SENSE: Modern Navigational Tools for the Blind

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Abstract

There has still not been any major technological advancement that comes remotely close to replacing the cane blind people use to interact with the world around them. Many of the modern blind aids that enable people to see, cater towards people with partial blindness and not to people who are totally blind. Data collected by the National Braille Press states that 0.45% or 1.5M of the US population are blind and thus SENSE aims to cater towards the needs of the totally blind and modernize the tools they use to navigate and interact with the world around them.

Two-devices: the SENSE glasses and the SENSE belt, capture and interpret data collected from the ultrasonic sensors and output haptic and audio feedback based on proximity to an obstacle. Utilizing a non-invasive technique called *sensory substitution*, we can bypass the loss of a sense (sight) by feeding its information through another channel (audio and touch). Leveraging this technique, we developed a low-cost vibratory belt and bone conducting audio glasses to allow blind people to perceive spatial awareness through small vibrations on their waist and audio alerts from bone conduction headphones.

Both SENSE devices compute and process data through individual raspberry pi zeroes. The SENSE glasses algorithm is designed based on the assumption that we dynamically scan areas of interest before and after sensing an obstacle. 3 ultrasonic sensors mounted on a pair of glasses gives the user free range to scan 3 meters ahead wherever they think may be an obstacle based on their instincts and other senses. Sensors on all SENSE devices are able to constantly and simultaneously take readings at the same time. This built-in functionality enables us to further divide the combined 75° sensor arc, into 5 smaller subsections: left, center-left, center, center-right and right. Depending on where the object within the 75° arc, audio cues will tell the user which sector the obstacle is in and how far away the obstacle is. Since our sensors are accurate till 3 meters, 3 beeps will represent 1 meter, 2 beeps will represent 2 meters and 1 beep will represent 1 meter. The glasses will output “center-left, beep, beep” when an obstacle is 2 meters away and in the center-left sector.

The SENSE belt, on the other hand, supplements the glasses by acting as a stationary 180° frontal guard that constantly scans for obstacles. Sensors are designed to point at a 30° downward angle to not only scan for obstacles at waist height but also sudden changes in elevation, such as stairs. With two sensors covering the outer sides, 270° and 90°, and another two sensors facing 315° and 45°, the SENSE belt guards against obstacles and changes in elevation within the user’s front facing 180° arc.

The SENSE system mimics how we perceive sight and movement. When utilized in conjunction with one another, the SENSE belt and glasses provides a full frontal obstacle avoidance system that allows blind people to scan and probe areas around them. With more research into more precise sensors and improvements to our algorithm, the SENSE system will replace the use of a cane.