# Finger–Mounted Obstacle Detector for People with Visual Impairment

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*Abstract*—Mobility is the ability to move. People with visual impairment has limited mobility as they have limited vision to move safely without colliding against obstacles. This paper presents a wearable device using technology to help people with visual impairment to detect obstacles. The device uses an ultrasonic sensor to obtain real time information of distance between device and obstacles. This information is interpreted into an audio feedback which will alert or notify users the presence of obstacles in their path. The device is small enough to be worn on the finger and direction of detection can be changed by pointing the hand or finger elsewhere. Three experimental testing were conducted to evaluate the prototype. First experiment was to determine the detection rate on indoor and outdoor obstacles of different sizes and shapes in a controlled environment. Second experiment was to test the prototype with participants wearing blindfolds (no vision simulator) and walking in an indoor environment filled with real life obstacles. Third experiment was conducted with participants wearing low vision simulators walking in an outdoor environment. Results showed the prototype works better for people with low vision than no vision.

*Index Terms*—assistive technology, obstacle detection, ultrasonic rangefinder, visual impaired

## I. INTRODUCTION

Mobility is the ability to move easily and safely from one location to another. Human beings are designed to be a mobile creature but not everyone is mobile. Disease, accident, and genetic can result in mobility limitation. One limitation, visual impairment, reduces the mobility of people who suffers from the impairment.

Assistive devices or tools are used to improve the mobility of people with visual impairment such as a cane, guide dog and human assistance. However, the existing tools have limitations. Sweeping or tapping of the cane on the ground helps people with visual impairment in detecting ground level obstacle but not obstacles that are above waist level such as tree branches and open windows. Guide dogs could be trained to stop when there is obstacle, but it requires more care and expenses to maintain the dogs. Human assistance is the best solution but is very impractical as it involves constant human supervision.

## II. BACKGROUND

Numerous studies were conducted to improve the mobility of people with visual impairment by designing a device that can detect obstacles. Two common obstacle detection techniques used are vision-based and sensor-based. Vision-based obstacle detector obtains information through camera which can be mono–camera, stereo–camera or RGB–D camera [1]. In most vision-based applications, it requires a processor with high computational power to break down and obtain the desired information from the camera image which contains many information. There are many algorithms developed by researchers to do certain tasks but it has limited functionality in obtaining information on objects that are transparent and in dark environment.

Sensor-based method is usually straightforward as the sensors are designed to perform a specific task. Laser sensor has high precision and resolution which are commonly found in mobile robot navigation. The sensor, however, can be expensive and may not perform well in an environment exposed to strong sunlight. An ultrasonic sensor can measure distance of obstacles but it has lower accuracy when compared to laser. It has a wider range of detection but depending on usage, this characteristic can be a drawback when a precise detection of obstacle location is desired.

Some existing research works are ultrasonic-based obstacle detection which can be categorized into cane, robot and wearable. Smart canes are walking sticks used by people with visual impairment embedded with smart technology and are developed by several researchers [2]-[6]. The distinct differences of the developed prototypes are the amount of sensor implemented, the feedback system used for notification, length of the stick, and the field of detection.

Two ultrasonic sensors were implemented and were located at the bottom of the stick [2]. It detects ground level obstacle from left and right simultaneously. Haptic feedback was implemented on the handle of the cane. The prototype was designed to replace walking stick and is capable of detecting obstacle taller than 10cm. However, the maximum detectable height was not evaluated.

A similar prototype [3] was built with two ultrasonic sensors located at the bottom, haptic feedback but with an additional feature of audio feedback. Sets of sound are stored and will be played when obstacles are detected. It is designed to detect ground-level obstacle so people with

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