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Evaluation of the iSensor as a COVID-19 Physical Distancing Design Concept for Visually Impaired Adults

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***Abstract*— When the World Health Organization declared the COVID-19 outbreak a pandemic, physical distancing measures (most recognizable through visual cues) were implemented to lower transmission rates. Lacking access to these visual cues, physical distancing requirements have become a significant source of anxiety and an obstacle to independence for visually impaired people. In response, a COVID-19 physical distancing design concept for visually impaired adults called the iSensor was developed. Consisting of a hat within an embedded LiDAR sensor system, paired with a belt containing vibration motors that communicate proximity and direction of people, it would allow users to self-regulate their distance from others in public. Here we present the configuration, methodology, and expectations of early experimental evaluation of the performance characteristics of the iSensor system.**

***Clinical Relevance*— Visually impaired adults are unable to accurately physically distance while in public and therefore require a method to self-regulate their distance from others while in public.**

I. Introduction

The iSensor is a COVID-19 physical distancing design concept for visually impaired adults consisting of a hat and belt. It would utilize a Light Detection and Ranging (LiDAR) sensor and data processing to detect the presence and relative direction of people within 6 ft of the user. This information would be conveyed to the wearer by vibrating motors embedded in the belt closest to the detected presence. The design goals are: 1) omnidirectional detection of objects and their position within 6 ft of the user, 2) non-visually communicate the proximity of people detected to the user, and 3) differentiating between humans and inanimate objects. The following sections outline the planned approach for experimental evaluation of the iSensor against these goals.

II. Experimental Design

A. Testing Setup

A Pioneer 3-AT robot, similar in design to the FLOBOT [1] would be used with a vertical extension to elevate the LiDAR sensor. Trials will be performed where the height of the structure is varied by 1.68 ± 0.30 m.

During testing, the maximum speed of the robot would be set to 5.0 km/h, and the maximum turning speed would be 140^{o}/s, as these values resemble a human's motion in typical conditions [2]. Similar to the testing configuration and procedure in [3], the cycle frequency of the LiDAR's laser component would be set to 10 Hz and connected to an embedded Intel i7-4765T PC with an 8 GB memory to store all operational data (i.e. LiDAR data, robot odometry and obstacle calculations with timestamps) during testing for subsequent analysis against actual obstacle proximity information.

B. Assessment Methodology

To test the design's ability to differentiate humans and inanimate objects, the robot assembly would be introduced into a room containing people (both stationary and moving) and objects located in varying positions. The robot's movements during testing will mimic a human's movements (i.e. beginning from rest, accelerating, decelerating, stopping, and turning). Analysis of data will include determining the success rate of the iSensor system to correctly identify certain cloud point clusters as targets (humans). False positives/negatives will be investigated based on distance from the user and velocity of the user and target. Data obtained from this analysis will be used to train a resampling algorithm which, with additional network training and sampling, is expected to yield an improved human classification system.

III. Conclusion

The planned assessment is expected to reveal the capabilities and limitations of the iSensor system for detecting, classifying, and indicating the direction of proximate human and inanimate objects under nominal operating conditions while also highlighting potential field implementation challenges. Future testing will be required to establish the system's consistency in conditions that would be seen in its practical application (i.e. erratic changes in position caused from bobbing, swiveling, or turning of the head).

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