- All Student Design Teams are asked to include two images of the design team with their submission. Both images should include the entire design team: one image should contain the device; one image should not contain the device
- The submission must document the design and fabrication of a device used by one or more individuals to maximize independence.
- Submissions must be made electronically at http://aac-erc.psu.edu/wordpressmu/RESNASDC/resna-student-design-competition/

- ALTERNATIVE TEXT DESCRIPTIONS Graphics in all formats are inaccessible to many people with visual disabilities. Types of graphics include: photos, equations, charts, graphs, diagrams, schematics, etc. Text descriptions for each graphic must be included as the images are entered in the RESNA SDC WordPress website.
- TABLES Tables don't need to have alternative text description; they should have a short summary description, which explains what the table content is about. For example, the summary might say, "This table displays the average propulsion force required using each of three types of wheelchair pushrim over hard level surfaces, soft surfaces, and uneven surfaces."
- IMAGES, PHOTOS, DRAWINGS All images should be uploaded to the RESNA SDC WordPress site in ".gif," ".jpg," or ".png" formats with size at 800/600. Alternative text must be entered as images are posted at the RESNA SDC WordPress site, and may be no more than 150 characters. The alternative text description of an image, photo, or graphic should provide the information that the image is intended to convey. If the images contain identifiable individuals who are not the authors of the paper, an image release should be signed and submitted.

REMEMBER: Your paper should not exceed 2,000 words of text. You can have an unlimited number of graphics in the submission.

Want it in Times New Roman, Size 12

*******START OF ACTUAL PAPER*******

AUTHORS

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Rochester Institute of Technology

TOPIC AREA

Technology for Cognitive and Sensory Impairments [TCS]

ABSTRACT

Individuals who have a reduced ability to hear and see may find that everyday tasks such as walking are challenging. To address this challenge, the project team has iteratively designed a user-friendly cane handle that improves user independence by providing haptic signal-detection feedback. Key attributes of this product are its affordability compared to alternative canes on the market and its unique non-auditory feedback. A series of tests are being performed on the cane to ensure that it meets functionality requirements along with being a desirable cane for intended users.

KEYWORDS

Obstacle detection; haptic feedback; mobility cane; spatial awareness

INTRODUCTION

Visually impaired individuals face daily challenges in regards to interacting with and navigating through their environments. While some support systems exist in the form of assistive devices, most of these solutions provide audio feedback to the user to alert them of obstacles in their surroundings. This solution does not offer support for deaf-blind users or for hard-of-hearing users trying to navigate through obstacle-ridden environments.

The "Smart Cane" designed by this senior design team is an advanced assistive device that improves a deaf-blind user's ability to detect obstacles and navigate more safely. In contrast to the auditory design, the Smart Cane relies on tactile signals to guide the user. Current canes on the market that provide haptic feedback are upwards of 600 USD and our customer base is seeking a more affordable option that can be used for up to eight hours without the need for charging, is comfortable to use, and has accurate feedback signals that are intuitive or easy to learn.

Comment [KMC1]: Are we calling this a Smart Cane still or should we convert the team to using a new name for copyright sake?

PROBLEM STATEMENT

The team needs to design and develop a working cane prototype for deaf-blind users that is competitive in the market with a low manufacturing cost. It must be able to detect obstacles, provide users with haptic feedback from the cane handle, is rechargeable for user convenience, is lightweight to avoid strain, and can be easily collapsed into segments for portability.

METHODOLOGY/APPROACH

Handle Frame

The shell of this handle is composed entirely of polylactic acid [PLA] material with a 50 percent infill. Its purpose is to provide a lightweight solution that has a good layer bond to provide strength. The choice of PLA also provides a solution that is weather-resistant as the material is insoluble in water. A user will be able to comfortably grip this cane handle while sweeping the cane side-to-side. Per the current cane standard, one side of the cane handle will be a straightedge to ensure that a user holds the cane in the proper orientation.

*******PHOTO OF HANDLE INCLUDED**** - NEED THURSDAY***

Power

To power-on the cane, a user moves a horizontal switch from left to right. Based on the final battery selected, the cane is expected to function for at least 8 consecutive hours and it is fully rechargeable.

Signal Detection

The selected sensor provides an obstacle detection range that goes as far as 9.25 feet from the sensor mount point of the cane, thus making the total detection range larger than ten feet. It provides a desirable vertical detection range of 4 feet and will be able to detect objects within a 180 degree radius as the user sweeps the cane from side-to-side. When an object is detected, the accelerometer indicates whether the obstacle is on the left or right side of the user. A signal is then sent from the electrical components to the two motors.

*******PHOTO OF ENTIRE CANE INCLUDED – MAKE A POINT OF WHERE THE SENSOR WILL BE & THE RANGE IN WHICH IT WILL BE ABLE TO DETECT OBJECTS**** - NEED THURSDAY***

Motors and Bearings

Each of the motors serves to rotate the bearing side-to-side on one side of the cane handle. One bearing contacts the palm of the hand while the other touches the user's fingers. Such placement ensures that, while the user holds the SmartCane in a way that mimics the traditional cane-handling technique, the haptic feedback can be easily felt. When users feel a bearing move in their hand, they intuitively know whether the obstacle is on the right-hand or the left-hand side as feedback side is identical to obstacle location side (i.e. Either to the left or right of the user).

Comment [KC(S2]: Need to change this once we know the new cane name

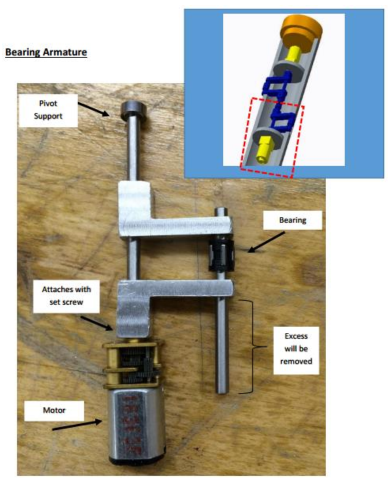

Figure 1. Bearing armature for cane handle

Above, Figure 1 displays one bearing armature that provides feedback to the user by rotating side-to-side. Two bearing armatures are included in the cane handle and each corresponds to detection of an obstacle on one side of the user.

RESULTS & DISCUSSION

The completed prototype will represent a traditional white cane with the standard handle replaced by the team's obstacle-detecting handle. Use of a new handle will effectively allow a user to detect obstacles within a horizontal plane while the user sweeps the cane. A detection range of over 9 feet will allow the cane's sensor to detect an obstacle and send feedback to the user in time to allow for obstacle avoidance. Haptic feedback in the cane handle will indicate that an obstacle exists on one side of the user. Having the haptic feedback will effectively increase a user's ability to be independent as they will feel confident in their ability to detect and avoid obstacles that could potentially be tripping hazards.

Feedback testing will be performed at ABVI of Rochester, NY because that site will allow the team to test cane functionality with users who are currently blind. To test signal detection, the user will go through an obstacle course while sweeping the cane and observers will take notes. A user will verbally indicate whether the feedback could be felt and whether it was easy to comprehend. Safety of the device must also be considered during the testing phase. Since the cane operates using a battery and two motors, heat tests will be implemented to ensure that no harm due to overheating will exist.

In addition to being functional, the cane will be exceptionally user-friendly. It will be collapsible into four segments and the time required to collapse or reassemble the cane is less than 10 seconds. This provides convenience as the user is able to more easily store the cane when it is not in use. Also, the battery life of at least 8 hours allows the user to take advantage of the cane's benefit for a full workday, if needed. Use of a rechargeable battery is convenient for users who may not be interested in purchasing and installing several batteries over time. Since the cane is intended to be used for a wide range of durations, the team has ensured that the additional weight of the new handle increases the cane's weight by less than one pound.

Cost Implications

Design for manufacturability was taken into account when finalizing cane design decisions. The cane's handle is a 3D printout for our prototype, but it will be injection molded when it is goes into production. The proposed design has a total bulk manufacturing cost of $136.05. Injection molding, overhead, general, and administrative costs will depend on where the cane is produced and on the volume produced. For manufacturing costing, ordering in bulk is presumed to require 500 pieces and all values are quotes from external vendors.

Market potential is great for this product as it is a lower-cost option than others on the market and it has the unique ability to be used by deaf-blind users. Our product was designed with the market in mind and we have ensured that its specifications meet current industry standards. Since all components are currently available from vendors, there is no additional work required from a sourcing perspective.

ACKNOWLEDGEMENTS

The team greatly appreciates the help of Dr. Iglesias for her assistance with design support and purchasing, Tom Oh and Carlos Barrios for their electrical design insights, and Gary Behm for patenting this idea and encouraging us to make his dream a reality. We would also like to thank our guide Charlie Tabb for his mentorship throughout this 32 week journey and Joe Kells and Nikki Llewellyn from ABVI for providing us with prototype test personnel, subject matter expert support on low-vision user needs, and financial support for the project. Denis Cormier had an integral role in providing design for manufacturability and design for assembly insights. We would like to thank both Denis and Mike Bufflin for their 3D printing knowledge and for helping us create a great prototype of the cane handle shell. Lastly, we are happy to have the help of our university's senior design staff who gave us guidance throughout the project.

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