Spatial Vibrotactile Navigation Assistance for the Blind

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Introduction

According to the World Health Organization, 285 million people are visually impaired worldwide, of which 39 million are blind and 246 million have low vision. The visually impaired face many daily challenges- the most obvious, and perhaps most challenging is navigating through different environments.

A multitude of devices already exist for helping the blind; however, they are often difficult to use and adjust to, and they suppress a natural inclination to feel around in an environment.

To address some of these shortcomings we have designed a modular and interchangeable system of range sensors and actuators that provide a full body touch enhancement experience.

The System

- Most people instinctively feel around using their limbs to apprehend their environment when visual perception has been lost.
- Our system is an array of vibrators controlled by range sensors designed to complement and enhance a person's instinctive tendency to feel.
- We offer a novel alternative, a "corporeal vision" with which the user can interpret their surroundings.

Figure 1: Franklin in an early set of sensor-vibrator sleeves

Figure 2: Demonstrating an early set of sensor-vibrator sleeves

Figure 3: Recent prototype consisting of 7 sensors and vibrators connected to a central control box.

Current Prototypes

Figure 4: Vibrator Testing Shirt

Figure 5: Digital vibrotactile Pod with range sensor and vibrator

Figure 6: Analog vibrotactile pod with range sensor and vibrator

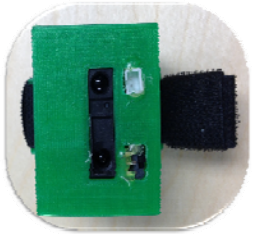

Figure 7: Another analog vibrotactile pod with range sensor and vibrator

Our current prototypes consist of a "pod" : a light and portable device consisting of a range sensor coupled with a small eccentric rotating mass pager vibrator. They come in two variants:

- The analog signal from the range sensor is first routed through a microcontroller which then controls the vibrator through PWM (Figure 5).
- The analog signal from the range sensor is amplified and sent directly to the vibrating motors (Figures 6 and 7).

In addition, we have a separate device consisting of a tight-fitting shirt outfitted with small vibrators (Figure 4). This allows us to control the intensity of each individual vibrator using a computer.

Experiments

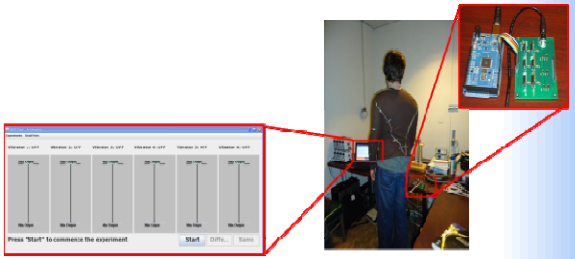

Figure 8: Setup for testing vibrotactile thresholds using the vibrating shirt and a computer

At the moment we are conducting experiments investigating the sensitivity of the skin to vibrotactile feedback using the PEST algorithm (Figure 8).

The PEST algorithm presents the user with sensations of more and more similar intensity, until the user indicates that they feel the same. The PEST algorithm operates in a manner similar to binary search.

Results

The results of the PEST experiments are shown below. We wanted to find the average number of thresholds as well as the intervals between thresholds for vibrotactile sensitivity.

	Left Wrist	Left Elbow	Left Shoulder	Right Shoulder	Right Elbow	Right Wrist
Average Interval Length	77.6	77.6	82.5	94.3	94.3	94.23
Average Number of Thresholds	3.8	3.8	3. 7	3.3	3.3	3.3

Conclusion

Through the experiments we have conducted so far, we have shown that this is a viable navigational device. However it is still too awkward to be of real use. Therefore we are currently working on making it smaller, wireless, and more comfortable.

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