%.

Manual Time (s)	Manual Distance (m)	Manual Speed (mm/s)	Walker Speed (mm/s)
12.28	3.05	103.0753633	71.1
15.24	3.05	193.4051997	85.9
29.59	3.05	200.1312336	79.3
15.77	3.05	248.3713355	72.1

The minimum error found between the manually calculated speed and the speed displayed by the smartphone app was 31%, and increased with speed. A paired t-test gave a p-value of 0.03494, so the expected values and actual values are statistically different when alpha = 0.05.





Conclusions/action items:

While we found that our actual and expected pressure values were not statistically different, the average error of 7.97~ was greater than our PDS value of 5%. We are confident in our design though, and believe that with more time we will be able calibrate our load cells to read more accurate values.

The minimum error between the expected and actual speed values was 31% and increased with speed. We observed that the speed read by the walker remained around 75 mm/s even as actual speed increased. We propose that this is due to the sensor delay caused by communication between the Arduino and Google Firebase. When the Arduino is sending data to the app, it is not reading the sensors. So at slower speeds, it is sensing fewer magnets each time the Arduino communicates with the sensors, but there are more periods of sensing over the course of a distance. At higher speeds, the Arduino senses more magnets each time it communicates with the sensors, but there are fewer periods of sensing over the course of the same distance. This limits the speed read by our design. A proposed solution would be to add a second Arduino to constantly communicate with the sensors, while the first Arduino sends the data to the server.

Product Design Specifications - 9/15/2023

Amara Monson - Nov 16, 2023, 10:34 PM CST

Title: Product Design Specifications

Date: 9/21/2023

Content by: Team

Present: n/a

Goals: Outline the scope of the project based on individual research and client requirements

Content:

The team has assembled a document outlining the specifics of the project. The document discusses characteristics that the final product needs to meet, client requirements, and codes and standards that the final product needs to comply with.

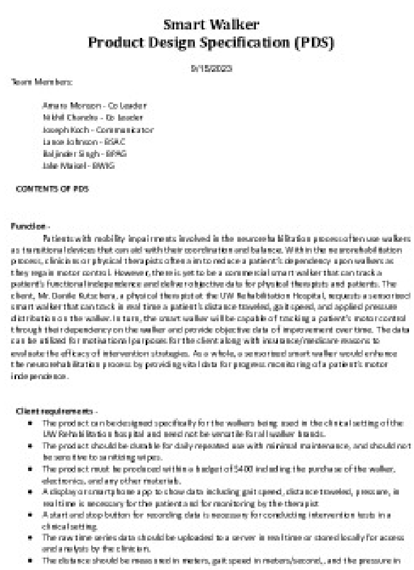
(Attached)

Conclusions/action items:

* Begin designing the Smart Walker and make sure it meets the PDS requirements

* Update the PDS as details changed throughout the semester

Amara Monson - Oct 27, 2023, 1:11 PM CDT



Smart Walker
Product Design Specification (PDS)

9/15/2023

Team Members:

Amara Monson - Co Leader
Nikhil Chandra - Co Leader
Joseph Koch - Communicator
Lance Johnson - BSAC
Baljinder Singh - BPAG
Jake Maisel - BWIG

CONTENTS OF PDS

Function -

Patients with mobility impairments involved in the neurorehabilitation process often use walkers as transitional devices that can aid with their coordination and balance. Within the neurorehabilitation process, clinicians or physical therapists often aim to reduce a patient's dependency upon walkers as they regain motor control. However, there is yet to be a commercial smart walker that can track a patient's functional independence and deliver objective data for physical therapists and patients. The client, Mr. Danilo Rutschera, a physical therapist at the UW Rehabilitation Hospital, requests a sensorized smart walker that can track in real time a patient's distance traveled, gait speed, and applied pressure distribution on the walker. In turn, the smart walker will be capable of tracking a patient's motor control through their dependency on the walker and provide objective data of improvement over time. The data can be utilized for motivational purposes for the client along with insurance/medicare reasons to evaluate the efficacy of intervention strategies. As a whole, a sensorized smart walker would enhance the neurorehabilitation process by providing vital data for progress monitoring of a patient's motor independence.

Client requirements -

- The product can be designed specifically for the walkers being used in the clinical setting of the UW Rehabilitation hospital and need not be versatile for all walker brands.
- The product should be durable for daily repeated use with minimal maintenance, and should not be sensitive to sanitizing wipes.
- The product must be produced within a budget of $400 including the purchase of the walker, electronics, and any other materials.
- A display or smartphone app to show data including gait speed, distance traveled, pressure, in real time is necessary for the patient and for monitoring by the therapist.
- A start and stop button for recording data is necessary for conducting intervention tests in a clinical setting.
- The raw time series data should be uploaded to a server in real time or stored locally for access and analysis by the clinician.
- The distance should be measured in meters, gait speed in meters/second, , and the pressure in

[Download](#)

Smart_Walker_-_Product_Design_Specifications.pdf (130 kB)

Preliminary Presentation - 10/6/2023

NIKHIL CHANDRA - Dec 13, 2023, 8:34 PM CST

Title: Preliminary Presentation

Date: 10/11/23

Content by: Team

Present: Team

Goals: Present our project and preliminary designs to our advising group

Content:

The team presented our project to our advising group. We shared a background on the project so that they could understand the purpose of our designs, as well as our preliminary designs and preliminary final design. The group asked some good clarifying questions and gave us some new things to consider.

https://docs.google.com/presentation/d/1JBWYizZ0nnGiXNkYMR2eVM8n6WPlQlynQMKpZ4tzZQs/edit?usp=sharing

Conclusions/action items:

***** Finish preliminary report

* Move forward with our chosen preliminary design

Preliminary Report - 10/11/2023

NIKHIL CHANDRA - Dec 13, 2023, 8:34 PM CST

Title: Preliminary Report

Date: 10/11/23

Content by: Team

Present: n/a

Goals: Compile all of the relevant information on the project into one preliminary report to share

Content:

The team has compiled a report on the project to this point. We discus the background information and codes and standards the impact the scope of the project, as well as preliminary designs, our chosen preliminary final design, and proposed fabrication and testing methods.

https://docs.google.com/document/d/1FYFOXkCgBxveHNjzkM0NDNSA_U2yXIbd7Z-Dl0kgfoA/edit?usp=sharing

Conclusions/action items:

* Begin purchasing materials to more forward with the chosen design

PDS and PDS Updated - 12/3/2023

BALJINDER SINGH - Dec 12, 2023, 12:10 AM CST

Title: PDS and PDS Updated

Date: 12/3/23

Content by: Team

Present: Team

Goals: Show original PDS versus updated PDS

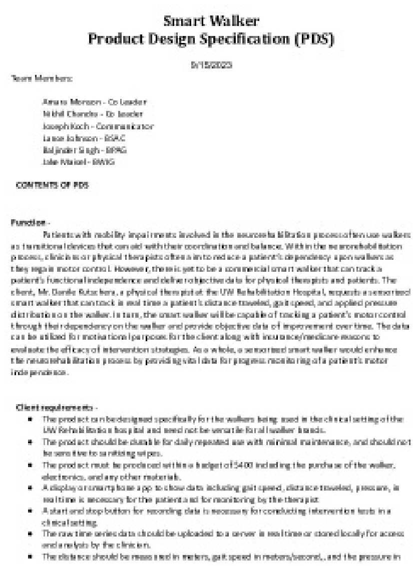
Content:

The UPDATED PDS has the new information **BOLDED**

Conclusions/action items:

The main differences between the 2 PDS's are the new testing statistics. And the removal of the display, that we originally planned on having, but due to time constraints, we were not able to attach one.

Amara Monson - Dec 17, 2023, 9:02 PM CST



Smart Walker
Product Design Specification (PDS)

9/15/2023

Team Members:

Amara Monson - Co Leader
Nikhil Chandra - Co leader
Joseph Koch - Communicator
Lance Johnson - BSAC
Baljinder Singh - BPAG
Jake Maisel - BWIG

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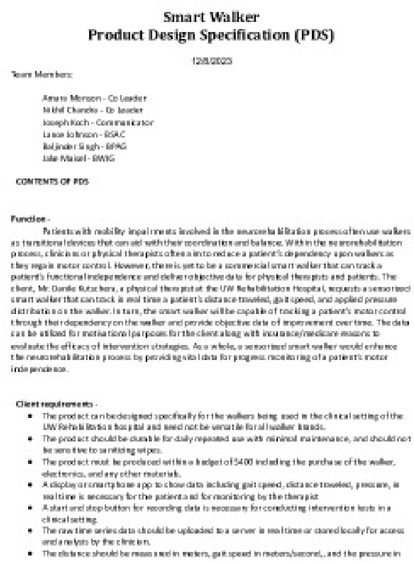
[Download](#)

Smart_Walker_-_Product_Design_Specifications.pdf (130 kB)

BALJINDER SINGH - Dec 12, 2023, 12:05 AM CST



Smart Walker
Product Design Specification (PDS)

12/3/2023

Team Members:

Amara Monson - Co Leader
Nikhil Chandra - Co Leader
Joseph Koch - Communicator
Lance Johnson - BSAC
Baljinder Singh - BPAG
Jake Maisel - BWIG

CONTENTS OF PDS

Function -

Patients with mobility impairments involved in the neurorehabilitation process often use walkers as transitional devices that can aid with their coordination and balance. Within the neurorehabilitation process, clinicians or physical therapists often aim to reduce a patient's dependency upon walkers as they regain motor control. However, there is yet to be a commercial smart walker that can track a patient's functional independence and deliver objective data for physical therapists and patients. The client, Mr. Danike Rutschers, a physical therapist at the UW Rehabilitation Hospital, requests a sensorized smart walker that can track in real time a patient's distance traveled, gait speed, and applied pressure distribution on the walker. In turn, the smart walker will be capable of tracking a patient's motor control through their dependency on the walker and provide objective data of improvement over time. The data can be utilized for motivational purposes for the client along with insurance/medicare reasons to evaluate the efficacy of intervention strategies. As a whole, a sensorized smart walker would enhance the neurorehabilitation process by providing vital data for progress monitoring of a patient's motor independence.

Client requirements -

- The product can be designed specifically for the walkers being used in the clinical setting of the UW Rehabilitation hospital and need not be versatile for all walker brands.
- The product should be durable for daily repeated use with minimal maintenance, and should not be sensitive to sanitizing wipes.
- The product must be produced within a budget of $400 including the purchase of the walker, electronics, and any other materials.
- A display or smartphone app to show data including gait speed, distance traveled, pressure, in real time is necessary for the patient and for monitoring by the therapist.
- A start and stop button for recording data is necessary for conducting intervention tests in a clinical setting.
- The raw time series data should be uploaded to a server in real time or stored locally for access and analysis by the clinician.
- The distance should be measured in meters, gait speed in meters/second, and the pressure in

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UPDATED_-_Smart_Walker_-_Product_Design_Specifications.pdf (135 kB)

Final Report & Poster 12/15/2023

Amara Monson - Dec 15, 2023, 7:22 PM CST

Title: Final Report & Poster

Date: 12/15/2023

Content by: Amara

Present: n/a

Goals: Compile information about our project to be presented to an audience

Content:

Final Report

Final Poster

Conclusions/action items:

Continue working on the walker as described in future work

Final Poster 12/8/2023

JOSEPH KOCH - Dec 15, 2023, 7:17 PM CST

Title: Final Poster

Date: 12/8/2023

Content by: Team

Goals: Display our project in poster form

Content:

Our completed poster detailing our team's work over the semester

Conclusions/action items:

Present the poster at the poster presentation

JOSEPH KOCH - Dec 15, 2023, 7:18 PM CST

Download

Smart_Walker_Poster_1_.pdf (2.25 MB)

Impact Document - 12/03/2023

Jake Maisel - Dec 12, 2023, 1:03 PM CST

Title: Impact

Date: 12/3/2023

Content by: Jake

Present: NA

Goals: To show the need for a Smart Walker and the impact that it will have.

Content:

Reference

D. I. Katz, “Recovery of ambulation after traumatic brain injury,” *Archives of physical medicine and rehabilitation*, Jun. 2004. Accessed: Dec. 3, 2023. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/15179637/

Many patients who suffer a neurological injury struggle with their balance and walking. This is proven by the fact that 30 percent to 65 percent of all patients with a serious brain injury struggle to keep their balance. This leads the hospital to supply a walker for the patient to use to aid in their recovery. The doctors look for improvements in the patient's recovery through the speeds at which a patient pushes the walker and the amount of pressure the patient puts on the walker. Our client struggled with recognizing improvements because there was no way to test for the amount of pressure a patient was putting on the walker and he would have to manually record time and distance to get the speed of a patient. The Smart Walker records the speed, distance, and applied pressure of a patient.

Conclusions/action items:

This greatly impacts our client who can now use the Smart Walker and connected smartphone app to track the recovery of his patients in more board sense than just the distance and speed of the patient. Additionally, this device saves our client a ton of time because our device receives and sends all the data to the doctors without them having to manually do anything. The Smart Walker could be used in hospitals everywhere to help doctors who are looking for an easy way to track their patients' neurological injuries. Additionally, the Smart Walker does not need to be limited to people recovering from neurological injuries. The Smart Walker could potentially help many others who have serious injuries. The walker could track the progress of someone's recovery from a leg injury, spinal injury, foot injury, etc. This would greatly impact hospitals' ability to recognize recovery in a ton of patients with various injuries.

Conclusion - 12/10/2023

Jake Maisel - Dec 12, 2023, 1:35 PM CST

Title: Conclusion

Date: 12/10/2023

Content by: Jake

Present: NA

Goals: To give a good understanding of the final project results and the conclusions that can be drawn from the results.

Content:

- For the speed distance tests that were run a very high percent error of 31% occurred, this percent error is much higher than the targeted 5%.
- The pressure tests that were run showed a percent error of about 8%. This percent error was still higher than the targeted 5%, however, the pressure results came back much better than the speed and distance results.
- Additionally, the data transfer time from the Arduino to the app can be longer than desired, depending on the strength of the Wi-Fi signal with the Arduino.

Conclusions/action items:

Many things worked very well in this project. The prototype cost less than the budget. The added weight requirements stated that less than 1.81 Kg of weight could be added to the walker, only 0.23 Kg was added. The app created for the Smart Walker is very clean and easy to use. The load cells work very well and attach to the leg very nicely. Additionally, the pressure sensors although have a higher percent error than desired, work very well in showing a decrease or increase of pressure on the walker. Although many things went well there are still many things that can be done to make the speed/distance and pressure sensor percent error much lower to get them to the targeted percent error. Additionally, there are improvements to be made to increase the speed at which the data can get from the Arduino to the app.

Future Work - 12/11/2023

Jake Maisel - Dec 12, 2023, 2:04 PM CST

Title: Future Work

Date: 12/11/2023

Content by: Jake

Present: NA

Goals: To show the future steps that need to be taken to improve the Smart Walker Design or to fix problems that were in the conclusion

Content:

- To fix the large percent error from the speed/distance testing, obtain strong magnets to put on the wheels and buy a more sensitive hall effect sensor. This is because the hall effect sensor right now skips recording a magnet from time to time. This is because the magnets are not strong enough to fully work with the strength of sensitivity of the hall effect sensor.
- The solution to improve the percent error from the pressure sensors is very simple. By recalibrating the pressure sensors located in the load foot cell. Through recalibration, the sensors will read better results leading to our pressure sensor percent error being below the target 5% error.
- To improve the speeds at which the current single Arduino system receives and sends the data to the app from the sensors by switching to a two-Arduino system. This system would work with one Arduino collecting the data, while the other Arduino sends that data to a server. This would increase the speed at which the data gets to the doctors.
- The wiring is very exposed right now which can lead to the possibility of a wire being damaged or ripped out. For future work to fix this would be to run the wiring through the hollow aluminum legs. This would decrease the amount of exposed wiring, which would in turn decrease the chances of the Smart Walker to break.

Conclusions/action items:

Overall, many improvements can be made to the Smart Walker to not only get better results but to make it more efficient and durable. The Smart Walker as it is, is a great point to work off of because the main functionality of it is there. The pressure and speed sensor pick up data that varies and gives data on whether a person's pressure and distance are increasing or decreasing on their recovery. This is important because that is the most important aspect of this project. However, as stated in the content there are so many ways to improve the Smart Walker in the future.

Neurorehabilitation Process Research - 9/18

NIKHIL CHANDRA - Sep 22, 2023, 1:20 PM CDT

Title: Neurorehabilitation Process Research - 9/18

Date: 9/18

Content by: Nikhil Chandra

Goals: To conduct research on the neurorehabilitation process and biologically how patients learn and recover motor function.

Content:

Reference:

Tomoko Kitago, et al. "Motor Learning Principles for Neurorehabilitation." ***Handbook of Clinical Neurology*****, Elsevier, 10 Jan. 2013, www.sciencedirect.com/science/article/abs/pii/B9780444529015000083.**

The research article investigates the motor learning process during neurorehabilitation process. They discuss the interesting idea of regaining motor control involves learning but there is not much that is known on how learning itself actually initiates biological recovery. Motor learning overall is split into two main categories, including functional resolution of impairment and relearning movement patterns prior to injury but also learning to adapt to one's environment through new movement patterns. An understanding of the neurorehabilitation process and how one regains motor control is important for clinicians to create appropriate intervention strategies and treatments to help their patients recover.

Conclusions/action items:

The article provides us with a better understanding of the neurorehabilitation process which can serve as useful background information when conversing with our client about the device as we are now more aware of previously unfamiliar terms and topics. Moving forward I need to conduct more research on the use of transitional devices in the neurorehabilitation process.

Walkers and Anatomical Movement - 10/8

NIKHIL CHANDRA - Oct 13, 2023, 11:20 PM CDT

Title: Walkers and Anatomical Movement

Date: 10/8

Content by: Nikhil Chandra

Goals: To conduct research on how walkers support the anatomical movements, balance, and coordination of patients with physical impairments.

Content:

Reference:

Alkjær, Tine, et al. "Biomechanical analysis of Rollator walking." *BioMedical Engineering OnLine*, vol. 5, no. 1, 2006, https://doi.org/10.1186/1475-925x-5-2.

The article, "Biomechanical analysis of rollator walking" investigates how rollator walkers affect the movement and gait patterns of individuals using them. They illustrate in the results how walkers are able to reduce the force required by the legs and hips of a user in multiple ways by decreasing the knee extension moment, the plantar flexion, and hip abduction moments. Overall it can improve balance as well since with a larger base of support and more points of contact, a walker can enable a patient to distribute their weight and make more refined adjustments to their center of pressure in relation to their center of mass such that they do not fall off balance.

Conclusions/action items:

With a more thorough understanding of walkers and how they can support the balance and alleviate the pressure patients face in generating anatomical moments during walking, we now have a better background before designing a smart walker to measure objective data on how reliant a patient is on the walker.

Neurological Disorders and Rehabilitation Research - 10/8

NIKHIL CHANDRA - Oct 13, 2023, 11:19 PM CDT

Title: Neurological Disorders and Rehabilitation Research

Date: 10/8

Content by: Nikhil Chandra

Goals: To conduct research on various neurological disorders of patients that become involved in the physical neurorehabilitation process.

Content:

Reference:

"Neurological Rehabilitation." *Johns Hopkins Medicine*, 19 Nov. 2019, www.hopkinsmedicine.org/health/treatment-tests-and-therapies/neurological-rehabilitation.

The article provides a general overview on various neurological disorders and what the neurorehabilitation process looks like. Some of the most common neurological disorders and injuries can include stroke, traumatic brain or spinal cord injury, neurodegenerative diseases(ALS, Parkinsons, …), musculoskeletal injuries among more.
There are an extensive number of unique ways in which different neurological disorders can lead to motor impairment and affect balance, coordination, and movement. Stroke and spinal cord injuries can lead to partial or complete paralysis rendering certain muscle groups unresponsive. Peripheral neuropathy among other sensory impairment related disorders can lead to sensory deficits that make it difficult to maintain balance. Other neurological disorders including Alzheimer's disease or traumatic brain injuries can affect a person's ability to plan and execute coordinated movements.

Conclusion/Action Items:

As a whole there are a number of neurological disorders from ALS to spinal cord injuries that can create unique physical impairments from sensory impairment to complete paralysis. With a better background understanding of the different neurological disorders that can induce physical impairment, it provides useful information and motivation to the smart walker design.

Rehabilitation Strategies Research - 10/10

NIKHIL CHANDRA - Oct 13, 2023, 10:06 PM CDT

Title: Rehabilitation Strategies Research - 10/10

Date: 10/10

Content by: Nikhil Chandra

Goals: To conduct research on rehabilitation strategies applied by physical therapists in the context of neurological rehabilitation and how they assess the efficacy of these interventions.

Content:

Reference:

J. Li *et al.*, "Rehabilitation for balance impairment in patients after stroke: a protocol of a systematic review and network meta-analysis," *BMJ Open*, vol. 9, no. 7, 2019, doi: 10.1136/bmjopen-2018-026844.

S. F. Tyson, J. Greenhalgh, A. F. Long, and R. Flynn, "The influence of objective measurement tools on communication and clinical decision making in neurological rehabilitation," *J. Eval. Clin. Pract.*, vol. 18, no. 2, Apr. 2012, doi: 10.1111/j.1365-2753.2010.01555.x.

A number of rehabilitative strategies exist for individuals with physical impairments that are targeted to the individual. Strategies may include patients working on walking, transferring from a bed to a chair, walking along a predetermined path and other mobility-related tasks. Throughout the physical neurorehabilitation process, walkers and other assistive devices can be used to supplement the balance and coordination of patients. Physical therapists conduct regular assessments to monitor the patient's progress. This includes evaluating changes in strength, range of motion, pain levels, balance, and other relevant factors. Assessments can be objective(strength tests, range of motion exercises, gait analysis…) but are also largely subjective through open communication and feedback from the patient. The integration of objective data in combination with subjective analysis is an effective approach to improving patient outcomes in the rehabilitation process

Conclusions/action items:

With a more complete understanding on how physical therapists can integrate objective measurements along with subjective analysis into the rehabilitation process, we now better understand the purpose and motivation for delivering objective sensor through the sensorizing and development of a smart walker. This objective data can enhance patient care and independence in a number of ways as depicted from extensive research.

Load Cell Sensor Drift Research - 12/10

NIKHIL CHANDRA - Dec 17, 2023, 11:53 PM CST

Title: Load Cell Sensor Drift Research

Date: 12/10/23

Content by: Nikhil Chandra

Goals: To do further research into the sensor drift present in load cells to see if there is a potential simple way we can alter the setup for the load cells in the next couple of days before handing the prototype to the client.

Content:

Citation:

Study of Creep Behavior of Load Cells | *Request PDF - Researchgate*, www.researchgate.net/publication/245222574_Study_of_creep_behavior_of_load_cells. Accessed 18 Dec. 2023.

The article conducts further research into a drift between the output calculated force from a load cell and the applied force and why creep behavior may be present, where under the application of a constant load or stress, the strain of the load cell keeps on changing leading to sensor drift and an erroneous force value. The article discusses the viscoelastic properties of load cells and how the alteration of the viscoelastic proportionality constant that affects the viscous property of load cells may have an effect on sensor drift. Although the research was interesting, it was not quite useful or what I was I looking for since building our own load cell or altering its mechanical properties is not necessarily feasible in the next couple of days although it would be interesting to do further research into other load cell brands and how they tackle this sensor drift issue.

Conclusions/action items:

Moving forward, potentially in a future we semester we will have to continue to do research and find a method to deal with the sensor drift issue for pressure sensors and it is possible our best approach may be algorithmic where we program a calibration system.

FDA Regulations for Medical Devices - 9/19

NIKHIL CHANDRA - Sep 22, 2023, 12:42 PM CDT

Title: FDA Regulations for Medical Devices

Date: 9/19/23

Content by: Nikhil Chandra

Goals: To review the FDA regulations around medical devices and how they may pertain to the development of a Smart Walker

Content:

Citation:

Center for Devices and Radiological Health. “Medical Devices.” *U.S. Food and Drug Administration*, FDA, www.fda.gov/medical-devices. Accessed 22 Sept. 2023.

The FDA regulates the distribution of medical devices depending on risks sorted into three categories, Class I, Class II, and Class III. The classification of the smart walker into the appropriate class will depend on the risk associated with its distribution. Since the device will be relaying important personal information on a patient’s progress in the neurorehabilitation process for a clinician to potentially make diagnostic decisions or to change intervention strategies, our device has a notable risk associated with it. The accuracy of the sensors and their maintenance over time will need to be thoroughly evaluated if this be distributed as a product to ensure that the data being given to clinicians is always an appropriate representation of a patient’s progress. As a whole, FDA approval would most likely be required.

Conclusions/action items:

The review on FDA regulations provides us with a better understanding of the approval process needed for the smart walker to become a commercial product. Moving forward, I need to conduct more research on other relevant specifications and standards for the smart walker.

IEC 60601 on Medical Electronic Equipment - 9/19

NIKHIL CHANDRA - Sep 22, 2023, 12:57 PM CDT

Title: IEC 60601 on Medical Electronic Equipment - 9/19

Date: 9/19

Content by: Nikhil Chandra

Goals: To conduct research on IEC 60601 which provides aguidelines and standards related to medical electronic equipment, a category which our smart walker would fall under as we employ electronic sensors.

Content:

Reference:

"IEC." IEC 60601-1:2023 SER | IEC Webstore | Electromagnetic Compatibility, EMC, Smart City, webstore.iec.ch/publication/2603. Accessed 22 Sept. 2023.

The standard provides safety guidelines related to the development of medical electronic equipment and since our device will contain electrical components, sensors, and a power source, it will be essential to ensure that the device is safe for patients to use and the the pressure sensors, IMU, among other sensors we employ don't cause discomfort for a patient. The standard also gives information on quality and reliability for medical electricla equipment which will be important as we ensure the sensors provide accurate data to clinicians on the progress of a patient in the neurorehabilitation process.

Conclusions/action items:

IEC 60601 provides more information on guidelines and recommendations for the development of medical electrical equipment which we can refer to in order to develop a safe and reliable prototype for the Smart Walker. Moving forward, I will be conducting more research on other relevant standards for our project.

HIPAA Data Privacy Act - 12/10/23

NIKHIL CHANDRA - Dec 17, 2023, 11:42 PM CST

Title: HIPAA Data Privacy Act

Date: 12/10/23

Content by: Nikhil Chandra

Goals: To do further into the HIPAA Data Privacy Act in order to determine how to best alter the security rules of the server that stores all patient data

Content:

Citation:

"Health Insurance Portability and Accountability Act of 1996 (HIPAA)." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, 27 June 2022, www.cdc.gov/phlp/publications/topic/hipaa.html

With the development of the prototype where data on patients for every test is sent and stored to a server in real time, we need to determine the appropriate security rules/programs for this server to safely abide by known and common regulations. The HIPAA data privacy act describes regulations and standards around data privacy for medical data. Importantly, all patients and the designated healthcare provider or physical therapist should have full access to healthcare data collected for that patient. Instead of giving every patient access to the server, it would be more reasonable to instead simply give the physical therapist access to the server which was the original plan and to allow the physical therapist to then share data with the patient which they can do by easily downloading data from the server.

Conclusions/action items:

With more information about the HIPAA data privacy act and who should and who can not have access to patient data, we plan on simply updating the security rules of the server such that only the physical therapist has access to the server, and also informing the therapist on how exactly to change the security rules to transfer access to individuals as necessary.

Individual Brainstorming Speed/Distance - 10/1

NIKHIL CHANDRA - Oct 13, 2023, 10:32 PM CDT

Title: Individual Brainstorming Speed/Distance Ideas

Date: 10/1

Content by: Nikhil Chandra

Goals: To conduct individual brainstorming prior to the group session for design ideas to tackle the challenge of measuring the gait speed and distance traveled of a user of the walker.

Content:

Speed/Distance

For measuring speed and distance, one idea is to use triangulation by having an two external devices outside of the walker and a device on the walker. The distance between each of these devices is initially calibrated, and we can then measure the speed and distance at any point in time.

Another idea is to attach an IMU sensor to the walker, however IMUS from my experience especially since integration will have to happen twice to get distance are incredibly inaccurate for speed and distance and the error just builds up overtime.

We could also create a mechanical system using a wheel encoder. A belt drive system could be attached to the wheel, and when the wheel turns it turns a wheel encoder as well, which is what is used in cars to measure the RPM of a wheel.

Similar to a wheel encoder, we could put a pressure sensor or another kind of sensor on the wheel itself to track the RPM of the wheel where the sensor's contact with the ground would be indicative of the rotation of the wheel.

Conclusion/Action Items:

I was able to brainstorm a number of ideas for the speed/distance challenge in sensorizing a walker, and moving forward I can now conduct research and brainstorm ideas for understanding the pressure distribution a patient applies on the walker.

Individual Brainstorming Pressure Ideas - 10/1

NIKHIL CHANDRA - Oct 13, 2023, 10:41 PM CDT

Title: Individual Brainstorming Pressure Ideas

Date: 10/1

Content by: Nikhil Chandra

Goals: To conduct individual brainstorming prior to the group session for design ideas to tackle the challenge of measuring the applied pressure distribution that a patient exerts on the walker.

Content:

Pressure Ideas:

Similar to the idea for measuring speed/distance, we could use a pressure sensor at the bottom of the wheel that could measure pressure as the wheel rotates.

We could also put pressure sensors in the handles of the wheel and as a user squeezes or places their weight on the handles, it would measure the pressure.

Other than electronic pressure sensors we could also potentially use a pneumatic or hydraulic system. For example we could put a balloon type device of water or air at the bottom of the walker that gets squeezed when the walker is in contact with the ground.

The pressure sensors could also be integrated into a glove that the patient wears that can provide a more comprehensive understanding of what parts of their hands and in what direction they are applying pressure.

Instead of sensorizing the walker, we could create a path that has integrated force sensor similar to force plates that will detect the pressure of the walker and we can use this same data to measure speed/distance by tracking the pressure distribution across the path.

Conclusion/Action Items:

I was able to brainstorm a number of ideas for sensing the pressure distribution a patient applies on the walker which would act as a measurement for understanding their reliance on the walker. During our group brainstorming session I can present some of this ideas and come up with new ones given feedback from the team.

Pressure UI Component Programming - 10/31

NIKHIL CHANDRA - Dec 11, 2023, 4:18 PM CST

Title: Pressure UI Component Programming

Date: 10/31/23

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To code the user interface component of the software app that will display the pressure in real time.

Content:

The below preview shows what the pressure component looks and the corresponding code for the UI is also shown below, coded using SwiftUI in Xcode.

Preview:

Code:

```
//
//  PressureComponent.swift
//  smartWalker
//
//  Created by Nikhil Chandra on 10/31/23.
//

import SwiftUI
```

```
struct PressureComponent: View {
  @Binding var leftPressure: String
  @Binding var rightPressure: String

  var body: some View {
    VStack {
          Text("Pressure")
            .font(.system(.title, design: .rounded))
            .fontWeight(.bold)
            .foregroundColor(.red) // Adjust color to fit your app's theme

          HStack {
            Spacer()
            VStack() {
              Text("Left")
                .font(.system(.headline, design: .rounded))
                .foregroundColor(.gray) // Adjust color
              Spacer()
              Text(leftPressure)
                .font(.system(size: 40))
                .fontWeight(.semibold)
                .foregroundColor(.primary) // Adjust color
              Spacer()
            }
            Spacer()
            Divider()
              .background(Color.gray) // Adjust color
            Spacer()
            VStack() {
```

```
                    Text("Right")

                        .font(.system(.headline, design: .rounded))

                        .foregroundColor(.gray) // Adjust color

                    Spacer()

                    Text(rightPressure)

                        .font(.system(size: 40))

                        .fontWeight(.semibold)

                        .foregroundColor(.primary) // Adjust color

                    Spacer()

                }

                Spacer()

            }

        }

    .padding()

    .frame(height: 180)

    .background(

        RoundedRectangle(cornerRadius: 20, style: .continuous)

            .fill(Color.white)

            .shadow(color: .gray, radius: 10, x: 0, y: 5)


    )

  }

}


struct PressureComponent_Previews: PreviewProvider {

    static var previews: some View {

        PressureComponent(leftPressure: .constant("0.0 N"), rightPressure: .constant("0.0 N"))

    }

}
```

Conclusions/action items:

With the pressure component designed showing left and right pressure, I can now move forward with designing and coding the UI component that will display speed and total distance traveled in real time.

Speed UI Component Programming - 10/31

NIKHIL CHANDRA - Dec 11, 2023, 4:30 PM CST

Title: Speed UI Component Programming

Date: 10/31/23

Content by: Nikhil Chandra

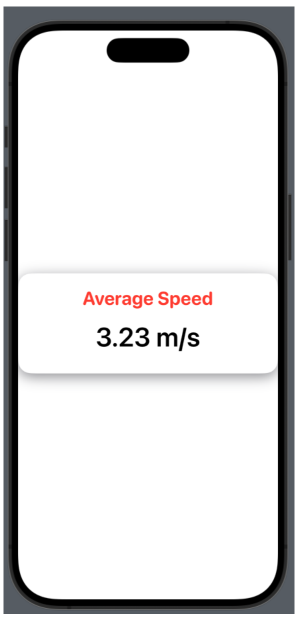
Present: Nikhil Chandra

Goals: To program the speed and total distance traveled UI component using SwiftUI and Xcode.

Content:

The below preview shows the speed and distance traveled UI components in Xcode preview and the corresponding code in SwiftUI.

Preview:



Code:

```
//
//  SpeedComponent.swift
//  smartWalker
//
//  Created by Nikhil Chandra on 10/31/23.
//


import SwiftUI


struct SpeedComponent: View {
```

```
    var title = "Average Speed"

    @Binding var value: String

    var body: some View {

        VStack {

            Text(title)

                .font(.system(.title, design: .rounded))

                .fontWeight(.bold)

                .foregroundColor(.red) // Adjust color to fit your app's theme

            Spacer()

            Text(value)

                .font(.system(size: 40))

                .fontWeight(.semibold)

                .foregroundColor(.primary) // Adjust color

            Spacer()

        }

        .padding()

        .frame(maxWidth:.infinity)

        .frame(height: 150)

        .background(

            RoundedRectangle(cornerRadius: 20, style: .continuous)

                .fill(Color.white)

                .shadow(color: .gray, radius: 10, x: 0, y: 5)

        )


    }

}


struct SpeedComponent_Previews: PreviewProvider {

    static var previews: some View {

        SpeedComponent( value: .constant("3.23 m/s"))
```

```
    }
}
```

Conclusions/action items:

Having completed the speed UI component, we can now move forward with coding the patient selection and creation UI then finally the code for data processing and communicating with the firebase server.

Patient Selection and Creation UI Component - 11/1/23

NIKHIL CHANDRA - Dec 11, 2023, 4:37 PM CST

Title: Patient Selection and Creation UI Component

Date: 11/1/23

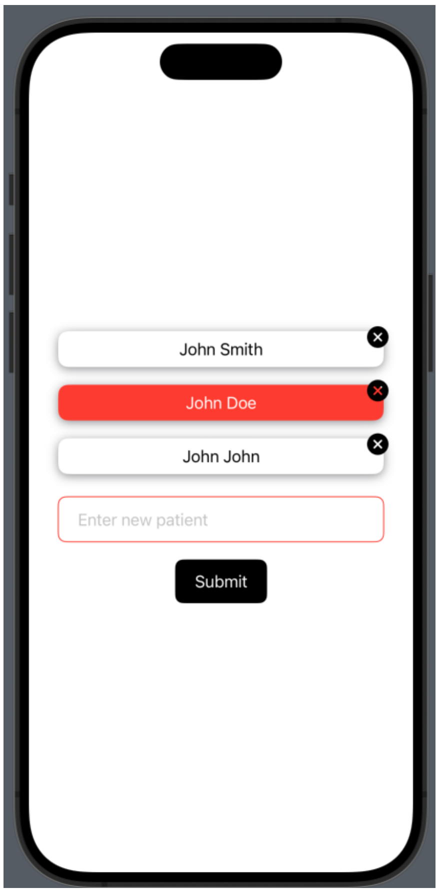
Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To program the patient selection and creation UI component in SwiftUI in Xcode.

Content:

The below preview in Xcode and the corresponding code is for the patient selection and creation UI Component.



Code:

//

// patientSelection.swift

// smartWalker

//

// Created by Nikhil Chandra on 11/6/23.

//

```
import SwiftUI


struct patientSelection: View {

  @Binding var patients: [String]

  @Binding var selectedPatient: String

  @State var newPatient: String = ""

  @Binding var showPatientSelection: Bool

  var body: some View {

    VStack {

          ForEach(patients, id: \.self) { patient in

            Button {

              selectedPatient = patient

              withAnimation(.easeInOut(duration: 0.5).delay(0.2)) {

                showPatientSelection.toggle()

              }

            } label: {


              Text(patient)


                .font(.body)

                .foregroundColor((selectedPatient == patient) ? Color.white : Color.black)

                .frame(maxWidth: .infinity)

                .padding(6)

                .background(

                  RoundedRectangle(cornerRadius: 10, style: .continuous)

                    .fill((selectedPatient == patient) ? Color.red : Color.white)

                    .shadow(color: .gray, radius: 5, x: 0, y: 2)


                )

                .overlay(
```

```
        VStack() {
            HStack {
                Spacer()
                Button {

                    patients.removeAll { $0 == patient }
                    if selectedPatient == patient {
                        selectedPatient = patients[0]
                    }
                } label: {
                    Image(systemName: "xmark.circle.fill")
                        .resizable()
                    .scaledToFit()
                    .frame(width:22, height: 22)
                    .foregroundColor(.black)

                }
                .offset(CGSize(width: 5, height: -5))
            }
            Spacer()


        }
            .frame(maxWidth:.infinity, maxHeight:.infinity)




    )
```

```
            }
            .padding(.vertical, 5)

        }

        .padding(.horizontal, 30)


    VStack {
            TextField("Enter new patient", text: $newPatient)
                .font(.body)
                .padding(.vertical, 10)
                .padding(.horizontal, 20)
                .background(Color.white) // White background
                .cornerRadius(8) // Rounded corners
                .overlay(
                    RoundedRectangle(cornerRadius: 8)
                        .stroke(Color.red, lineWidth: 1) // Black border
                )

                .padding(.vertical, 10)

            Button("Submit") {
                if !newPatient.isEmpty {
                    patients.append(newPatient)
                    selectedPatient = newPatient

                }
                newPatient = ""
```

```
                    }
                    .font(.body)
                    .foregroundColor(.white)
                    .padding(.vertical, 10)
                    .padding(.horizontal, 20)
                    .background(Color.black) // Black background
                    .cornerRadius(8) // Rounded corners

                }
            .padding(.horizontal, 30)





        }
        .frame(maxWidth:.infinity)
        .frame(height: 300)



    }
}


#Preview {
    patientSelection(patients: .constant(["John Smith", "John Doe", "John John"]), selectedPatient: .constant("John Doe"),
showPatientSelection: .constant(false))
}
```

Conclusions/action items: Now that the patient selection and creation UI component is coded, we can now integrate it into the larger UI with speed and distance then code the server communication and data processing.

Overall User Interface Code - 11/2

NIKHIL CHANDRA - Dec 11, 2023, 4:59 PM CST

Title: Overall User Interface Code

Date: 11/2/23

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To integrate the speed, distance, and pressure UI components with the patient selection UI component into an overall UI in SwiftUI in Xcode.

Content:

The below code shows the integration of these components into an overall UI.

```
//
//  ContentView.swift
//  smartWalker
//
//  Created by Nikhil Chandra on 10/29/23.
//

import SwiftUI

struct ContentView: View {
    @State var showPatientSelection = false

    @StateObject var realTimeData = dataProcessing()

    @State private var counter = 0
    @State private var timer: Timer?

    var body: some View {
        VStack {
            HStack {
                Text("Patient: " + realTimeData.selectedPatient)
                    .font(.system(.body, design: .rounded).bold())
```

```
                .foregroundColor(.blue)


        }
        .onTapGesture {
            withAnimation(.easeInOut(duration: 0.5)) {
                showPatientSelection.toggle()
            }
        }



        StartButton(ColorSelection: realTimeData.start ? "Red" : "Green", buttonTitle: realTimeData.start ? "Stop Recording" : "Start Recording")
            .disabled(!realTimeData.loadedPatients)
            .onTapGesture {
                withAnimation(.spring()) {
                    realTimeData.start.toggle()
                }
            }
            .scaleEffect(realTimeData.start ? 1 : 0.95) // Add a subtle bounce effect

        Button {
            realTimeData.zeroButton.toggle()
        } label:{
            Text("Zero")
                .padding(4)
                .font(.system(.body, design: .rounded).bold())


        }

        Spacer()
                .frame(height: 10)
```

```
        PressureComponent(leftPressure: $realTimeData.leftPressure, rightPressure: $realTimeData.rightPressure)
        Spacer()
          .frame(height: 30)
        SpeedComponent( value: $realTimeData.speed)
          Spacer()
            .frame(height: 30)
        SpeedComponent(title: "Distance", value: $realTimeData.distance)
      }
      .frame(maxWidth:.infinity, maxHeight:.infinity)
      .overlay(
        VStack {
          if showPatientSelection {
            patientSelection(patients: $realTimeData.patients, selectedPatient: $realTimeData.selectedPatient, showPatientSelection:
$showPatientSelection)
              .frame(maxWidth:.infinity, maxHeight:.infinity)
              .background(
                Color.white.opacity(0.9)
                  .onTapGesture {
                    withAnimation(.easeInOut(duration: 0.5).delay(0.2)) {
                      showPatientSelection.toggle()
                    }
                  }

              )
          }
        }
          .frame(maxWidth:.infinity, maxHeight:.infinity)
          .onAppear {
            // Start the timer when the view appears
```

```
                self.startTimer()
            }








        )


    }
    func startTimer() {
        // Invalidate any existing timer
        timer?.invalidate()

        // Create a new timer that fires every second
        timer = Timer.scheduledTimer(withTimeInterval: 1, repeats: true) { timer in
            // Update the counter
            self.realTimeData.counter += 1
        }

        // Make sure the timer is in the run loop
        RunLoop.current.add(timer!, forMode: .common)
    }

    func stopTimer() {
        // Stop the timer
        timer?.invalidate()
    }
}

struct ContentView_Previews: PreviewProvider {
    static var previews: some View {
```

```
        ContentView()
    }
}
struct StartButton: View {
    var ColorSelection = "Green"
    var buttonTitle = "Start Recording"
    var body: some View {
        Text(buttonTitle)
            .font(.title)
            .fontWeight(.semibold)
            .foregroundColor(.white)
            .frame(width: 250, height: 60)
            .background(
                RoundedRectangle(cornerRadius: 10)
                    .fill(ColorSelection=="Green" ? Color.green : Color.red) // Set the desired button color
            )
            .shadow(color: .gray, radius: 5, x: 0, y: 5) // Add shadow effect
    }
}
```

Conclusions/action items:

With the overall UI completed, we now can finish off the server communication and data processing code then begin testing for the walker prototype with the software app.

Firebase Server Organization

NIKHIL CHANDRA - Dec 11, 2023, 4:51 PM CST

Title: Firebase Server Organization

Date: 11/15/23

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To organize the firebase server to store real time data and patient data.

Content:

In firebase documents store key value pairs and collections store documents. Anytime lots of data is being appended to firebase it is recommended to store it in multiple documents within a collection or subcollection as opposed to just appending it all to a single document.

Given this main organizational recommendation, we can have a document that stores the pressure speed and distance as key value pairs in real time. Then we can have a separate document for all patient data. Within the all patient data document we can store key value pairs of the patient list and the currently selected patient. Then within this document, every patient can be a subcollection for which there are documents titled by date and time for tests run for that patient. Each test document will contain the average pressure, speed, and distance over the test duration.

Documentation Reference:

"Fundamentals | Firebase Documentation." *Google*, Google, firebase.google.com/docs/guides. Accessed 11 Dec. 2023.

Conclusions/action items:

Given the organizational scheme for the firebase server, we can now move forward with coding the server communication and data processing part of the software app.

Data Processing and Server Communication Code - 11/21

NIKHIL CHANDRA - Dec 11, 2023, 4:56 PM CST

Title: Data Processing and Server Communication Code

Date: 11/21/23

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To program the data processing and server communication with firebase code in the software app in swiftUI in Xcode.

Content:

The data processing and server communication code is shown below:

```
//
//  dataProcessing.swift
//  smartWalker
//
//  Created by Nikhil Chandra on 11/21/23.
//


import Foundation
import Firebase
import FirebaseFirestore
import Combine
class dataProcessing: ObservableObject {


    init() {
        setupFirebaseListener()
        loadData()
    }
    @Published var zeroButton = false {
      didSet {


        initialPressureReading = String((Double(initialPressureReading) ?? 0.0) +  (Double(leftPressure.replacingOccurrences(of: "
N", with: "")) ?? 0.0))
        leftPressure = "0 N"
```

```
        rightPressure = "0 N"

        print(initialPressureReading)



    }

}

@Published var initialPressureReading = "0.0"

@Published var counter = 0.01

@Published var initialTime = 0.0

@Published var documentData: Codable?

@Published var leftPressure: String = "0 N"

@Published var rightPressure: String = "0 N"

@Published var speed: String = "0 mm/s"

@Published var distance: String = "0.0 m"

var distanceBetweenMagnets = 0.5

@Published var patients: [String] = [] {

    didSet {

        if loadedPatients {

            let documentRef = db.collection("smartWalker").document("allPatientData")

            let uploadData = ["patientList": patients]

            documentRef.setData(uploadData, merge: true) { error in

                if let error = error {

                    print("Error setting data: \(error.localizedDescription)")

                } else {

                    print("Data set successfully!")

                }

            }

        }



    }

}
```

```
@Published var loadedPatients = false

@Published var selectedPatient = "John Doe" {

  didSet {

    if loadedPatients {

      let documentRef = db.collection("smartWalker").document("allPatientData")

      let uploadData = ["selectedPatient": selectedPatient]

      documentRef.setData(uploadData, merge: true) { error in

        if let error = error {

          print("Error setting data: \(error.localizedDescription)")

        } else {

          print("Data set successfully!")

        }

      }

    }


  }

}


let db = Firestore.firestore()

@Published var start = false { //true means started/recording

  didSet {

    if start { //started recording


      pressureList = []

      speedList = []

      distance = "0.0" + " m"

      counter = 0.01

      speed = "0.0" + " mm/s"


    } else {
```

```
            if !pressureList.isEmpty {

                let pressureSum = pressureList.reduce(0, +)

                let pressureAverage = String(Double(pressureSum) / Double(pressureList.count)) + " N"

                let speedSum = speedList.reduce(0, +)

                let speedAverage = String(Double(speedSum) / Double(speedList.count))

                let finalDistanceTraveled = distance.replacingOccurrences(of: " m", with: "")



                let currentDate = Timestamp(date: Date())

                let documentID = currentDate.dateValue().description



                // Create a reference to the Firestore collection and document with the current date and time

                let documentRef =
db.collection("smartWalker").document("allPatientData").collection(selectedPatient).document(documentID)

                let uploadData = ["averagePressure": pressureAverage, "averageSpeed": speed, "distanceTraveled": distance]



                // Set the data in Firestore

                documentRef.setData(uploadData, merge: true) { error in

                    if let error = error {

                        print("Error setting data: \(error.localizedDescription)")

                    } else {

                        print("Data set successfully!")

                    }

                }




            }



        }

    }

}
```

```
var pressureList: [Double] = []
var speedList: [Double] = []
var initialDistance = "0.0"



private var listener: ListenerRegistration?


func setupFirebaseListener() {
  let documentReference = db.collection("smartWalker").document("realTimeData")


  listener = documentReference
    .addSnapshotListener { [weak self] snapshot, error in
      guard let self = self else { return }


      if let error = error {
        print("Error fetching document: \(error.localizedDescription)")
        return
      }


      guard let document = snapshot else {
        print("Document does not exist")
        return
      }


      do {
        let documentData = try document.data(as: UserData.self) // Replace YourDataType with the type of data you expect


        self.documentData = documentData
```

```
if let documentData = documentData as? UserData {
    print(documentData.pressure)
    print(Double(initialPressureReading))
    var pressureCalc = documentData.pressure - (Double(initialPressureReading) ?? 0.0)


    leftPressure = String(format: "%.1f", pressureCalc) + " N"
    rightPressure = String(format: "%.1f", pressureCalc) + " N"




    if !start {
        //not recording, keep storing initial distance values
        initialDistance = String(documentData.distance)
    } else {
        //recording, send values to arrays, display distances relative to initial


        pressureList.append(pressureCalc)


        if let initalDistanceFloat = (Double(initialDistance)) {
            var distanceConversion = String(format: "%.1f", (documentData.distance - initalDistanceFloat))
            self.distance = distanceConversion + " m"
            if (documentData.distance - initalDistanceFloat) > 0.0 {
                var speedCalc = ((documentData.distance - initalDistanceFloat) / (counter))*1000.0
                speed = String(format: "%.1f", speedCalc) + " mm/s"
                speedList.append(speedCalc)
            } else {
                counter = 0.01
            }
```

```
                    }
                  }
                }
              } catch {
                print("Error decoding document: \(error.localizedDescription)")
              }
            }
        }

    func loadData() {
        let documentReference = db.collection("smartWalker").document("allPatientData")
        documentReference.getDocument { document, error in
            if let error = error {
                print("Error getting document: \(error.localizedDescription)")
            }
            else if let document = document, document.exists {
                if let documentData = document.data() {
                    if let patientList = documentData["patientList"] as? [String] {
                        self.patients = patientList
                        self.loadedPatients = true
```

```
                }
                if let lastPatient = documentData["selectedPatient"] as? String {
                    self.selectedPatient = lastPatient
                }
            }
        }
    }
}
}

struct UserData: Codable {
    var pressure: Double
    var distance: Double
    var speed: Double
}
```

Conclusions/action items: With the data processing and server communication code complete, we can now do some initial testing of the software app with firebase and the walker prototype as a team to verify the code.

Title: Data Processing and Server Communication Code

Date: 11/21/23

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: To program the data processing and server communication with firebase code in the software app in swiftUI in Xcode.

Content:

The data processing and server communication code is shown below:

```
//
//  dataProcessing.swift
//  smartWalker
//
//  Created by Nikhil Chandra on 11/21/23.
//


import Foundation
import Firebase
import FirebaseFirestore
import Combine
class dataProcessing: ObservableObject {


    init() {
        setupFirebaseListener()
        loadData()
    }
    @Published var zeroButton = false {
      didSet {


        initialPressureReading = String((Double(initialPressureReading) ?? 0.0) +  (Double(leftPressure.replacingOccurrences(of: "
N", with: "")) ?? 0.0))
        leftPressure = "0 N"
        rightPressure = "0 N"
        print(initialPressureReading)


      }
    }
    @Published var initialPressureReading = "0.0"
    @Published var counter = 0.01
    @Published var initialTime = 0.0
```

```
@Published var documentData: Codable?

@Published var leftPressure: String = "0 N"

@Published var rightPressure: String = "0 N"

@Published var speed: String = "0 mm/s"

@Published var distance: String = "0.0 m"

var distanceBetweenMagnets = 0.5

@Published var patients: [String] = [] {

  didSet {

    if loadedPatients {

      let documentRef = db.collection("smartWalker").document("allPatientData")

      let uploadData = ["patientList": patients]

      documentRef.setData(uploadData, merge: true) { error in

        if let error = error {

          print("Error setting data: \(error.localizedDescription)")

        } else {

          print("Data set successfully!")

        }

      }

    }


  }

}

@Published var loadedPatients = false

@Published var selectedPatient = "John Doe" {

  didSet {

    if loadedPatients {

      let documentRef = db.collection("smartWalker").document("allPatientData")

      let uploadData = ["selectedPatient": selectedPatient]

      documentRef.setData(uploadData, merge: true) { error in

        if let error = error {
```

```
                print("Error setting data: \(error.localizedDescription)")
              } else {
                print("Data set successfully!")
              }
            }
          }


        }
      }


      let db = Firestore.firestore()
      @Published var start = false { //true means started/recording
        didSet {
          if start { //started recording


            pressureList = []
            speedList = []
            distance = "0.0" + " m"
            counter = 0.01
            speed = "0.0" + " mm/s"


          } else {
            if !pressureList.isEmpty {
              let pressureSum = pressureList.reduce(0, +)
              let pressureAverage = String(Double(pressureSum) / Double(pressureList.count)) + " N"
              let speedSum = speedList.reduce(0, +)
              let speedAverage = String(Double(speedSum) / Double(speedList.count))
              let finalDistanceTraveled = distance.replacingOccurrences(of: " m", with: "")


              let currentDate = Timestamp(date: Date())
```

```
                let documentID = currentDate.dateValue().description


                // Create a reference to the Firestore collection and document with the current date and time

                let documentRef =
db.collection("smartWalker").document("allPatientData").collection(selectedPatient).document(documentID)

                let uploadData = ["averagePressure": pressureAverage, "averageSpeed": speed, "distanceTraveled": distance]


                // Set the data in Firestore

                documentRef.setData(uploadData, merge: true) { error in

                    if let error = error {

                        print("Error setting data: \(error.localizedDescription)")

                    } else {

                        print("Data set successfully!")

                    }

                }



            }


        }

    }

}



    var pressureList: [Double] = []

    var speedList: [Double] = []

    var initialDistance = "0.0"



    private var listener: ListenerRegistration?
```

```
func setupFirebaseListener() {
    let documentReference = db.collection("smartWalker").document("realTimeData")

    listener = documentReference
        .addSnapshotListener { [weak self] snapshot, error in
            guard let self = self else { return }

            if let error = error {
                print("Error fetching document: \(error.localizedDescription)")
                return
            }

            guard let document = snapshot else {
                print("Document does not exist")
                return
            }

            do {
                let documentData = try document.data(as: UserData.self) // Replace YourDataType with the type of data you expect

                self.documentData = documentData

                if let documentData = documentData as? UserData {
                    print(documentData.pressure)
                    print(Double(initialPressureReading))
                    var pressureCalc = documentData.pressure - (Double(initialPressureReading) ?? 0.0)

                    leftPressure = String(format: "%.1f", pressureCalc) + " N"
                    rightPressure = String(format: "%.1f", pressureCalc) + " N"
```

```
        if !start {
            //not recording, keep storing initial distance values
            initialDistance = String(documentData.distance)
        } else {
            //recording, send values to arrays, display distances relative to initial

            pressureList.append(pressureCalc)

            if let initalDistanceFloat = (Double(initialDistance)) {
                var distanceConversion = String(format: "%.1f", (documentData.distance - initalDistanceFloat))
                self.distance = distanceConversion + " m"
                if (documentData.distance - initalDistanceFloat) > 0.0 {
                    var speedCalc = ((documentData.distance - initalDistanceFloat) / (counter))*1000.0
                    speed = String(format: "%.1f", speedCalc) + " mm/s"
                    speedList.append(speedCalc)
                } else {
                    counter = 0.01
                }


            }


        }

    }
```

```
            } catch {
                print("Error decoding document: \(error.localizedDescription)")
            }




        }


    }


func loadData() {
    let documentReference = db.collection("smartWalker").document("allPatientData")
    documentReference.getDocument { document, error in
        if let error = error {
            print("Error getting document: \(error.localizedDescription)")
        }
        else if let document = document, document.exists {
            if let documentData = document.data() {
                if let patientList = documentData["patientList"] as? [String] {
                    self.patients = patientList
                    self.loadedPatients = true

                }
                if let lastPatient = documentData["selectedPatient"] as? String {
                    self.selectedPatient = lastPatient
                }
            }
        }
    }
```

```
    }

}

struct UserData: Codable {
    var pressure: Double
    var distance: Double
    var speed: Double
}
```

Conclusions/action items: With the data processing and server communication code complete, we can now do some initial testing of the software app with firebase and the walker prototype as a team to verify the code.

Injuries Caused by Walkers - 9/20/2023

Jake Maisel - Oct 15, 2023, 7:47 PM CDT

Title: Injuries Caused by Walkers

Date: 9/20/2023

Content by: Jake Maisel

Present: N/a

Goals: To analyze patients who are injured to find out the best way to create this walker to be safe and reliable

Content:

Reference

Mali1, N., Restrepo2, F., Abrahams3, A., Sands4, L., Goldberg5, D. M., Gruss6, R., Zaman7, N., Shields8, W., Omaki8, E., Ehsani8, J., Ractham9, P., Kaewkitipong9, L., Science, 1Department of Computer, & Kaewkitipong, C. A. (2023, February 3). *Safety concerns in mobility-assistive products for older adults: Content analysis of online reviews*. Journal of Medical Internet Research. https://www.jmir.org/2023/1/e42231

This article goes through the results of over 48,000 walker reviews online to find patterns in major and minor injuries caused by using a walker. For major injuries, the common occurrence is that one of the wheels falls off or the walker ultimately falls apart if the metal frame breaks. This causes the patient to take a hard fall and seriously hurt themselves. Moreover, the common occurrence when a minor injury happens is that one of the legs or wheels falls off causing a patient to take a fall. These injuries are usually less severe because the walker is still mostly intact allowing the patient to have somewhat of a support to hold onto as they fall. The walkers that caused injuries were predominately cheaply made and inexpensive walkers. Our walker mustn't break because some of the patients who will be using it have very bad injuries and cannot afford to get hurt again. Additionally, our client wants our Smartwalker to be able to be used for a long time at least 5 years.

Conclusions/action items:

- The most important takeover of this article is that cheap walkers can break leading to injuries in the patient.
- We must buy a high-quality walker to use to create our Smartwalker so that it will last for a very long time and will be safe.
- I need to do more research on more ways to make sure that our Smartwalker will be safe and comfortable for the patient.

- I will also do more research on what pressure sensors can be used to pick up the wide range of pressure put on the sensors by a wide variety of patients.

Impact Document - 12/03/2023

Jake Maisel - Dec 12, 2023, 1:02 PM CST

Title: Impact

Date: 12/3/2023

Content by: Jake

Present: NA

Goals: To show the need for a Smart Walker and the impact that it will have.

Content:

Reference

D. I. Katz, “Recovery of ambulation after traumatic brain injury,” *Archives of physical medicine and rehabilitation*, Jun. 2004. Accessed: Dec. 3, 2023. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/15179637/

Many patients who suffer a neurological injury struggle with their balance and walking. This is proven by the fact that 30 percent to 65 percent of all patients with a serious brain injury struggle to keep their balance. This leads the hospital to supply a walker for the patient to use to aid in their recovery. The doctors look for improvements in the patient's recovery through the speeds at which a patient pushes the walker and the amount of pressure the patient puts on the walker. Our client struggled with recognizing improvements because there was no way to test for the amount of pressure a patient was putting on the walker and he would have to manually record time and distance to get the speed of a patient. The Smart Walker records the speed, distance, and applied pressure of a patient.

Conclusions/action items:

This greatly impacts our client who can now use the Smart Walker and connected smartphone app to track the recovery of his patients in more board sense than just the distance and speed of the patient. Additionally, this device saves our client a ton of time because our device receives and sends all the data to the doctors without them having to manually do anything. The Smart Walker could be used in hospitals everywhere to help doctors who are looking for an easy way to track their patients' neurological injuries. Additionally, the Smart Walker does not need to be limited to people recovering from neurological injuries. The Smart Walker could potentially help many others who have serious injuries. The walker could track the progress of someone's recovery from a leg injury, spinal injury, foot injury, etc. This would greatly impact hospitals' ability to recognize recovery in a ton of patients with various injuries.

GPS Design - 9/26/2023

Jake Maisel - Oct 15, 2023, 6:33 PM CDT

Title: GPS Design

Date: 9/5/2023

Content by: Jake Maisel

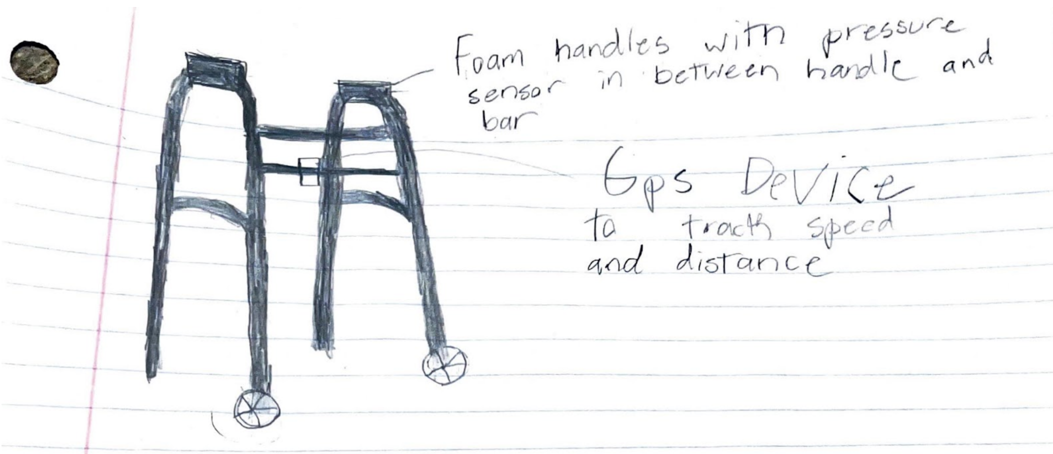
Present: N/a

Goals:

Content:

This is an initial design of mine for what the smart walker might look like and how it will function. The Smartwalker will have a GPS device mounted on the frame of the walker, this will track the distance and speed of the patient. Additionally, there will be pressure sensors located on the handles.

Conclusions/action items:



Preliminary Mechanical Box Design - 11/20/2023

Jake Maisel - Dec 11, 2023, 6:48 PM CST

Title: Preliminary Mechanical Box Design

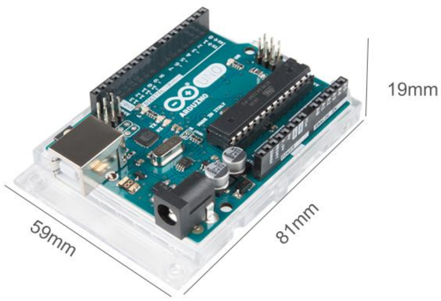
Date: 11/20/2023

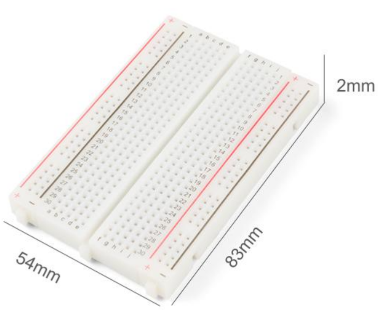
Content by: Jake

Present: NA

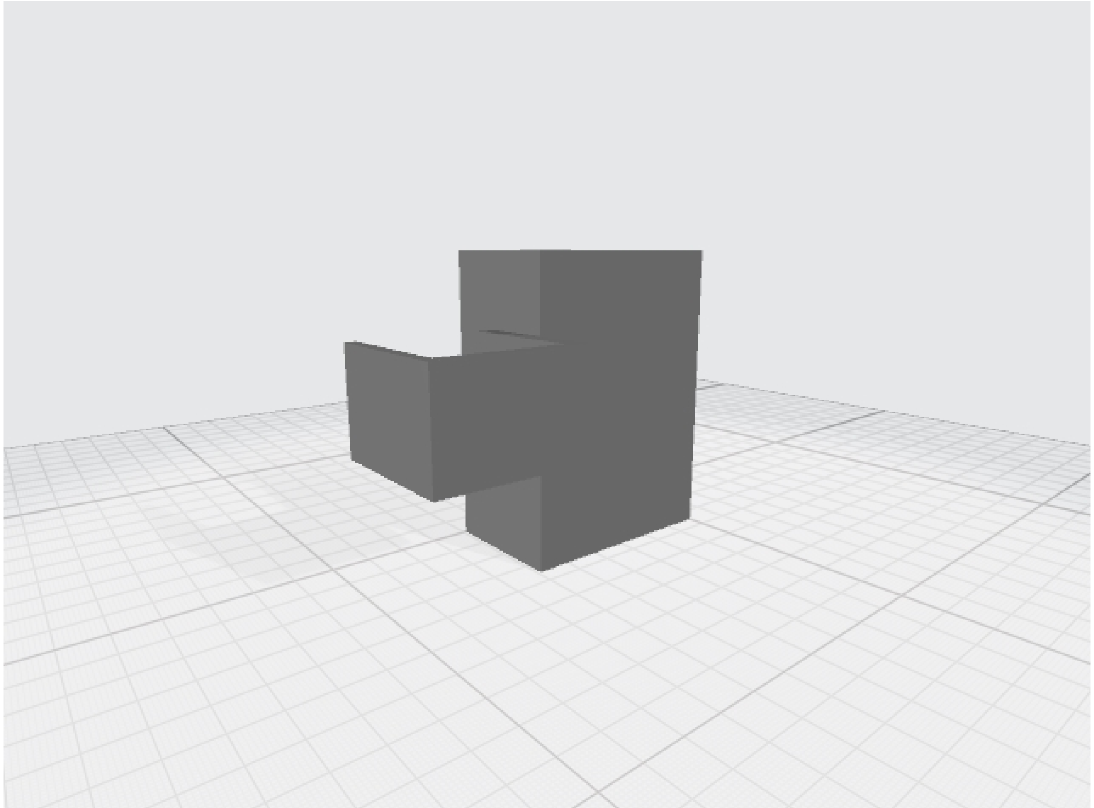
Goals: To create a 3D printed box that can fit all of the electronic devices.

Content:





These are the main three components that have to fit in the 3D printed box along with the wiring connecting these components to the sensors on the walker.



Initial 3D printed design.

Conclusions/action items:

This was a very simple design that would allow the box to fit the components. This box was designed to connect to the walker by screwing holes into the three sides extended from the walker. Then screw holes into the walker frame, this would allow for the box to stay in place on the walker. There were some issues with this design, the first being the frame. The frame of the walker does not detach which would make drilling into it very difficult. Additionally, most of the walker is made of aluminon which is a soft metal however the frame of the walker was made of a hard metal. Moreover, the box fit all the components, but the wiring would have to be bent a ton to fit. All these problems ultimately show that this box is a good start, but has to be renovated to work for the walker.

Final Mechanical Box Design - 12/6/2023

Jake Maisel - Dec 11, 2023, 10:55 PM CST

Title: Final Mechanical Box Design

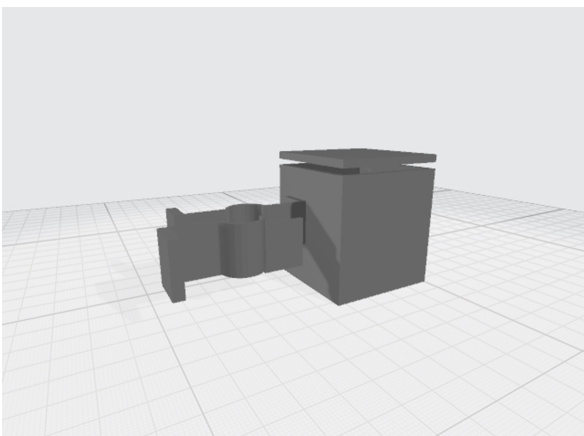
Date: 12/6/2023

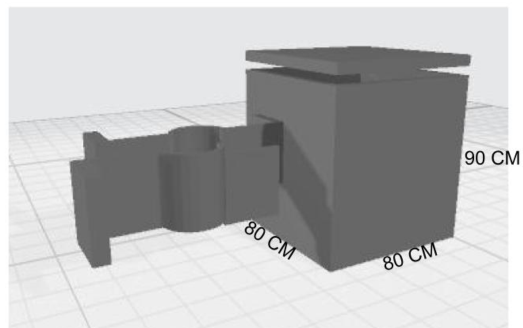
Content by: Jake

Present: NA

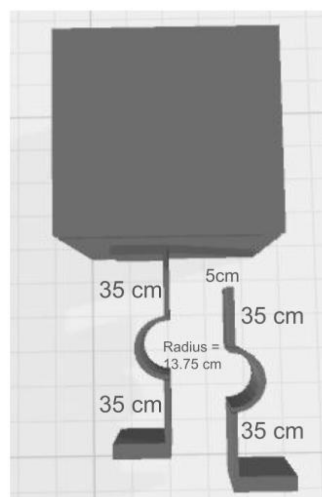
Goals: To create a box that can easily be attached to the walker and can hold all the electronic components without causing the wiring to break

Content:





Final Design



Final Design with Dimensions

Conclusions/action items:

This design works by attaching a box to one of the two same dimensions, outer structures. The half circle then attaches to the frame of the walker. The other outer structure that's not connected to the box is screwed into the outer structure that is attached to the box to keep the box attached to the frame of the walker. This box can be installed without screwing into the frame of the walker which would become very difficult. The infill was set to 30 percent, which is more than enough to drill through and be able to put a screw in. Additionally, because we need this box to last and protect the electric components, I used a hard PLA material.

Walker standards research 9/28/2023

JOSEPH KOCH - Dec 15, 2023, 7:22 PM CST

Title: Walker standards research

Date: 9/28/2023

Content by: Joseph Koch

Goals: determine the standards that our walker must meet

Content:

The walker must have a durable lightweight frame the upper tube at least 25.4x1.62 mm lower at least 21.6x1.4 mm. The Legs should be adjustable to account for varying heights.

Walking frame should be able to withstand minimum load of 100kg and the mass of the walker should be less than 2 kg

Citation:

[1] Assistive product specification for procurement, https://www.who.int/docs/default-source/assistive-technology-2/aps/mobility/aps22-walking-frames-oc-use.pdf?sfvrsn=49508707_2 (accessed Sep. 28, 2023).

Conclusions/action items:

ensure that our walker meets these standards

Walker Requirements Research - 9/30/2023

JOSEPH KOCH - Dec 15, 2023, 7:25 PM CST

Title: Walker research

Date: 9/30/2023

Reference

Assistive product specification for procurement -

[2] Assistive product specification for procurement, https://www.who.int/docs/default-source/assistive-technology-2/aps/mobility/aps22-walking-frames-oc-use.pdf?sfvrsn=49508707_2 (accessed Dec. 16, 2023).

Content:

Durable lightweight frame - upper tube at least 25.4x1.62 mm lower at least 21.6x1.4 mm.

Legs should be adjustable

Walking frame should be able to withstand minimum load of 100kg

Mass should be less than 2 kg

Action Items:

make sure the walker we purchase fits these standards

Load Cell research 11/5/2023

Title: Load Cell Research

Date: 11/5/2023

Content by: Joseph Koch

Goals: Research load cells to find a better sensor and troubleshoot problems with the current circuit

Content:

[1] “Load Cell amplifier HX711 breakout hookup guide,” Load Cell Amplifier HX711 Breakout Hookup Guide - SparkFun Learn, https://learn.sparkfun.com/tu hookup-guide? _gl=1%2A1etfn5n%2A_ga%2AMTIwMDYzMjA1NS4xNjk1Njc3ODI0%2A_ga_T369JS7J9N%2AMTcwMjM1MzU3My4yNi4wLjE3MDIzNTM1NzMuNjAu 3932-1200632055.1695677824 (accessed Dec. 15, 2023).

Single, strain guage load cell - often arranged in a 4 sensor wheatstone bridge configuration. With four single load sensors and combinator boar connections. There is no set color coded standard for the wires but there should be around 1000 ohms of resistance across 2 wires. These shou while the two center tap wires are connected to the voltage. This can be found using a multimeter.

Conclusions/action items:

Purchase new load cells and look into the combinator board and if it will be necessary

Distance Sensor Speed and Distance Measurements - 9/30/2023

BALJINDER SINGH - Dec 13, 2023, 11:06 PM CST

Title: Distance sensor

Date 9/30/2023

Content by: Joseph

Present: Joseph

Content:

The Ping ultrasonic rangefinder detects distance by sending and receiving wave. The sensor could be mounted to the front of the walker. The sensor does not account for turning and needs reference wall. The ultrasonic distance sensor would be a cheap and easy solution if turns do not need to be accounted for.

Conclusion/Action Items:

Determine if turning needs to be accounted for and if so if there is a way to measure turning with the sensor.

Force Resistance Sensor Circuit and Code - 11/1/2023

JOSEPH KOCH - Dec 15, 2023, 7:28 PM CST

Title: force sensing circuits and codes

Date: 11/1/2023

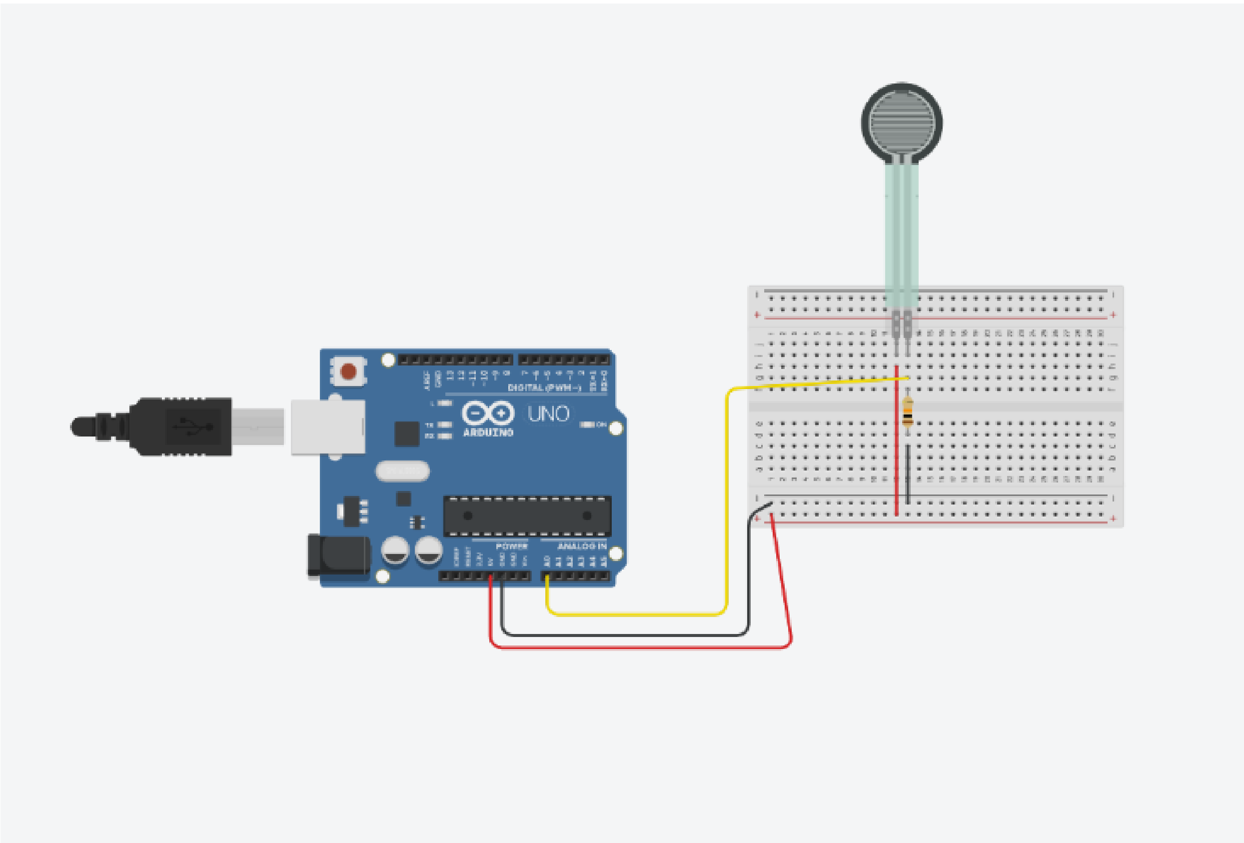
Content by: Joseph Koch

Goals: develop a code and circuit that could work with force sensing resistor

Content:

```
int fsrPin = 0;
int fsrReading;
int fsrVoltage;

unsigned long fsrResistance;
unsigned long fsrConductance;
long fsrForce;
long fsrForcelbs;

void setup(void) {
  Serial.begin(9600);
}

void loop(void){
  fsrReading = analogRead(fsrPin);
  Serial.print("Analog reading = ");
  Serial.println(fsrReading);

  fsrVoltage = map(fsrReading, 0, 1023, 0, 5000);
  Serial.print("voltage reading in mv = ");
  Serial.println(fsrVoltage);

  if (fsrVoltage == 0) {
    Serial.println("no pressure");
  } else {
    fsrResistance = 5000 - fsrVoltage;
    fsrResistance *= 10000;
    fsrResistance /= fsrVoltage;
    Serial.print("Fsr resistance in ohms = ");
    Serial.println(fsrResistance);

    fsrConductance = 1000000;
    fsrConductance /= fsrResistance;


    if (fsrConductance <= 1000){
      fsrForce = fsrConductance / 80;
      Serial.print("Force in Newtons: ");
      Serial.println(fsrForce);
    } else {
      fsrForce = fsrConductance - 1000;
      fsrForce /= 30;
      Serial.print("Force in Newtons: ");
      Serial.println(fsrForce);
    }
```

```
      fsrForcelbs = fsrForce / 4.448;
      Serial.print("Force in Pounds: ");
      Serial.println(fsrForcelbs);
    }
  Serial.println("---------");
  delay(1500);
}
```



Conclusions/action items: Determine if this circuit will work for our project

Full circuit diagram 12/2/2023

JOSEPH KOCH - Dec 11, 2023, 9:56 PM CST

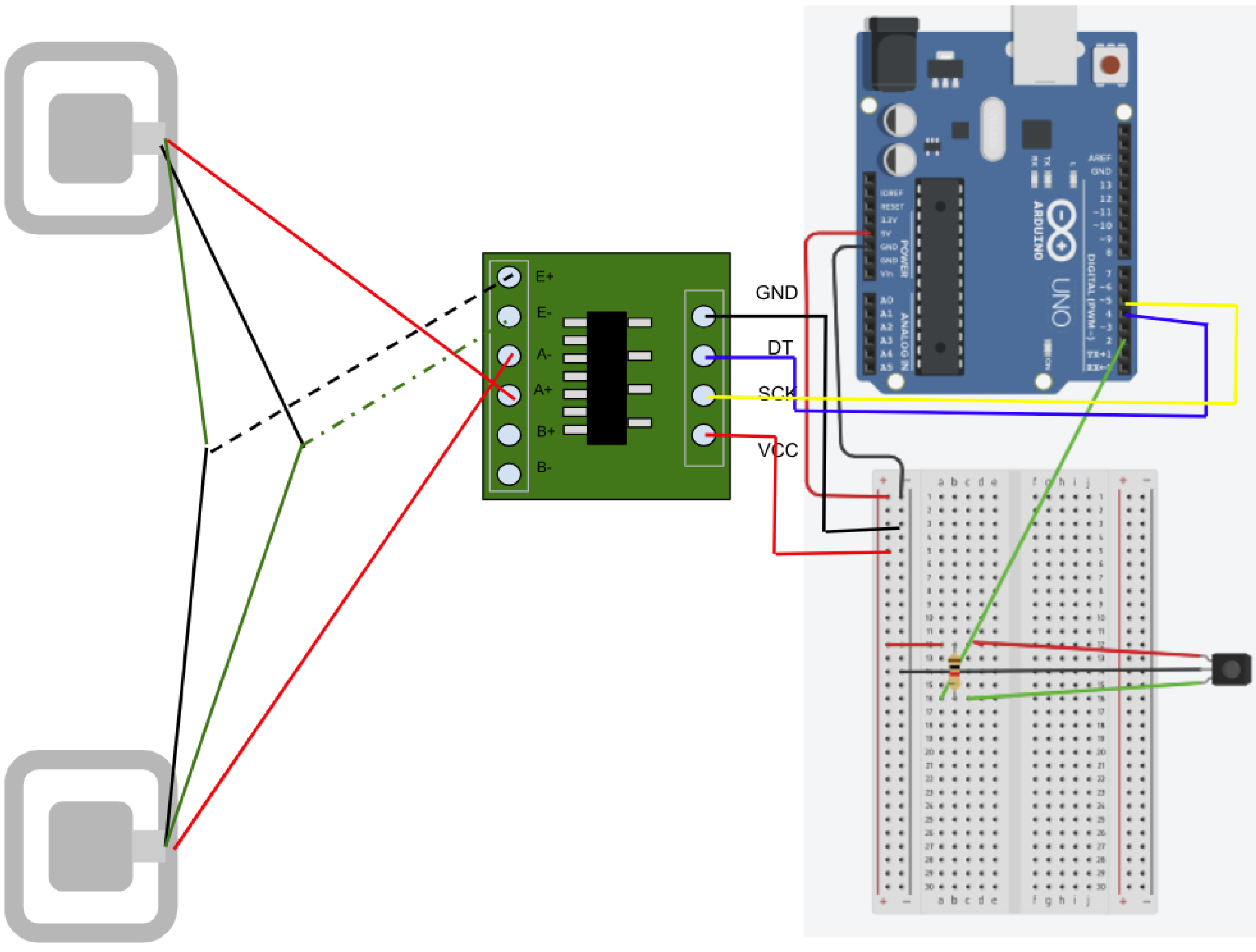
Title: Full Circuit Diagram

Date: 12/2/2023

Content by: Joseph Koch

Goals: Show the complete circuit system of the smart walker

Content:



Conclusions/action items:

Add to poster and calibrate sensors

Hall Effect Sensor - 10/05/2023

Amara Monson - Dec 15, 2023, 7:27 PM CST

Title: Hall Effect Sensor

Date: 10/05/2023

Content by: Amara

Goals: Understand hall effect sensors for possible use in speed/distance design

Content:

A hall effect sensor is a sensor that produces a voltage when in proximity to a magnetic field and does not when it is not in proximity to a magnetic field. There are wide ranges of accuracy and sensitivity, with some hall effect sensors able to detect very small magnetic fields. This could be useful in our case, as it would allow us to use low-cost magnets. Some sensors can tell where the magnet is within the range of the sensor, but most only say generally if the magnet is within the range of the sensor. This design should be able to use the general hall effect sensors, if we can determine the boundaries of the range of the sensor to determine magnet position.

"Introduction to Hall-Effect Sensors", *Texas Instruments*, May 2023. https://www.ti.com/lit/ml/slyt824a/slyt824a.pdf?ts=1702689797478&ref_url=https%253A%252F%252Fwww.google.com%252F.

Conclusions/action items:

- Look into additional resources provided in this source

- look into specific hall sensors and their specifications

Incremental Rotary Encoders - 10/07/2023

Amara Monson - Dec 15, 2023, 7:29 PI

Title: Incremental Rotary Encoders

Date: 10/07/2023

Content by: Amara

Goals: Understand incremental rotary encoders to evaluate feasibility for the magnetic sensor design

Content:

The method of incremental rotary encoding I am focusing on is magnetic, as this is relevant to the design. This method uses a two hall effect sensor and a magnetic loop with multiple poles. Tl hall effect sensors are placed (n+1/2) poles away from each other so that the aspect of the magnetic field they each sense is 90deg out of phase with other and thus the whole B-field vector ca measured. This can then be used to determine the speed and direction of the magnetic loop as it is rotating.

"Incremental Rotary Encoders", *Texas Instruments*, Dec. 2021. https://www.ti.com/lit/an/sboa200b/sboa200b.pdf?ts=1702668951855&ref_url=https%253A%252F%252Fwww.google.com%252F#:~:text=Incremental%20rotary%20encoders%20translate%20rotational,direction%20of%20the%20rotating%2C

Conclusions/action items:

This method of using a magnetic sensor to measure the speed of the wheels is more complicated than is needed for the scope of the project. Proximity detection should suffice for the magneti sensor design.

Arduino Connections - 11/27/2023

Amara Monson - Dec 15, 2023, 7:41 PM CST

Title: Arduino Connections

Date: 11/27/2023

Content by: Amara

Present: n/a

Goals: Figure out how to connect the Arduino to Google Firebase

Content:

https://github.com/StorageB/Google-Sheets-Logging/tree/master

Storage B. "Log Data from an ESP8266 to Google Sheets". *GitHub. Nov. 2023. https://github.com/StorageB/Google-Sheets-Logging/tree/master.*

https://github.com/adesolasamuel/ESP8266-NodeMCU-to-Google-Firebase

Adesolsamuel. "ESP8266 NodeMCU to Google Firebase". *GitHub. Apr. 2022. https://github.com/adesolasamuel/ESP8266-NodeMCU-to-Google-Firebase.*

https://docs.arduino.cc/tutorials/mkr-wifi-1010/connecting-to-wifi-network

K. Soderby, "Connecting MKR WiFi 1010 to a Wi-Fi Network", *Arduino*, https://docs.arduino.cc/tutorials/mkr-wifi-1010/connecting-to-wifi-network.

None of the three websites are exactly what we need, but they could be helpful in figuring it out. One of them is about connecting to Google Firebase but from the ESP8266 Wifi module instead of the Wifi Arduino we have, but maybe it could be adapted to our uses.

Conclusions/action items:

- connect Arduino to Wifi and Google Firebase to send data from walker

Magnetic Sensor - 9/23/2023

Amara Monson - Dec 15, 2023, 7:42 PM CST

Title: Magnetic Sensor

Date: 9/23/2023

Content by: Amara

Present: n/a

Goals: Measure distance and speed

Content:

The idea of the magnetic sensor is to place small magnets on each the spokes of the wheels of the walker, and then have a sensor that could pick up when a magnet passes. The magnets would be at know distances, so we can use that to find distance and find speed using the known distance and the time between when each magnet passes the sensor.

Perhaps a hall effect sensor.

Conclusions/action items:

- compare with other designs

- find possible magnets and sensors

Speed/Distance Design Drawings - 10/05/2023

Amara Monson - Dec 15, 2023, 7:46 PM CST

Title: Speed/Distance Design Drawings

Date: 10/05/2023

Content by: Amara

Present: n/a

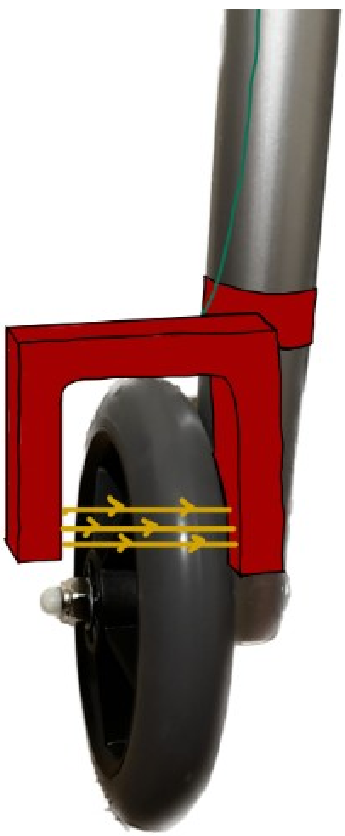
Goals: Present design ideas visually

Content:

1. Magnetic sensor - Amara

2. Distance sensor - Nikhil

3. Photosensor - Lance



Conclusions/action items:

We determined that we would be moving forward with the hall effect sensor. These images should be put into the report and design matrix.

Hall Effect Sensor Circuit - 10/15/2023

Amara Monson - Nov 16, 2023, 10:47 PM CST

Title: Proposed Hall Effect Sensor Circuit

Date: 10/15/2023

Content by: Amara

Present: n/a

Goals: Find a circuit to use with the hall effect sensor

Content:

https://maker.pro/arduino/tutorial/how-to-use-a-hall-effect-sensor-with-arduino

The simple circuit shown in this article, consisting of the hall effect sensor, a 10k resistor, and input, output, and ground attachments seems to be a sufficient circuit to start with for this project. Preliminary testing of the circuit has produced satisfactory magnet sensing results. After the hall effect sensor and magnets have been attached to the walker, testing will show if any changes need to the sensitivity to account for the speed of the wheels.

Conclusions/action items:

* attach hall effect sensor, magnets, and circuit to the walker

* test attachments

Magnet Clips - 11/16/2023

Amara Monson - Nov 16, 2023, 11:03 PM CST

Title: Magnet Clips

Date: 11/16/2023

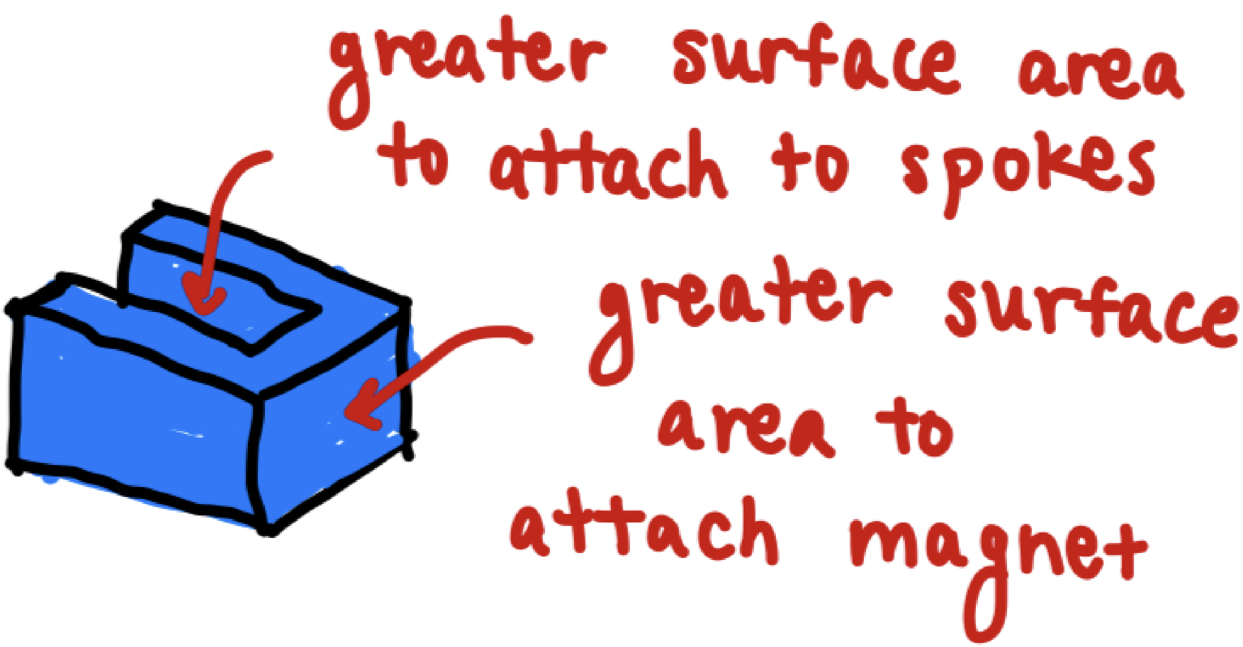
Content by: Amara

Present: n/a

Goals: Securely attach magnets to wheel

Content:

The issue with attaching the magnets directly to the spokes of the wheel is that the outward facing edge of the spoke is very thin, and the attachment would be precarious. Instead of this, I propose gluing the magnet to the face of a clip, which then has legs on either side of the spoke. This would both increase the surface area for gluing the magnet to the face of the clip, and the surface area for gluing the clip to the spoke.



Conclusions/action items:

* propose design

* create CAD model

* 3D print clips

Design Recommendations - 09/06/23

BALJINDER SINGH - Dec 15, 2023, 7:42 PM CST

Title: Design Recommendations

Date: 09/06/23

Content by: Baljinder

Present: Baljinder

Goals: Understand what the best conditions are for a walker, and how one should optimize their usage.

Content:

Walkers come in many sizes and varieties. There are many different ranges of walkers depending on age of the patient. The 3 biggest factors are width, handle height, and weight limit.

Width :

- Walkers vary in width, from narrow to standard to heavy-duty, affecting maneuverability in confined spaces.
- Most home doors are 22" wide. Most doors are between 22-24 inches wide

Weight Limit

- Most heavy duty walkers and support up to 225kg, while standard ones can support up to 135kg
- The higher the weight capacity, the heavier the device. This needs to be taken in consideration when looking at someones medical condition

Handle Height

- The height needs to be adjustable. Typically between 29-39 inches.
- When grabbing handles, angle of elbow should be around 15 to 20 degrees

Conclusions/action items:

Before purchasing, determine your height and weight, choose a walker with an appropriate weight capacity, and opt for a handle height that can be adjusted within a comfortable range. A proper fit is essential to avoid discomfort, aches, and poor posture.

Different Rehabilitation Centers - 09/06/23

BALJINDER SINGH - Dec 16, 2023, 5:34 PM CST

Title: Different Rehabilitation Centers

Date: 09/06/23

Content by: Baljinder

Present: Baljinder

Goals: Identify the different types of rehabilitation centers, and their purposes. Also identify which center is best for the walker we are planning on creating.

Content:

Acute Care Rehab Setting:

- Intensive care for severe trauma patients.
- Addresses extreme physical trauma, strokes, amputation, or debilitating diseases.
- Therapists work with patients at least three hours a day, up to five days a week.
- Focuses on making significant improvements within a reasonable timeframe.

Subacute Care Rehab Setting:

- Less intense than acute care, with shorter sessions over a longer period.
- Patients see an attending physician about once a month.
- A middle-ground between acute rehab and home health care.
- Ideal for those who completed acute rehab or need a less intense setting.

Long-term Acute Care Rehab Setting:

- For patients requiring long-term hospitalization.
- Addresses unique medical needs, often an intensification of existing conditions.
- Intensive like acute rehab but with a longer stay in the healthcare facility.

Home Health Care Rehab Setting:

- Therapists provide services at the patient's home.
- Includes assistance with implementing changes for a more comfortable recovery.
- More affordable than inpatient care and suitable for recovery at home.

Inpatient Care Rehab Setting:

- Patients receive care during or after a hospital stay.
- Extended stay with more one-on-one sessions and 24/7 access to medical assistance.
- Typically for severe injuries requiring intensive rehabilitation.

Outpatient Care Rehab Setting:

- Patients are not admitted to the hospital.
- Allows patients to return home while continuing rehabilitation.
- Suitable for less severe injuries that still require therapy.

School-Based Rehab Setting:

- Enables students with disabilities or trauma to continue education with minimal disruption.
- Implements physical and occupational therapy practices in and around the classroom.
- Prepares children with impairments for college and career settings.

Skilled Nursing Facility Rehab Setting:

- A hospital branch providing around-the-clock medical assistance and various therapists.
- Similar to a nursing home but discharges patients upon moderate improvement.

Conclusions/action items:

Each setting caters to specific needs and conditions of patients on the path to recovery. The diverse options, from the intensity of acute care to the flexibility of home health care and the specialized focus of school-based rehabilitation, offer professionals a range of environments to make a positive impact. In our case, any of these settings would be perfect for our walker. They are all in clinical settings in which the SMART Walker will thrive in.

The Use of Walkers Notes - 11-25-23

BALJINDER SINGH - Dec 11, 2023, 10:03 PM CST

Title: Notes on Walkers

Date: 11-25-23

Content by: Baljinder

Present: Baljinder

Goals: Learn more about how dependent people are on walkers, and how long they are required to use transitional devices.

Content:

- People use walkers for reasons other than Neurological conditions or injuries
- Reasons include getting tired easily and suffering from poor balance.
- Many people want to be independent and therefore want the walker's help instead of a family member's.
    - Easier to get around and increases confidence.
    - A cane is usually not enough support for a person.
        - People want to get away from walkers, so they aren't referred to as "old"
        - Patients are in therapy based on many reasons
- Type and severity of conditions, stage of rehabilitation, specific goals of therapy, individual progress, and patient confidence are all factors to how fast people get off of transitional devices, and how dependent they are on their devices.

Conclusions/action items:

In summary, the use of walkers is influenced by a variety of factors, and individuals often choose them for reasons beyond medical conditions. The goal of physical therapy is to address these factors, gradually promoting independence and improving overall mobility and confidence.

2 Wheel Walker vs 4 Wheel Walker - 10/02/23

BALJINDER SINGH - Dec 12, 2023, 11:56 PM CST

Title: 2 Wheel Walker vs 4 Wheel Walker

Date: 10/02/23

Content by: Baljinder

Present: Baljinder

Goals: Compare a 2 wheel walker with a 4 wheel walker, and understand the differences

Content:

Stability:

Standard Walker: Provides the most stability as it has four rubber-tipped legs, but it requires lifting to move.

Two-Wheel Walker: Offers good stability with the assistance of two wheels, suitable for those who need weight-bearing support.

Four-Wheel Walker: Less stable than a standard walker but provides continuous balance support.

Three-Wheel Walker: Offers continuous balance support but is lighter and may be less stable than a four-wheel walker.

Knee Walker: Provides stability by supporting the injured leg on a knee platform and allows movement with the non-injured leg.

Maneuverability:

Standard Walker: Limited maneuverability due to the need to lift the walker.

Two-Wheel Walker: More maneuverable than a standard walker, especially in terms of turning and navigating.

Four-Wheel Walker: Offers greater maneuverability with four wheels, but may still be bulkier than others.

Three-Wheel Walker: Easier to move and navigate, especially in tight spaces.

Knee Walker: Generally more maneuverable than traditional walkers, particularly in indoor settings.

Weight-Bearing Assistance:

Standard Walker: Provides support but requires more effort for lifting and moving.

Two-Wheel Walker: Assists with weight-bearing, making it easier for users to stand fully upright.

Four-Wheel Walker: Provides continuous balance support, making it suitable for those unsteady on their feet.

Three-Wheel Walker: Offers continuous balance support, but lighter and easier to move.

Knee Walker: Relieves weight from the injured leg and provides an alternative means of mobility.

Posture Improvement:

Standard Walker: May not directly improve posture.

Two-Wheel Walker: Can help improve posture by allowing users to stand more upright.

Four-Wheel Walker: May or may not contribute to improved posture, depending on the model.

Three-Wheel Walker: Similar to the four-wheel walker, it may help maintain better posture.

Knee Walker: Generally promotes an upright posture while resting the injured leg.

Versatility:

Standard Walker: Less versatile due to the need for lifting.

Two-Wheel Walker: Versatile, suitable for various situations and terrains.

Four-Wheel Walker: Versatile with options for seats, but may be less suitable for uneven terrain.

Three-Wheel Walker: More versatile than a standard walker, especially in tight spaces.

Knee Walker: Versatile for indoor use and short-term mobility challenges.

Use Cases:

Standard Walker: Ideal for those who need maximum stability but can lift the walker.

Two-Wheel Walker: Suited for individuals who need weight-bearing support and improved posture.

Four-Wheel Walker: Helpful for those with balance issues and the option for seated rest.

Three-Wheel Walker: Ideal for those who prioritize maneuverability in tight spaces.

Knee Walker: Used for a short time when walking is difficult due to ankle or foot problems.

Conclusions/action items:

Ultimately, the choice of walker depends on an individual's specific needs, mobility challenges, and preferences, and a healthcare professional should be consulted to make the most appropriate recommendation.

Camino Smart Walker - 10/02/23

BALJINDER SINGH - Dec 12, 2023, 10:41 PM CST

Title: Camino Smart Walker

Date: 10/02/23

Content by: Baljinder Singh

Present: Baljinder Singh

Goals: Compare the Camino Smart Walker to our SMART Walker.

Content:

What is the Smart Walker: World's First Smart Walker.

5 hour usage per charge
Takes 1 hour to charge
It uses AI technology track how you walk with 22 different gait metrics.
Auto boost, auto brake
Fully electric
Advantages:

Fully Electric
Auto brake and boost
Easy to use
Disadvantages:

Expensive
Cannot measure pressure

Conclusions/action items:

The Camino Smart Walker is a luxury item. It it not for the average man. It also does not measure pressure, which is really bad since the client wants that as one of the statistics

Ambutrak Distance Tracker - 10/02/23

BALJINDER SINGH - Dec 12, 2023, 10:51 PM CST

Title: Ambutrak Distance Tracker

Date: 10-02-23

Content by: Baljinder

Present: Baljinder

Goals: Compare the Ambutrak Distance Tracker to our SMART Walker

Content:

What is the Ambutrak Distance Tracker: An attachment put on a walker that records distance and speed.

Advantages:

Super easy to use.
Simple attachment
Records sped and distance efficiently
Disadvantages:

Does not measure pressure.
Does not upload information to a server.

Conclusions/action items:

Cheap but very old style. Does not suit the clinical setting. Also does not measure pressure, which the client asked for.

Dial Potentiometer Design for Speed

BALJINDER SINGH - Oct 13, 2023, 10:09 PM CDT

Title: Brainstormed Design - Dial Potentiometer

Date: 09-27-23

Content by: Baljinder Singh

Present:

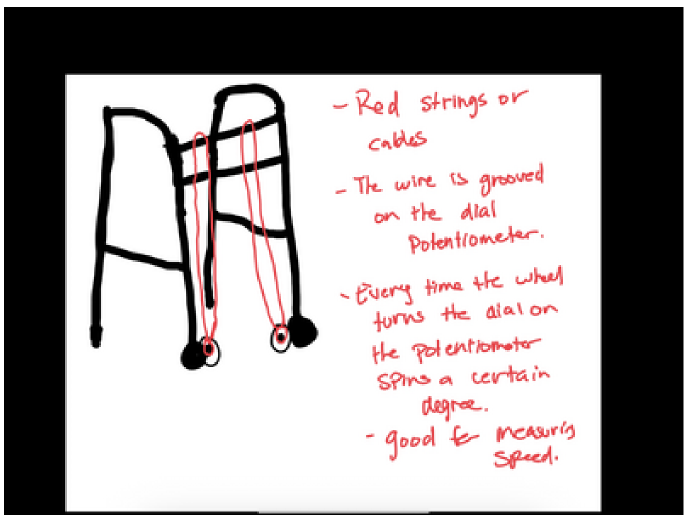
Goals:

Content:

This is a design I created when brainstorming. It uses dial potentiometers on the wheel with wires connected to the frame of the walker. As the dial spins, the wire coils up on the potentiometer. Depending on how many degrees the dial turned, speed can be measured.

Conclusions/action items:

BALJINDER SINGH - Oct 13, 2023, 10:07 PM CDT



Download

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Background Research - 10/13/2023

Lance Johnson - Dec 11, 2023, 4:34 PM CST

Title: Background Research

Date: 10/13/2023

Content by: Lance

Present: N/A

Goals: Complete research in areas surrounding patient-related concerns of walker use

Content:

Because the device will undergo continuous utilization by patients within the clinic, necessitating sanitation precautions to ensure an easily sanitizable/sterilizable product between each patient use. Moreover, given the device's multiple-user nature and its recording and storage of sensitive data, either on the device or an external database, it is crucial to uphold patient confidentiality in compliance with HIPAA regulations. The HIPAA Privacy Rule sets forth nationwide standards to safeguard individuals' medical records and identifiable health information [11]. Finally, as the device will be employed by various patients, prioritizing its robustness and safety is essential to safeguard patient health. Stringent criteria, including specifications for weight, size, and materials, were previously chosen to maintain the walker's integrity and, consequently, ensure patient safety. Any additional concerns related to liability should be addressed with the client.

- HIPAA privacy regulations:

(OCR), Office for Civil Rights. “Privacy.” HHS.Gov, 31 Mar. 2022, www.hhs.gov/hipaa/for-professionals/privacy/index.html#:~:text=The%20HIPAA%20Privacy%20Rule%20establishes,care%20providers%20that%20conduct%20certain.

Conclusions/Action Items: The sections of the PDS have been completed, showing the size and weight concerns, and the patient-related concerns surrounding the fabrication of our design. We will need to consider these criteria when beginning brainstorming of ideas and fabrication of the design.

Preliminary Design Ideas - 9/28/23

Lance Johnson - Oct 27, 2023, 1:22 PM CDT

Title: Preliminary Design Ideas - (9/28/23)

Date: 9/28

Content by: Lance

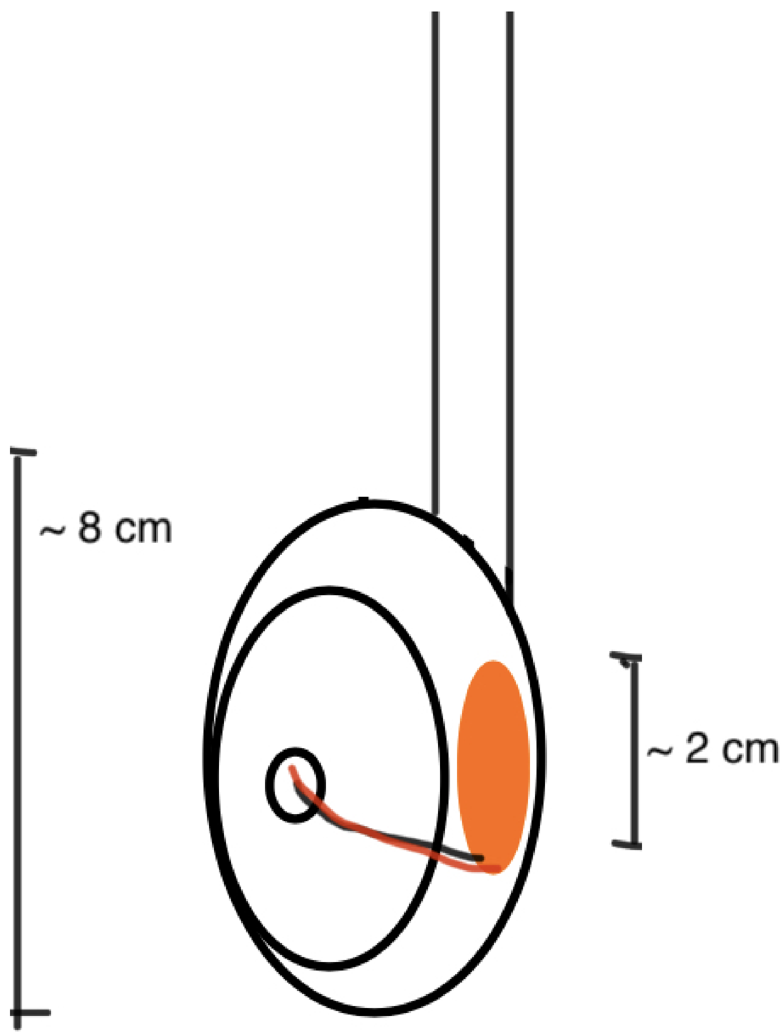
Present: N/A

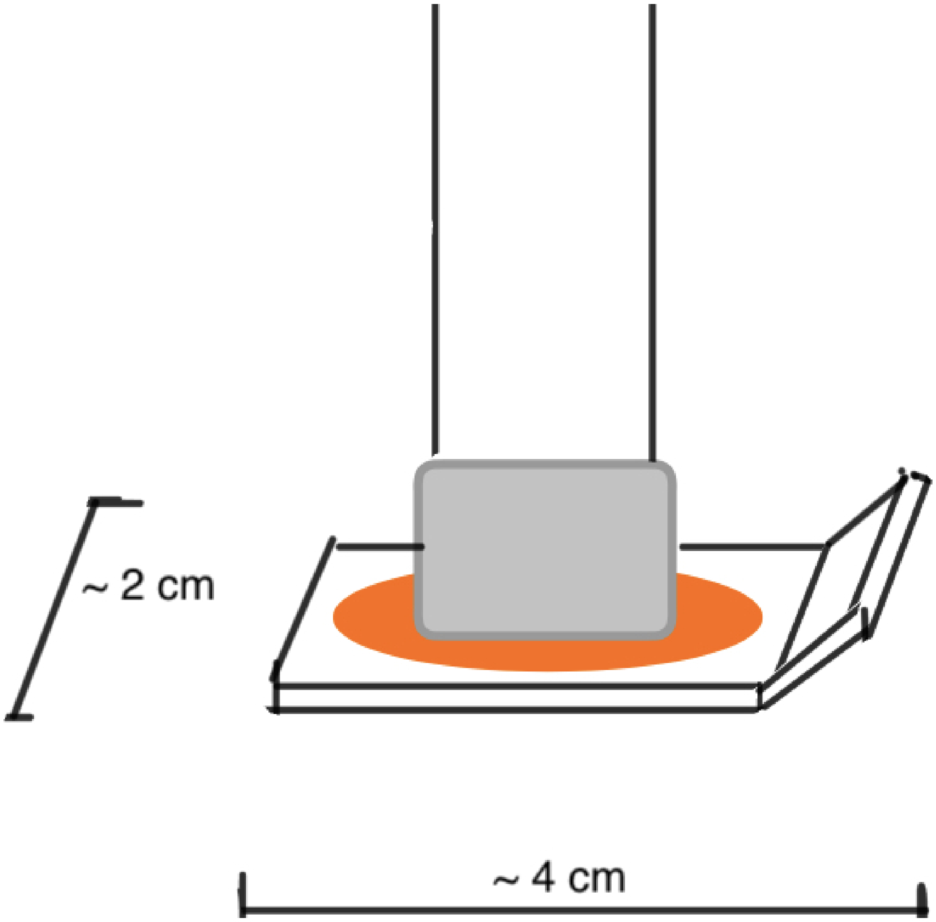
Goals: To determine and brainstorm some reasonable design ideas, then draw the final design ideas

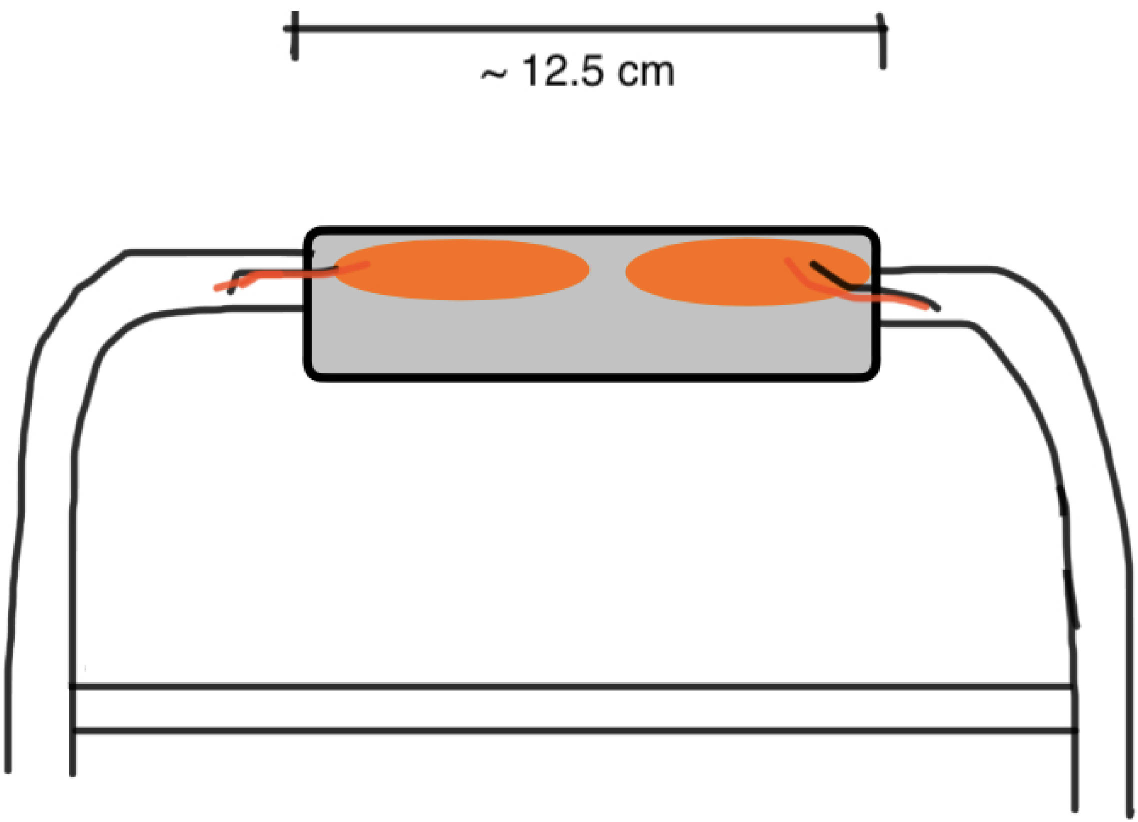
Content:

- use a photogate sensor for gait speed
- compression force sensor, hyrdraulics?, pneumatics?

Initial Design Drawings




~ 2 cm
~ 4 cm


~ 12.5 cm

Conclusions/action items: The designs look good and seem to be reasonable and functional for the sensors the team has chosen.

Pressure Sensor Circuit Design - 10/27

Lance Johnson - Nov 01, 2023, 11:50 PM CDT

Title: Pressure Sensor Circuit Design

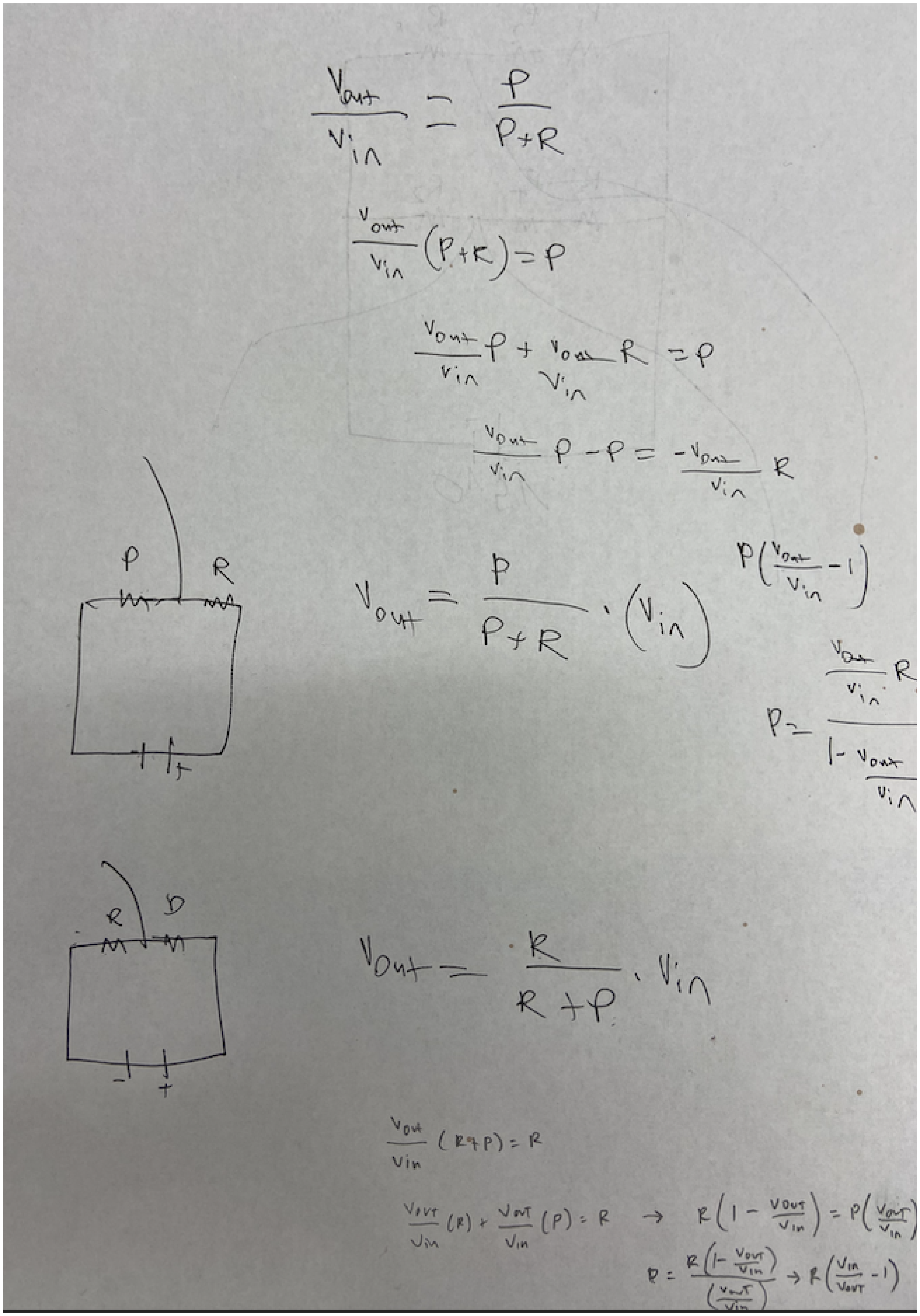
Date: 10/26/23

Content by: Lance

Present: N/A

Goals: To design a preliminary circuit for the force sensor and derive an equation for the force sensor resistance

Content:



Conclusions/action items: The formula for the voltage divider circuit shows how voltage should be divided amongst the resistor and the force sensing resistor and provides a formula for finding the resistance of the force sensing resistor given the other inputs, which can be used by the Arduino to compute the applied pressure on the device handles.

Strain Gauge Research - 11/1/23

Lance Johnson - Dec 11, 2023, 4:36 PM CST

Title: Strain Gauge Research & Integration

Date: 11/1/23

Content by: Lance

Present: N/A

Goals: to further understand strain gauges and how they can be integrated into the walker to better measure pressure.

Content:

A strain gauge is a device used to measure the strain that occurs in an object or material when it is subjected to force, also known as stress. It operates on the principle that the electrical resistance of certain materials changes when they undergo mechanical strain. When the material deforms, the electrical resistance of the strain gauge changes proportionally. The type of strain gauge that we would use in our project would be a metal thin, flexible device made from a wire, foil, or semiconductor material, configured in a zigzag or spiral pattern. When this device is bonded or attached to an object, typically a metal beam, as the object experiences stress or strain, the strain gauge deforms along with it, causing a change in its electrical resistance. This change in resistance is then measured using a Wheatstone bridge circuit, which is a method to calculate the precise amount of strain applied to the material. This measurement can be used to determine factors such as force, pressure, weight, or stress on the object to which the strain gauge is attached.

These kinds of strain gauges are commonly used in digital scales, which gives hope for our use of the components in a similar situation where relatively inexpensive circuitry and sensors can be used to accurately measure the force being placed through a certain point, in this case, the foot of the walker.

- Engineering, O. (2023, May 27). *Strain gauges*. https://www.omega.com/en-us/. https://www.omega.com/en-us/resources/strain-gages#:~:text=A%20Strain%20gauge%20is%20a,and%20strain%20are%20the%20result.

Conclusions/action items:

Wheatstone bridge circuits will need to be further researched to understand the strain gauges, but the use of a strain gauge rather than a force sensing resistor seems promising for the success of the project.

Walker Foot Model - 11/27/23

Lance Johnson - Nov 27, 2023, 11:57 PM CST

Title: Walker Foot Model

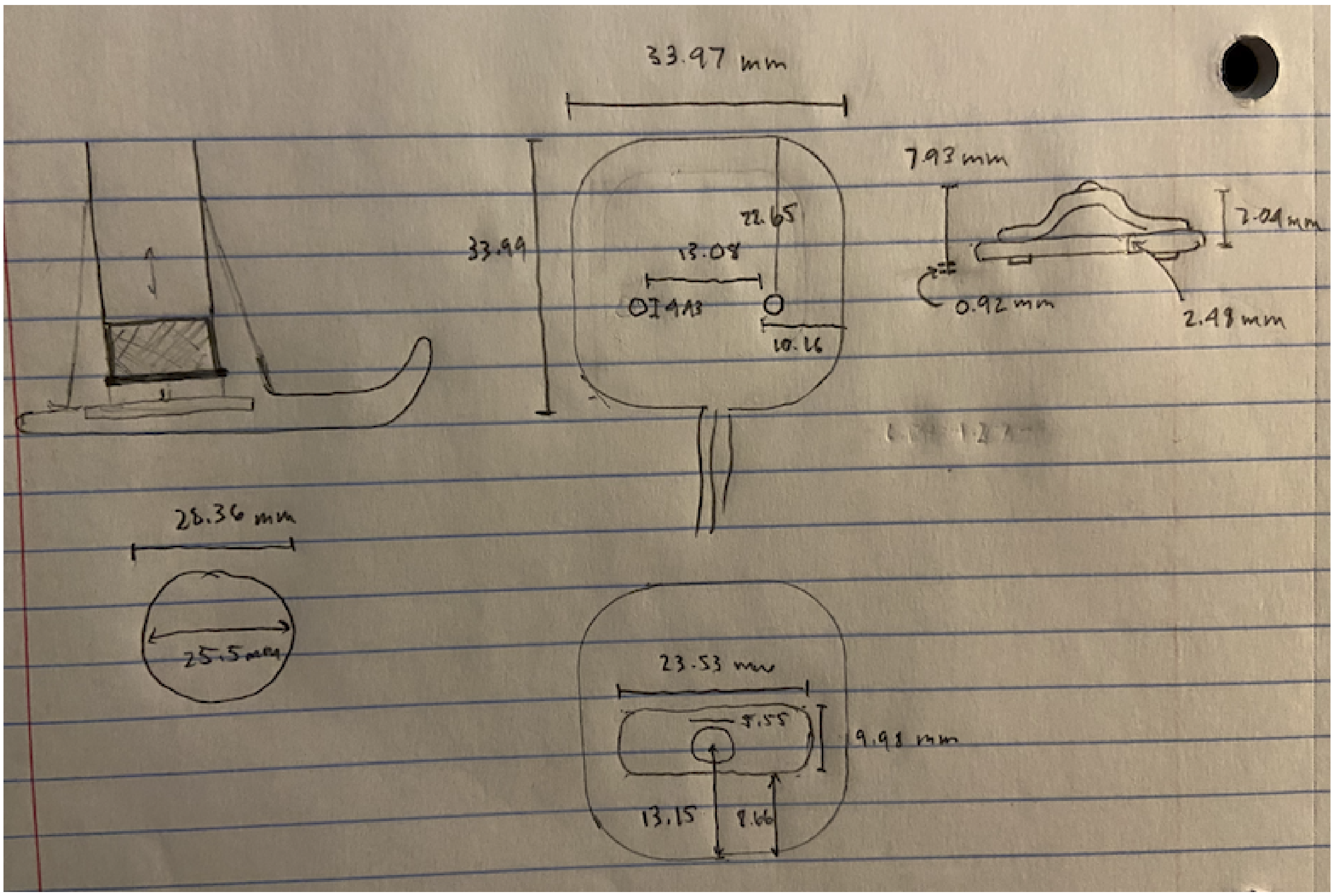
Date: 11/27/23

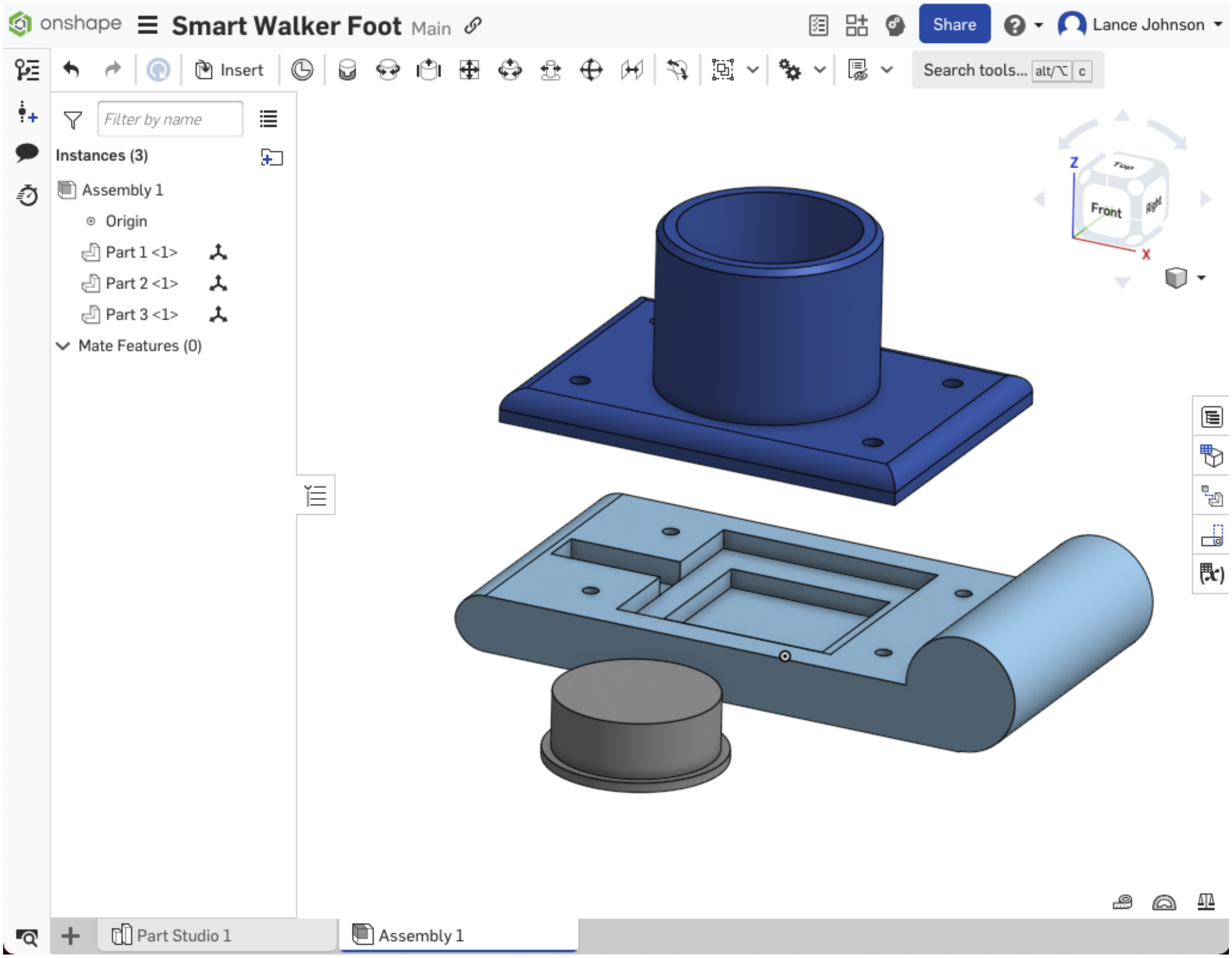
Content by: Lance

Present: N/A

Goals: To model an initial prototype for the new walker foot that can properly hold the load cell.

Content:





Conclusions/action items: The goal is to print the prototype as soon as possible to allow for early testing. When printing, it will be important to use durable PLA material with maximal infill to achieve a rugged bottom layer that will be in contact with the ground. Future iterations may be required to get a satisfactory friction between the walker leg and the cuff.

Walker Foot V.2 - 12/6/23

Lance Johnson - Dec 12, 2023, 10:30 PM CST

Title: Walker Foot V.2

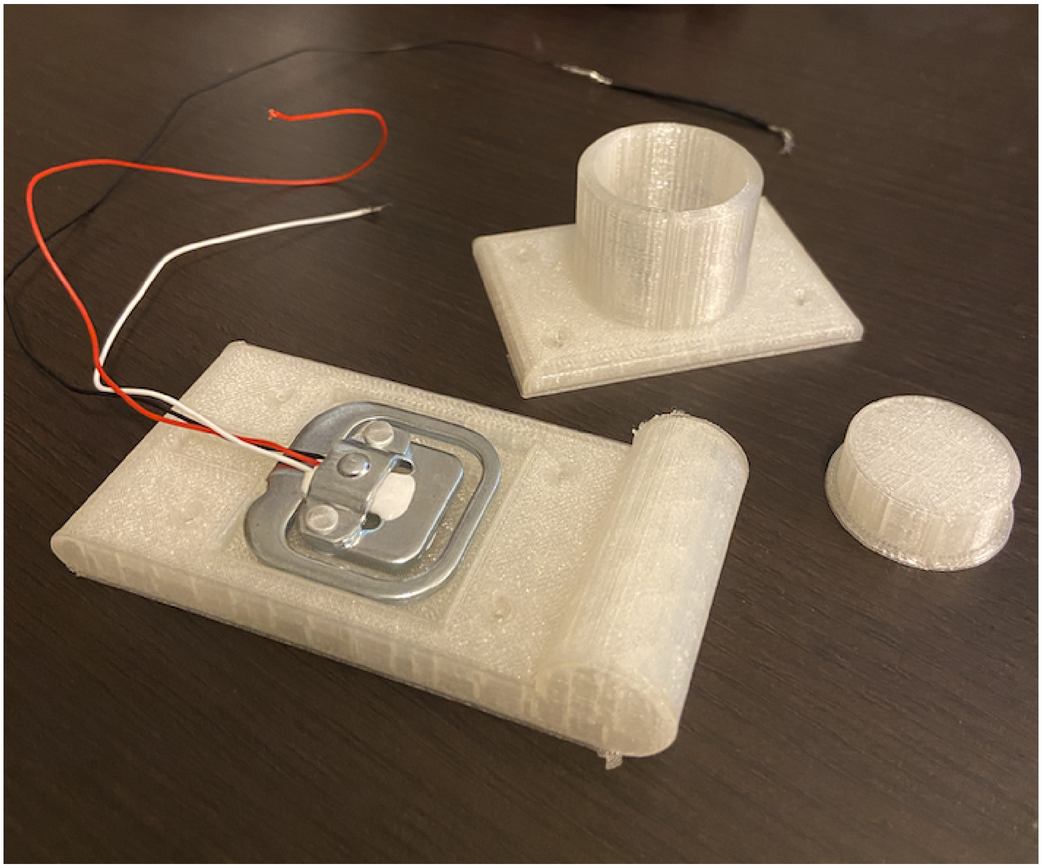
Date: 12/6/23

Content by: Lance

Present: N/A

Goals: To examine the first walker foot prototype and make necessary adjustments before printing the second prototype.

Content:



The first prototype of the walker foot assembly was printed successfully, but the dimensions weren't exactly perfect in the first iteration. Despite some sanding on the inside of the cuff piece, the cuff remained too small to accept the walker leg with appropriate friction, so I increased the diameter of the cuff from 28.3 mm to 28.6mm. Likewise, the end cap for the pipe was too small to fit into the end of the walker leg, so the radius was decreased. Lastly, the recess for the load cell was a little too shallow as well as being a little bit too wide, so the dimensions were adjusted in the Onshape model.

Conclusions/action items: The goal is to print the second prototype as soon as possible to allow for early testing. This time, I will increase the infill which will increase the print time, but will yield a more robust piece that will hopefully provide a better function as the final foot model.

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

Lance Johnson - Dec 10, 2023, 10:55 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: