CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

S0905

Project Title

Enabling Situational Awareness: A Hat-Based Hands-Free Haptic Navigational Aid for the Visually Impaired

Abstract

Objectives/Goals

According to the WHO, an estimated 285 million people worldwide are blind or have low vision. Unfortunately, white canes and guide dogs, the most popular aids, don't detect face-level obstacles, are cumbersome, can be expensive, and aren't hands-free. To answer this need, the researcher designed and constructed a hat, the Haptic Navigational Aid for the Visually Impaired (H-NAV), which helps blind users detect face-level obstacles.

Methods/Materials

The hat senses obstacles using a laser distance sensor (LDS), like those on self-driving cars, mounted on top. An array of 12 vibrating motors (such as those in cell phones) inside the hatband alerts users to obstacles' presence and direction, and a slider adjusts the motors' vibration strength.

Arduino-based Version 2.1 was tested by assessing 12 sighted, blindfolded test users' ability to perform basic navigational tasks such as walking through doorways and along walls while wearing it. Based on user feedback, the hat's hardware and software were completely redesigned to accelerate assembly, improve comfort, and add features. For Version 3, the Arduino was replaced with a system of two AVR microprocessors. An ATMEGA324 on a rigid PCB under the LDS interprets LDS data and user inputs as vibrating motor commands. These are mounted on a flexible PCB inside the hatband, directly controlled by an ATTINY2313a. This system allows additional features such as a distance threshold adjustment, but the switch required a complete software rewrite, redesigning its structure and implementing basic I/O functions previously included in the Arduino libraries. Six blind users experimented with Version 3.0, providing qualitative feedback.

Results

The blindfolded users had a 90% average success rate over all tasks tested. The blind users were enthusiastic about the idea, and provided much useful feedback about the hat's user interface.

Conclusions/Discussion

To date, the H-NAV has two patents pending, U.S. 61/959,215 and U.S. 62/071,689. After revisions based on blind users' feedback, testing with a statistically significant group of vision-impaired users is the next step; several organizations for the blind have already expressed interest. The H-NAV could be produced at the low per-unit materials cost of $90-150, and has the potential to significantly improve the lives of the vision-impaired, enabling them to be safer and more independent.

Summary Statement

A hat-based navigational aid for the blind which indicates obstacle direction and distance via vibrating motors in the hat band.

Help Received

Neato Robotics donated four Laser Distance Sensors; Dr. Youssef Ismail provided technological advice; Homebrew Robotics Club advised on sensors and electronics; David Curtis supervised the project.