Sensors for Headgear for the Visually Impaired

Introduction

There is a need to develop devices that make navigation easier for the visually impaired. While a few devices already exist, like the Intel HELIOS Headgear and the RNIB Smart Glasses, the technology is not yet as widely accessible as it should be [1,2]. This paper reviews sensor technologies available for headgear for the visually impaired; specifically it reviews sensors that provide a better understanding of the user surroundings, like proximity of obstacles and ambient lighting.

Types of sensors

Ultrasonic sensors

Ultrasonic sensors are used for proximity sensing through time of flight feedback. These sensors are additionally used for fluid level sensing, fluid ID/concentration sensing, and flow sensing. Measurement range varies from a few cm to about 7m. Texas Instruments makes these sensors and they cost $1.5 - $3/1ku (kilo units) [3].

Light sensors

Light sensors detect the intensity of incident light. Infrared (IR) sensors use light sensors to detect only wavelengths in the IR spectrum. Passive IR sensors can be used for proximity sensing. These sensors can detect objects and gestures up to 200cm away [4]. Ambient Light Sensor (ALS) emulates the human eye response to varying light intensity. ALS is used in phones for changing screen brightness according to surrounding environment brightness. Companies like AMS and Silicon Labs sell light sensors for $1.5 - $4 (checked on DigiKey).

LIDAR sensors

LIDAR (Light Detection and Ranging) sensors measure distance to an object using lasers. It is a type of a *light sensor* that uses visible, ultraviolet, or IR light for detection. It is used in precise environment perception and object recognition and classification. There are two types of LIDAR systems – terrestrial LIDARs that are laser scanning systems that can be mounted on portable platforms and airborne LIDAR systems that can fly on rotary or fixed-wing platforms and satellites [5]. LIDAR sensors are used in remote sensing, archaeology and robotics. A LIDAR costs $100 - $150 (costlier LIDARs also exist).

Cameras (image sensors)

A camera or an imaging module can be used for precision in object detection. However, these are more expensive than ultrasonic and light sensors and are bigger in size. A camera module costs $30 - $50 (checked on SparkFun). A counterpart of the LIDAR sensor is 'Structure-from-Motion' (SfM) photogrammetry. SfM resolves 3-D structure from a series of overlapping, offset images. This method combines computer vision concepts with camera inputs to obtain a solution that costs lower than a LIDAR [6].

Sensor implementation

The sensor data can be processed using a microcontroller like an mbed, arduino or a raspberryPi that decides how the device should behave based on the input. This behavior is implemented through actuators like haptic and audio feedback modules. Haptic actuators add tactile feedback to devices through vibrations [7].

Citations

[1] https://software.intel.com/en-us/articles/helios-headgear-uses-intel-realsense-technology-to-empower-the-visually-impaired

[2]http://www.rnib.org.uk/sites/default/files/Smart%20Glasses%20User%20Testing%20Final%20Report%202016%20v7.pdf

[3] http://www.ti.com/product/PGA450-Q1/datasheet

[4] http://www.silabs.com/Support%20Documents/TechnicalDocs/Si1153.pdf

[5]
https://books.google.com/books?id=axxzZWiD9BMC&pg=PA66&dq=lidar+sensor&hl=en&sa=X&ved=0ahUKEwjfpY7a1fLPAhVI7SYKHS5LCvkQ6AEIODAB#v=onepage&q=lidar%20sensor&f=false

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[7] http://www.ti.com/lit/ml/slyt418a/slyt418a.pdf