Project Proposal

Project Title: Designing an Assistive Device for the Visually Impaired For Ground-Level Object and Surface Condition Detection

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Project Definition:

The overall aim of this project is to create a device to assist the visually impaired with walking and navigation. This will be done through the use of an infrared, ultrasonic, and/or alternate distance sensor in order to detect ground-level obstacles and unsafe ground surface conditions. The project goal is to be able to convert data from the sensors into meaningful haptic feedback for persons with visual impairment. The expected result is a completed device that is able to detect ground-level hazards and conditions as well as convey this information to the user.

Project Background:

Individuals with visual impairments have difficulty navigating while alone due to obstacles and uncertainty in ground conditions. The objective of this project is to engineer an easy-to-use, portable device that will detect and provide feedback to inform the user of ground-level obstacles and conditions. The device is currently planned to be either hand-held or wearable. As of 2020, the World Health Organization reported that there are 1.3 billion people with visual impairment and 36 million of these people are completely blind (*Vision Impairment and Blindness*, n.d.). These large numbers indicate a need for assistive devices to help this population with safe navigation.

Current Devices:

This project focuses on creating a device that can help with the detection of ground-level hazards. This kind of hazard includes staircases, potholes, pits, ramps, ditches, and loose surfaces (Paiva, 2020). In surveys of the visually impaired, these hazards are some of the most prominent issues they face when going outside (*Outdoor Difficulties Experienced by a Group of Visually Impaired Iranian People | Elsevier Enhanced Reader*, n.d.). Most commercially available assistive technologies use one or a combination of infrared sensing, ultrasonic sensing, and/or laser telemeters in order to achieve the goal of obstacle detection. However, very few look at ground condition detection (Paiva, 2020). Many devices and methods that look at ground-level hazards have also proved to be bulky or heavy and unfeasible for use by a visually impaired person (Paiva, 2020).

Tactile Ground Surface Indicators.

One of the current common methods for warning the visually impaired of hazards is tactile ground surface indicators (*Tactile Ground Surface Indicators, TGSI, Tactile Surface Indicator*, n.d.). They are bright yellow and create bumps on the ground surface so that individuals with visual impairment are able to detect this unusual surface using a white cane or their feet (*Tactile Ground Surface Indicators, TGSI, Tactile Surface Indicator*, n.d.). While this method is effective, it is typically only in urban areas and often installed improperly (Mizuno et al., 2008). The lack of functional or consistently accessible technologies for detecting ground-level hazards and conditions presents the need for an assistive device in order to help the visually impaired population safely navigate.

Experimental Design and Research Plans/Goals:

One of the major parts of this project will be to research how the signal intensity and an object's distance from an ultrasonic or infrared sensor can be used to detect ground conditions or materials. Research on this topic has been done but is yet to be applied to technology for the visually impaired. (Nakashima et al., 2016) The goal would be able to effectively be able to use these types of data in order to detect ground conditions. The other main part of this project will be to use some sort of distance sensor in order to detect nearby obstacles near ground level. The goal would be to integrate these hazard detection methods into a wearable device that would be able to give feedback to the user through either haptic feedback, audio feedback, or a combination of both.

Risk/Safety Concerns:

As there will not be human testing, there are no risk or safety concerns.

Data Analysis:

The two main goals of the data analysis are to detect obstacles and to detect ground conditions. Distance measurements will be taken from ultrasonic or infrared sensors in order to locate when an object is nearing. Close distance readings will be interpreted as obstacles(s). This data will be converted into haptic or audio feedback to be conveyed to the user.

The other data that will be gathered is frequency intensity data from the sensors used. Part of this data analysis would be choosing if an ultrasonic or infrared sensor is most accurate. I plan to use the frequency intensity and distance data from different surfaces and make equations for the relationship. The goal would be noticeable differences between the equations, as seen in Nakashima et al., that can be used to create thresholds for different types of ground conditions/surfaces. Then, based on the distance from a surface and the frequency intensity from the sensor, I would be able to determine the ground condition. This will also be converted into audio or haptic feedback to be conveyed to the user.

Potential Roadblocks:

Some of the potential roadblocks of the project will be in the creation of the device to be wearable and the application of my desired methods. One of the main issues many other assistive devices for the visually impaired face is that they are bulky or heavy and impractical for use. Designing a device that will be feasibly wearable will likely be a challenge and I may have difficulty effectively doing so. In order to try and combat this potential issue, I am working on acquiring compact sensors and looking at effective designs for similar devices as inspiration. There is also the potential that the ground condition detection method I plan to use may not work. It has never been adapted to technology for the visually impaired so I will have to figure out a way to do so on my own. This kind of ground condition detection has also only been done parallel to the surface it's detecting. As that may not be best for all kinds of designs, this method may not fit my needs and prove hard to use. In order to overcome this, I plan to try and adapt the method to work at an angle. This could also be a roadblock as it may not be possible, although using an infrared sensor is a promising option.

References:

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Timeline:

August	September	October	November	December	January
Brainstorming and project ideas	Continue brainstorming Journal Research for potential topic	Final brainstorming In-depth research on the chosen subject Contact professionals and journal authors Isolate criteria for device zFair forms	Begin sketching and prototyping zFair forms Contact professiona ls and journal authors	December fair Continue sketching and prototyping Work on the presentable pieces of the project	Testing and data collection completed Device design being finalized or actively worked on Preliminary work needed for February fair