A Wearable Tactile Sensor Array for Blind Navigation

Franklin G. Palmer, S.T.E.P. Scholar, Computer Engineering, Class 2012

Professor Zhigang Zhu, Computer Science, The Grove School of
I became interested in sensor input fusion and computer vision after reading about the DARPA Grand Challenge in high school.

I chose to major in Computer Engineering after taking a course in assembly language. Majoring in Computer Engineering allows me to study the many layers of abstraction present in modern computer systems. I am currently in my 4th year.
I hope to attend graduate school and get a PhD in something related to Computer Engineering.

I would also like to present at least one technical paper at Siggraph before finishing school.

I hope to continue to work on projects that allow computers to have better perception of the environment.
Currently, people who are totally blind rely on canes, seeing eye dogs, and assistants.

Recent advances in technology have allowed the development of artificial retinal implants for people with functioning optic nerves, and systems that provide vision through the tongue for people with functioning taste buds.

There have been attempts to provide the blind with sonar-based navigational aids, but these provided a limited field of view and capabilities.
The cost of sensor electronics has gone down to the point that it is now possible to use many more sensors than before.

Our project seeks to provide the blind with a wearable navigation aid that will provide tactile feedback relating the distances of objects relative to different parts of the body.

We hope to use computer analysis of the sensor data to find an optimal placement of the sensors on the body. We would also like to use computational analysis to create a map of the environment being traversed by the wearer of the sensors, and perhaps help better understand the role of perception in navigation.
How it works:

A sensor is attached to a part of the body, along with a small vibrator. The sensor shoots a signal, either an infrared beam of light or sound waves in a direction perpendicular to the surface of the part of the body it is attached to.

The light or sound bounces off a surface in the environment and returns to the sensor.

The sensor measures the time it took for sound or light to return, and converts it to a distance. The vibrator is adjusted accordingly, usually such that closer objects cause faster vibration.
There are three groups of sensors:

- A sonic sensor on the chest
- An array of sensors on the arms
- A sensor on the shoe
The sonic sensor, seen here in a box, will be worn on the chest as a vest to provide an overall understanding of the environment.
An array of sensors on the arms and hands allow the wearer to “feel” their way around the environment. Objects closer to a given sensor on the arm cause the vibrators to oscillate faster while those farther away cause slower oscillation.
The Shoe Sensor:

A sensor on or around the shoe, pointing toward the ground vibrates at a constant rate when a given threshold distance has been detected. This would happen as the wearer is walking on steps, or on very uneven terrain, to allow them to know if the ground is beyond a given threshold distance away from their foot before they put it down.
Future Work:

As mentioned earlier, we would like to continue work on computer analysis of the sensor data to find optimal arrangements to allow for easy navigation and maximum coverage of the environment.

We would also like to use the sensor input to create a map of the environment to ease navigation through frequently traversed areas. Eventually we might try to create a 3D computer environment from the sensor inputs.

We might also see what applications our project can have to other areas involving perception using limited sensory input such as robotics.
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