Haptic Feedback to Assist the Visually Impaired in Navigating

Need

Sensory substitution has been researched as a method of rehabilitation for the visually impaired, including representation of visual information in auditory format or as a tactile grid on the tongue [1]. While promising, these methods come at the cost of being intrusive to the patient by utilizing key sensory systems, such as hearing, to relay visual information. A paper published in the IEEE Transactions on Biomedical Engineering last year described a method of providing sensory feedback by means of a few vibrating motors placed on the forearm and allowing the user to distinguish vibration patterns by varying the frequency and pattern of motors activated [2]. While intended to provide tactile feedback for hand prosthetic users, there is the opportunity to extend this setup to assisting the visually impaired. One possibility would be to encode distance information and relay it to the user using the method in [2] to allow the blind to sense both the presence and the distance to upcoming obstacles further than would be possible with a cane.

Solution

The proposal is to design a wearable distance sensor that encodes and transmits the information to an array of vibrating motors on the user’s arm. Ultrasonic or infrared rangefinders would be the most likely sensor choice due to their low cost and range of use, up to several meters. A microcontroller and motor controller will be needed to encode the sensor input into a stimulus the user can feel and interpret. Depending on time and resources, a worthwhile addition would be to incorporate an accelerometer chip to provide haptic feedback to the user only when requested, such as by moving the sensor. An accelerometer could also add persistence to the haptic feedback: for instance, the user could use the sensor to scan an object in the distance and the accelerometer would measure how much the sensor in one motion, mapping the sensed distances over the vibration motors.

Requirements

Development will need to meet the following milestones

1) Determine exact design specifications (sensor type, number, fixed vs. mounted on servo for scanning) and create schematics for electronics, drawings for mechanical components
2) Design and assemble motor controller and interface for sensors to microcontroller on breadboard
3) In parallel:
   a) Output distance reading using microcontroller and calibrate if necessary
   b) Write code to control speed and intensity of motor vibration and test
4) Write microcontroller code to encode sensor inputs as motor vibrations.
5) Perform user testing
6) Transfer design to PCB and re-test

References