Preliminary Design Report

Alert Device for Walker (WARNS)

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Abstract

Older adults want to remain independent. Annually, 47,000 older adults are injured from falls related to walkers and canes [1].Those who use a walker device often feel confined or don't want to admit when it isn't as easy anymore and possibly lose independence. Current walker designs on the market are extremely outdated and do not consist of anything more than a storage compartment, metal frame, and wheels to some extent. These devices are not designed for safety or comfort. The lock systems on these walkers are typically a squeeze activated brake system similar to that of a bike, which can prove to be easy to forget and difficult for patients who suffer from arthritis. Current devices on the market look to improve the lock system through pressure based designs, however a major problem is these can become difficult to make successfully when the walker is on inclined or uneven planes that may hinder the pressure a person can apply to the walker [2]. Designing a more effective lock activation and an alert system to notify users when the device isn't locked can help increase the safety of use with walkers and decrease the number of falls that older patients are susceptible to. The device will involve an improved locking system and a low pitch frequency emitted attached onto the device. The walker should be able to be used in all settings and not hinder the movement of the patient. Testing for the improved safety system will involve use of a focus group provided by the client and data extraction and analysis of the microcontroller storage to assess the performance of the walker.

Table of Contents

I. Introduction

Walkers are a common type of walking aid used by the elderly and people who suffered injuries that inhibit their ability to walk. These walking aids can greatly increase mobility and independence. Although they have systems in place to maintain the safety of users they can fail due to various reasons. The main reason these systems fail is due to impaired cognition from the user [3]. Specifically, a common issue is users forgetting to lock the brakes on their walker. Along with this, walks can be heavy and cumbersome making walkers difficult to use. These factors make traditional walkers a safety issue for certain groups of people.

This project addresses this issue by designing a walker that is more user friendly and has a safer braking system. To address these issues the walker created will have better mechanisms to trigger the braking system that does not require a level of dexterity and hand strength to activate. Additionally, the design will include reminders for users to activate the safety mechanism. Together these improvements aim to improve the quality of life of people who use the walker.

Existing designs are currently on the market that tackle the issue of safety and usability. One specific product that offers similar functionality is a walker with electronically controlled brakes, Patent No. CA2605609C. [4] This design incorporates one or more electronically operated brakes controlled by a touch sensor. The controller is responsive to touch sensitive switches for easy operation, and is adjustable and responsive to the operator patterns. The controller may be used on sloped terrain and may be adjusted to accommodate for the weight of the user to to set limits to the speed at which it can move. This walker, although exceptional in some ways, still has limitations. The goal in this project is to create a walker that further minimize these limitations.

II. Background

The client Dr. Beth Martin comes from the Pharmacy Practice and Translational Research Division at the University of Wisconsin- Madison. She has a clinical practice at Oakwood Village, a senior living facility.

Some of the main design considerations include the ability to lock wheels to prevent falls and maintain safety, an alert system to remind the user to lock the brakes when needed, and be easy to use for older adults and caregivers. The design must allow for accessories such as a seat, basket, handles, wheels, and locks for the brakes. The design must follow FDA/ADA guidelines for an assistive device. The design must also fall within the budget given by the client of $300 to $500. To see the full product design specifications, see Appendix A: PDS.

After reviewing the design requirements, background information is necessary in order to execute the design properly. The first section of background research completed was regarding walkers and their users. Walker users often correlate to a lower wellbeing. Most walker users face independence and mobility issues which leads to less inclination to use the safety aspects of a walker [5].

The majority of injuries caused by walkers are falls. Falls happen because of incorrect sized walkers, poor training or direction for using the walker, and not engaging the safety aspects completely. There are a variety of walkers used by older adults. Of the walkers available, one is chosen based on the user's physical mobility. The design will be applicable to a four wheeled walker with grip brakes. The brakes on a four wheeled walker are used by engaging the grip to lock them into place. The brakes are independent of each other, meaning they do not stop at the same time [6]. When creating designs, the independence of the brakes will be taken into consideration.

Looking into competing designs is required to create a well rounded design. A major competing design idea is a self-locking walker concept [7]. The concept requires hand sensors that are engaged when a certain amount of pressure is applied. The brakes then trigger to lock into place.

The brake system is to prevent unwanted movement on a sloped surface and unwanted movement of the walker. Another competing design was developed by Cornell biomedical researchers [8]. The design developed was an electronic braking system. The walker in the design would start in the braked setting. A button is pressed by the user to release the brakes for movement. Once the user removes their hands from the hand grips, the brakes engage again. Both ideas discovered have similar aspects to the design ideas, but differ in many ways.

For each preliminary design, research on materials has been conducted on each. The first being button brakes. For button brakes, an adafruit fingerprint sensor would be used to trigger the fingerprint button. The adafruit sensor would work with an arduino microcontroller [9]. The two would allow for tapping to lock and unlock the brakes. The second design is a noise alert for the brakes. For the noise alert system, an arduino touch sensor component and digikey speaker component would be used for execution of the design [10]. The third design is pressure sensing brakes. For pressure sensing brakes, a digikey pressure sensor along with an Arduino UNO. Across all three ideas, Arduino components are essential to the execution of the project.

III. Preliminary Designs

Design 1: Button Brakes

Design one is a button braking system that utilizes a fingerprint for the locking mechanism. The design consists of two major components; the Adafruit Fingerprint sensor and the Arduino Uno Rev 3, along with smaller components such as wires, resistors, capacitors and a breadboard.

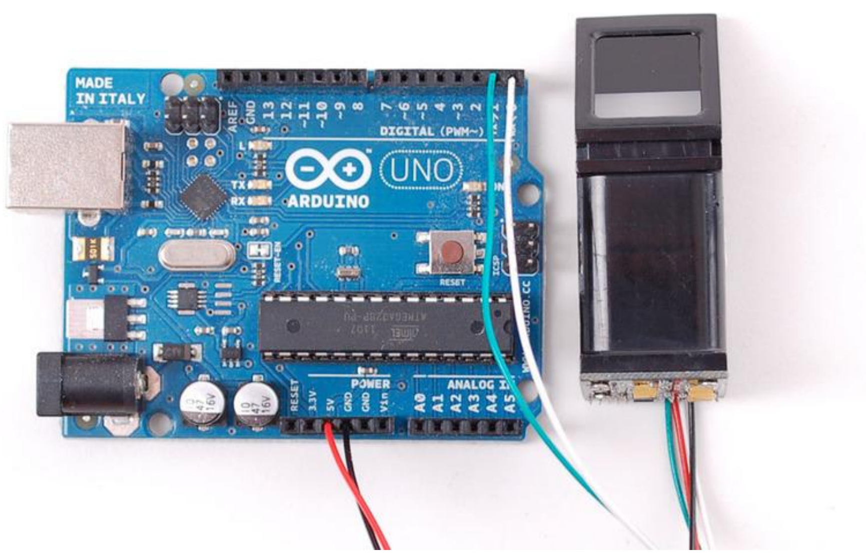


Figure 1: Arduino Uno and Adafruit sensor[11]

The design will rest on the handles of a walker as and manually control the brakes upon the pressing of the sensor. The Adafruit sensor is a 6 pin sensor that can use basic Arduino sketches to register the differences in fingerprints. The sensor can handle between 3.6-6 V battery source and a 0.15 A current. These characteristics helped determine that the Arduino microcontroller would be a suitable device to pair with the sensor due to its similar power and digital pins. The button will work similar to that of a light switch where each time it is touched will change it from off to on or vice versa.

There are several benefits to this design consideration, the first being that the integration of a fingerprint sensor to a walker is not a feature of walkers currently and add a sense of individualism and uniqueness for the person using it. Users of walkers tend to associate their device with self worth, and so providing them with easy and personalizable technology can vastly improve interaction and use of the device [12]. This design is also feasible due to the team already having all of the materials to build the schematic apart from the adafruit sensor, which can be ordered for around $50. With the teams budget being relatively small at $300-$500, it is important to make sure that there is not overspending on any components of the design and so being able to build the most of the circuit with a fraction of the budget makes several prototyping stages possible.The design is also extremely user-friendly and easy to use. If the device was placed into a hospital setting, it would require no training to integrate and give to patients making it a great option.

There are also several constraints of this device. The button brake system's biggest drawback is the lack of a fail system. The purpose of the project is to create an easier alert system for patients who forget to lock the device. Despite the fact that the button would be much easier to use than squeeze brakes, if the patient forgets to lock the wheels, the walker may move without the patient anticipating and lead to injury. Another constraint is the team's coding ability. Although most of the resources are already purchased before the project, the team does not have a lot of experience coding or using Arduino and so there will be a large amount of time early on in the fabrication process that requires learning and becoming familiar with the technology. A related constraint is also integrating the arduino and lock onto the walker, the team will need to do a significant amount of work to effectively be able to attach the locking system onto the walker to a point where it can be used both inside and outside. All these factors were taken into account when the team began to compare and evaluate the designs against each other.

Design 2: Noise Alert for Brakes

Design two is an alert system using sound. It consists of two main components. The first component is a touch sensor on both of the handles of the walker, and the second component is a sound alarm. The two components are shown below in Figures 2a and 2b respectively.

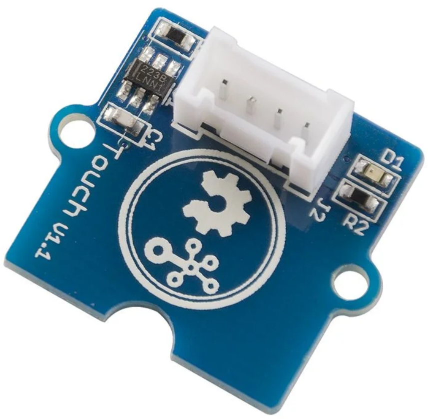


Figure 2a: Arduino Touch Sensor Component [10] Figure 2b: DigiKey Speaker Component [13]

The first component is made by Arduino and the second component is distributed by DigiKey. They are both capable of being integrated using a breadboard such as one from Arduino. Together, they will sense when the brakes are not engaged and the user is not holding on to the handles for a certain amount of time, such as 15 seconds, and then the speaker will emit a low frequency sound repeatedly until the handles are touched again, or the brakes are engaged. This will effectively remind users to engage the brakes when the walker is not in active use, such as when the user is sitting on it, or has left the walker somewhere it could roll away. After the alarm system has been successfully integrated, a light flashing alarm would also ideally be added, so users with hearing impairments could be alerted as well.

This design has many benefits, and some constraints to consider. The first benefit is that it will effectively meet the requirement of reminding the user to lock their brakes when the walker is not in use. The second benefit is that the device would be easy to use because it doesn’t change much from the fundamentals of a walker. Nurses would not have to be specially trained in order to use this device. Another benefit is how cost effective it is. The two components above make up the majority of the device, and just a few other components would have to be bought. All of the design would easily fit into the $300-$500 budget. The last benefit is how this design would create a habit for the user. The sound alert system would keep reminding them every time they forgot to lock the brakes, and over time, hopefully the user would develop the habit of locking it every time so they don't have to hear that alarm go off.

This design also has several constraints to consider. The first is that this design does nothing to change how the brakes themselves work. If there are issues the users have with how easy it is to physically lock the brakes, this design will not improve that. It also does not lock the brakes automatically, which could be seen as desirable by users. Another constraint lies in how to determine what time interval works best for deploying the alarm. If it goes off too soon from when the user lets go of the handles, it could be very frustrating for users who let go of the handles often such as when they are grabbing things. In those situations, the brakes wouldn't need to be used, so an alarm would be unnecessary. If the alarm goes off too late, it could defeat the purpose of the alarm system if it lets the user get injured before the alarm goes off to tell them the brakes were not on. The last constraint to consider is that the sound itself could be annoying to hear a lot when the user is first learning to remember to put on the brakes. The purpose is to create that habit, but if the user gets too frustrated by the sound before they learn, they could give up on the device completely.

Design 3: Pressure Sensing Brakes

Design three utilizes pressure sensors to engage and disengage the brake system on the walker. This design is composed of one pressure sensor embedded into each walker grip. The pressure sensors used in this design are shown in Figure 3a and 3b.

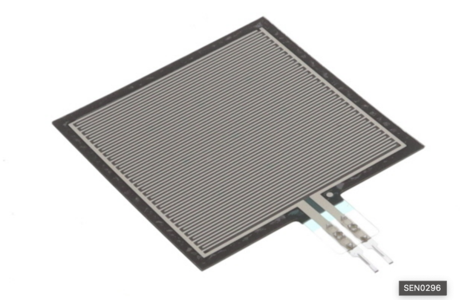


Figure 3a: DigiKey Pressure Sensor [14]

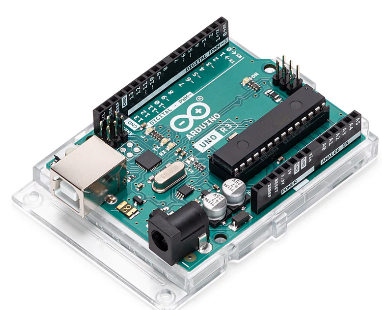


Figure 3b: Arduino UNO [15]

These pressure sensors can be integrated into the walker system by using an arduino microcontroller, shown in Figure 3b. Together, this will enable the pressure sensors to communicate with the walkers brakes. When the pressure sensors are not being triggered, the brakes on the walker remain on. When a user places their hands on the walker grips, the pressure sensors are activated and the brakes are triggered to disengage. This will prevent users from forgetting to engage the brakes when sitting on the walker, or when the walker is not in use.

This design creates a safer and more user friendly walker compared to traditional models. For starters, this design has improved safety features. The default condition for the breaking mechanism on this walker is on. As a result, the brakes are always engaged when the walker is not in use. This removes the necessity for the user to manually engage the brakes when sitting on the walker or when it is out of use. In turn, decreasing the likelihood that users will fall and injure themselves while using the walker. Along with being safer, this design is more ergonomic. Instead of using a lever system that requires a level or hand strength and dexterity to operate, this system functions without any extra actions. The user doesn't have to worry about engaging the brakes or disengaging the brakes. They simply place their hands on the walker grips and begin walking. When the user is finished using the walker, they remove their hands and the walker will remain in place where it is left.

Although this walker offers many benefits, there are also some constraints to consider. Most notably, the coding required to link the arduino, pressure sensor, and locks together would be challenging. Additionally, purchasing the necessary hardware to create this design would be expensive compared to our other designs. Along with the monetary cost of purchasing hardware, the time necessary to integrate the pressure sensors into the walker grips would be very complex and time consuming. Lastly, this design only offers two options for breaking, fully on or fully off. Sometimes it's necessary to apply the brakes a little to slow the walker down, but not to stop. This system does not allow for this to occur.

IV. Preliminary Design Evaluation

Design Matrix

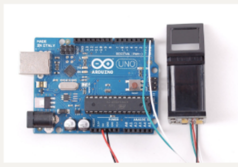
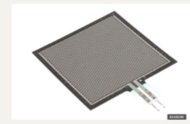
	Design 1: Button Brakes 		Design 2: Noise Alert for Brakes 		Design 3: Pressure Sensing Brakes 	
Criteria (weight)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Feasibility (20)	3/5	12/20	4/5	16/20	2/5	8/20
Ease of Use (30)	4/5	24/30	5/5	30/30	4/5	24/30
Safety(30)	4/5	24/30	4/5	24/30	3/5	18/30
Cost (10)	4/5	8/10	5/5	10/10	3/5	6/10
Durability (10)	5/5	10/10	5/5	10/10	5/5	10/10
	Sum	78/100	**Sum**	90/100	**Sum**	66/100

Figure 4: Design Matrix for evaluating team design ideas

* Scores are out of 5

** Weighted Score = Weight * (Score / 5)

Design Criteria

Ease of Use - The ease of use of this product should be defined by how teachable and simply the steps of using the device can be translated from one person to another. This included the amount of training required to use it, any certification requirements that may exist, and how long it takes to teach the procedure. Ease of use was ranked high because it is important that all people using the device understand its functionality.

Safety - The safety of this product should be one of the most important aspects to consider because the device is made to assist those with mobility issues. The device can not be restrictive, heavy or require a large amount of physical effort in order to function properly. Safety was ranked equally as high as ease of use because it needs to help the patient complete daily activities.

Feasibility - Feasibility refers to the ease in which it is possible to make the final prototype, taking into account the materials, manufacturing tools, and technical skills required to make the final deliverables.

Cost - The budget for this project is $300-$500. All design costs made during this semester should fall around or below this value. The cost of fabrication for one device on the market should be within the budget of medical manufacturers. Overall, this was weighted the least value because we believe that the cost of designing and fabricating any of the proposed designs falls within both budgets.

Durability - Durability refers to the longevity of the device. The device should not have frail materials on the exterior and should be able to withstand the toll of constant use both inside and outside of buildings. The walker should last many years before needing to be replaced.

Design Scoring

Button Brakes:

Ease of Use - This design received a ⅘ for its ease of use. The design is a very simple design that only requires tapping a sensor button in order to use. This design is also easy to teach to new users which would make it easy to integrate into hospitals and physical therapy. They could have scored higher if there was certainty that there will not be user issues when more than one fingerprint is registered on the microcontroller.

Safety - The button brakes scored a ⅘ for its safety. This design scored high in safety due to its lack of sharp edges and inability to harm the patient upon use. The design is also small and does not hinder the handles or the frame of the design. The design does not include a fail safe if the brakes are not manually locked and so it did not receive full points when considering the design.

Feasibility - The fingerprint design scored a ⅗ for feasibility for a few reasons. The design requires a large amount of coding which the team does not have a large amount of experience with. Due to the lack of background knowledge a large portion of the project will involve the team learning the syntax and language that Arduino uses. This design also has to be portable and so later into the fabrication process there will be struggles finding a power source that is portable for when the device is used outside. There are several resources in the BME department at UW Madison that the team will take advantage of to try and counter the learning curve.

Cost - The cost to make the button brakes scored a ⅘ because some of the team members already own an electronics kit that can be used for a large part of the schematic. Items such as wires, resistors, Arduino, breadboards, and capacitors will not need to be purchased for this design. The funding from the client will be allocated to purchasing the Adafruit sensor and the clamp for the wheels which should stay within the budget. The team may need to purchase several types of clamps and sensors in order to find the most efficient design and this could require extra spending.

Durability - The durability of this design scored the highest of all the design criteria. This is because this design should not require any repair and last several years without any maintenance or extra coding after the initial fingerprint calibration. The device may require altercations if there is an injury to the finger and or the walker tips over and the sensor breaks. Under normal conditions and everyday use this design should be easy to maintain.

Noise Alert for Brakes:

Ease of Use - The ease of use of the noise Alert scored the highest possible. The device will work similar to an alarm for seatbelts in the car and does not require any interaction with the user in order to work. With this device requiring no effort for the patient there will be no integration time for the user or training required for medical professionals. The device may be harder to use for people with poor hearing and so sound tests will be considered by the team.

Safety - The safety of the noise alert design scored a ⅘. The noise device should improve the safety of the walker by reminding users to lock it when it is not in motion so that they don't slip and fall when using it. The device would have scored higher but does require research and testing to understand that the noise is set to the appropriate pitch and volume. If the speakers are too loud it could startle the user and if the pitch is not heard then there is risk of the locks being disengaged when they should be, leading to injury.

Feasibility - The feasibility of this design scored the highest of all 3 designs due to its simplicity. The noise alert utilizes a speaker that will hook up to the Arduino. Though there will be the same coding issue as with the button brakes design, the addition of an audio device is much easier than coding for recognition of specific fingerprints and is why it scored higher. Adding the noise alarm to the walker will be a major challenge the team faces when making the first prototype. There will also be struggles to collect quantitative data for sound and thus it may be difficult to change or improve the design down the road.

Cost - The cost of the noise alert design scored the highest of the 3 designs considered in the design matrix. The cost of creating the noise alert system is extremely easy to keep within the $500 budget due to the noise emitting component being so cheap and the team owning every other part of this design. This design scored high in cost also because it is possible to purchase several different types of noise makers to test without exceeding the budget which is not the same for the other designs.

Durability - The durability scored full points for this design and tied with the other two designs. The longevity of this design is extremely high because there should be no need to provide any maintenance checks nor will there be typical scenarios where the risk of the noise alarm breaking occurs. A consideration that the team will have to think about is when the speaker is exposed to water if it is raining when the patient is using the device outside. Water damage may break the speaker or change the sound quality and hinder its ability to perform as it should.

Pressure Sensing Brakes:

Ease of Use - The ease of use for the pressure locking design scored a $4/5$ because, like the other designs, it is made to be as simple as possible for the user and medical professionals to understand. The pressure system will be easy to use but will require getting used to how much pressure must be applied to the device in order for the locks to engage. By applying pressure to the sensors that will be located on the handles the device should be able to lock. This will require no background training to integrate into a real world scenario where a walker is used. The walker would be locked until enough pressure is applied.

Safety - The pressure based locking design scored a $3/5$ and the lowest of all designs in safety. This is largely due to the struggle this design will have when on inclined surfaces. When the user of the walker is moving down a hill the center of gravity and center of pressure of the person changes and if the person needs the walker for stability, this could cause them to accidentally lock the walker while trying to move, this could then cause injury to the patient and others in the surrounding. The other problem is that there is an error possibility with setting the threshold of the system. If the pressure value is set too high the person using the device may not be able to successfully unlock the walker for use, defeating its purpose.

Feasibility - The feasibility of the pressure design scored a $2/5$ and was also the lowest score for all 3 designs in this category. The reason this design scored so poorly is due to the difficulty of making a successful system that will lock the walker using pressure. To connect a pressure sensor to the handle of the walker will require an extremely flexible and durable material which will be hard to attain. This will also require the most advanced coding for the 3 designs that were considered.

Cost - The cost of the pressure breaks scored a $3/5$ and was the lowest score across the 3 considered designs. The reason that this design scored low in cost is because it will cost the most amount of money to fabricate. The cost of sensors that can handle the weight of a person cost upwards of hundreds of dollars and this is not realistic with the specified budget of $300-$500 dollars. The team would not have enough money to purchase and fabricate an entire lock system if one component is going to be a majority of the budget and for these reasons it was given a poor score.

Durability - The durability of the pressure locks scored a 5/5 which is the same score as the other two designs. The pressure system should not see a lot of damage nor be under any extreme conditions that would cause the device to break. The biggest problem with this device is how it will handle sweat from the patient. The exposure to body fluid and liquid could cause the pressure sensor to break and until the other designs, these sensors must be on the exterior of the walker in order to register the pressure the user applies to unlock it.

Proposed Final Design

The proposed final device will be a walker that includes both the button brakes design and the noise alert for brakes design. The walker will have these components attached to the handles of the walker in order to make them the easiest to access for the patient. The arduino microcontroller will be able to manage both the noise emitting and finger sensing portion of the lock system and connect down to a clamp that will be placed on the back wheels, thus restricting the movement of the walker when activated. By combining the two designs the team will better be able to meet the needs of the client by making an easier to use and more effective locking system. This final design was considered to be most effective but the team will have to understand that the cost and feasibility of compressing two designs into one will take more time and be more expensive as more parts will have to be ordered and fabricated.

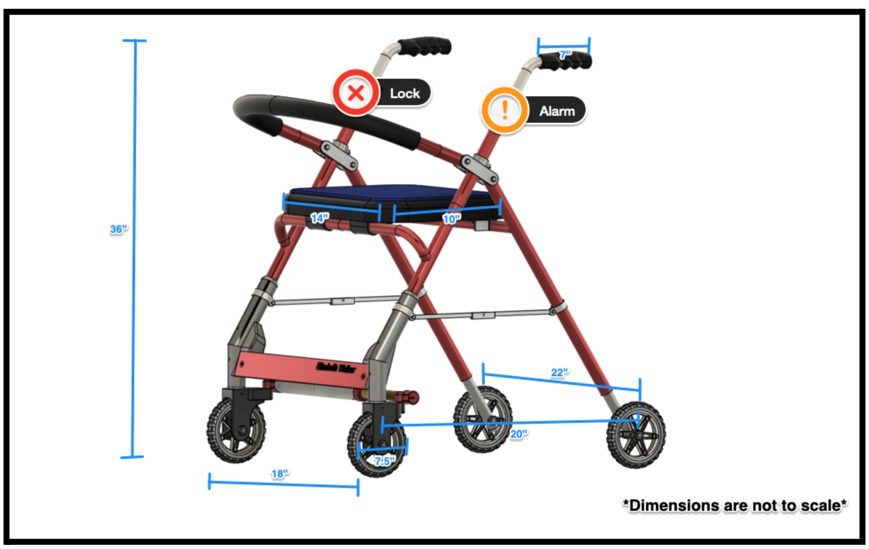


Figure 5: Initial walker system design with dimensions and location of alert/lock system

V. Fabrication/Development Process

Materials

The device will be used by both elderly and differently-abled persons to increase safety and mobility. The materials should be able to accommodate the needs of the user being both durable and lightweight. Using a client-provided walker, the material of the walker is guaranteed to be FDA compliant and accessible to the users. The sound component of the device will use an arduino microcontroller along with an inexpensive digikey speaker, making it easily accessible and affordable [13]. The braking component of the device will utilize another arduino microcontroller along with a small adafruit touch sensor [10]. Further research and testing will be required to decide which material should be used to connect the button braking system to the wheel-locking mechanism, but the design will incorporate some variation of a high-quality metal steel wire as is commonly seen in many similar braking mechanisms. Finally, a small container to fix the electrical components to the walker will be used, created from a low-cost plastic known as PLA [16].

Fabrication Plan

The two components of the design the team will pursue are the touch-sensor braking system and the noise-alerting system, both of which will require arduino components and coding. The team will assemble the button-braking system consisting of the touch sensor, microcontroller, and brake cord and brakes. The team will then assemble the noise-alerting system consisting of a speaker, microcontroller and sensor that will alert the user when the brake system needs to be engaged. Finally, the team will use SOLIDWORKS for CAD designing of a components box to be 3D printed from PLA, which will finally be attached to the walker via some form of a mechanical fastener.

VI. Results

The newly designed walker will be tested against several criterias in order to determine how successful the new design is. To get a baseline of data, the same tests will be done on a traditional walker. After data is collected, it will be analyzed in order to make relevant conclusions in regards to the new walker's success. As the semester progresses, the team will provide more quantitative data. The team is not in the testing stage of the design process yet.

VII. Discussion

Results from testing will be crucial in the determination of functionality of the alert device. One of the major factors that will need to be considered in testing is the frequency of the alerting tone. Many elderly individuals struggle with hearing certain frequencies as a result of hearing loss, so further research alongside a test will need to be performed to determine what frequencies are ideal for use in the arduino speaker system to best notify the user that the brakes should be engaged. This test will be conducted with a series of ranges of frequencies to determine which is the most effective frequency to code the alert system to. Secondly, a test will be performed to determine the braking capabilities of the stock walker received from the client Dr. Martin through a brake test that will determine the stopping distance after applying the brake. This test will provide data regarding how the secondary braking system should be implemented, specifically how much braking power it should contribute. It will also lend to discussion about upgrading the traction of the wheels, as it was noted that the smooth, treadless wheels easily slid across tile and wooden flooring.

The team has been recommended to study within a focus group of potential users to gather valuable feedback regarding the design. This focus group will allow the team to interview current walker users about functionality, safety, and other features that can be improved in the new design. For example, one identified risk of many current walkers is the height, which leads to poor posture in the users resulting in slips or falls. This focus group will be a valuable resource for the team in gathering data regarding the design.

Another consideration is price and availability. The device should be as low cost as possible, while still maintaining its integrity to allow for universal accessibility. This is important so that all consumers will be able to afford this device, to decrease falls and increase the overall safety of elderly and differently-abled users.

VIII. Conclusion

Many older adults struggle with remaining independent on account of many challenges that come with age. Those who choose to use walker devices tend to feel confined or don't want to admit when they need assistance. An alert system associated with their walker could help them feel more independent while simultaneously improving their safety and mobility. The team will solve this problem by creating an alert device for a walker to help older adults retain their independence, which will both improve the widely used braking system as well as implement an alerting sound system to remind the user to engage their brakes. After extensive background research and collected feedback from walker users, the team decided on a final design that would best incorporate both of these features onto a provided walker. The team will fabricate a product through several processes that meets the predetermined criteria. The team will then put the design through several tests to ensure that it is not only up to client Dr. Martin’s expectations, but could also have the capability to improve safety and mobility for users around the world.

IX. References

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X. Appendix

A. Preliminary Design Specifications

Previously Revised: 10/01/2023

Title: Alert Device for Walker (WARNS)
Client: Dr. Beth Martin
Team: Matt Hudson, Meghan Kaminski, Colin Bailey, Sara Sagues, Daniel Pies
Function:

The device will provide walking assistance along with an integrated safety system that will produce a low pitch frequency as a cautionary mechanism for potential dangers to the stability of the device. The low pitch frequency will emit when objects are within 10 ft of the device and when the walking gradient exceeds that of 2% incline. The device must include a locking mechanism that prohibits movement in any direction if activated.

Client requirements:

- Device should be similar in height to similar walkers on the market assisting people from 5’3ft to 5’11ft
- Device should have wheels at the base of the device that can easily lock and unlock upon patients decision
- Device should have an alert system that emits low frequency noise at a range older patients would be able to hear
- Device should be able to record gradient it rests and moves on along with alerting patients if the incline becomes unsafe
- Device should include the following accessories; seat, basket, handles, wheels, and lock for wheels
- Device should follow FDA regulations
- Budget between $300 and $500.

Design Requirements

1. Physical and Operational Characteristics
    a. *Performance requirements*:

i. Device should focus on emphasizing the safety features of the walker
ii. Device should be able to alert the user if an incline becomes unsteady
iii. Device should have a low frequency alert system
iv. Device should emphasize the brake features of the walker

b. *Safety*:
i. The product must allow the user more comfort during use of their walker
ii. The product must remind the user to use their walker
iii. The volume of the alert system will be lower frequency in volume
iv. The product will provide additional alert for the user to use their brake system
v. The product will focus on alerting the user of uneven ground that may harm the user

c. *Accuracy and Reliability*:
i. Due to the time constraints and new nature of the project, a prototype is requested
ii. The product should be testable on a walker
iii. The product should follow a list of precautionary tests for safety
iv. The product should follow a list of accuracy tests in terms of the technology and details to the prototype

d. *Life in Service*:
i. The device should last throughout the entire use of the user
ii. If the device breaks there should be replaceable parts so it continues to be usable after repair
iii. The device is used everyday for up to 10 hours per day
iv. The device will not be used for long periods of time over long distances, but over short periods of time over short distances.

e. *Shelf Life*:
i. The device should remain undamaged throughout time in storage

f. *Operating Environment*:
i. Older adults aged 74-85+ will use this product [5]

ii. The walker should support a weight of the average adult in independent living up to the higher threshold of weights
iii. The walker will be used indoors on hardwood, tile, and carpet
iv. The walker will also be used outdoors on concrete, grass, and gravel

g. *Ergonomics*:
   i. The device will be easy for patients and medical staff to use
   ii. The device will not further hinder the mobility of the patient
   iii. The device will not be loud enough to disturb others patients, staff, or people in the vicinity

h. *Weight*:
   i. The device produced must be light and compact as to minimally increase the weight of the walker. The total weight should be similar to a traditional non-altered walker as to avoid causing injuries to patients while using our walker
   ii. Walkers range from 5-12 pounds depending on the type of walker [20]

i. *Materials*:
   i. All materials used to fabricate the device must comply to FDA guidelines
   ii. Materials used must be easily accessible nationwide and affordable

j. *Aesthetics, Appearance, and Finish*:
   i. The overall size of our smart-walker must be able to accommodate the standard person and be adjustable to different heights
   ii. The device must be minimally intrusive and blend in seamlessly with the walker
   iii. Appearance must be appropriate for use in elderly care facilities

2. Production Characteristics
   a. *Quantity*:
      i. The client wants use to create one working prototype in the given timeframe
      ii. Long term goal is to mass produce the device such that several could be in hospitals, retirement homes, and recovery clinics

b. *Target Product Cost*:
    i. The client has provided a budget of $300-$500
    ii. The cost of production should be feasible for medical facilities nationwide

3. Miscellaneous
    a. *Standards and Specifications*:
        i. Must comply with Sec. 890.3825 of the FDA within Title 21 [18]
        ii. The device must comply with the ADA's restrictions for manually powered devices [17]
    b. *Customer*:
        i. The customer highlighted that the design should focus on safety, specifically focused on brakes to prevent the device from slipping out from under the user
        ii. The customer would prefer that the device be light-weight
        iii. The customer wants the device to be modular, to adapt to a variety of needs
    c. *Patient-related concerns*:
        i. Device should allow patients to minimize pain while moving.
        ii. Device should enable patients to access any and all areas around their homes and in their daily lives
    d. *Competition*: This section covers other devices and patents on the market related to alert devices for walkers.
        i. [19] Collapsible Upright Wheeled Walker Apparatus (Patent No. US10322056B2) - This is a patent for a walker device with adjustable armrests to support sufficient user upper-body weight to facilitate a natural and upright gate for a wide range of mobility-impaired individuals.
        ii. [4] Electronically Controlled Brakes For Walkers (Patent No. CA2605609C) - This is a patent for an improved electronic braking system for walkers that incorporates one or more electronically operated brakes. The controller is responsive to touch sensitive switches for easy operation, and is adjustable and responsive to the operator patterns. The controller may be used on sloped terrain and may be adjusted to

accommodate for the weight of the user to to set limits to the speed at which it can move.

B. Expense Sheet

Item	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
Filter Device								
N/A							$0.00	
Tubing								
N/A							$0.00	
						TOTAL:	**$0.00**	

Currently, no expenses for the Fall 2023 semester.