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Object Detection for the Blind Using Haptic Technology

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ABSTRACT

Blind people face many difficulties in obtaining information, communication, and mobility in almost every aspect of their lives. In this project we have developed a low-cost visual aid program called the Haptic Obstacle Detector that helps them avoid head-on barriers. Experiments have shown that HOD is able to see complex objects like glass. The thesis project aims to build an accurate and affordable device that helps blind people avoid obstacles around the head area. The device is called a Haptic Obstacle Detector (HOD). The HOD uses an infrared sensor and an ultrasonic sensor to measure the distance between a user and an object within a range of 3m. The results suggest that the Haptic Object Detector is easy to use and shows a promising concept to help the visually impaired avoid obstacles.

INTRODUCTION

Unlike normal visionaries, visually impaired people cannot see the world around them. Therefore, they are limited in almost every aspect of their lives such as walking, making decisions, etc. They have to deal with difficult access to information and communication. Thus, their personal, social, and professional lives are affected. We propose an object recognition algorithm, as well as a very helpful support system for their safety, quality of life and freedom for the other person at all times [1-4]. The purpose of this system is to enable the visually impaired to make independent decisions based on the vibration output from this model. The paper aims to build an accurate and affordable device that helps blind people avoid obstacles around the head area. The device is called a Haptic Obstacle Detector (HOD). The HOD uses an infrared sensor and an ultrasonic sensor to measure the distance between a user and an object within a range of 3m. HOD can work best in low light conditions [5-8]. The accuracy of measurement varies with object, object geometry and complexity.

METHODOLOGY

OBSTACLE AVOIDANCE AND OBJECT DETECTION

Avoiding obstacles is a basic but important task for the blind. While the blind can use the echo area to detect obstacles, it does not apply to everyday life as it is usually surrounded by people and ambient noise. Hearing then becomes busy hearing things moving and indeed the blind are right in this. When it comes to solid objects, work is almost impossible. So avoiding obstacles is in the interest of many manufacturers.

CHOICE OF SENSOR-ULTRASONIC

Ultrasonic sensor operates by extracting ultrasonic sound from the surrounding environment. If there are obstacles, a sound will appear. By measuring the time elapsed between output and receiver and known audio speed, distance can be calculated. Usually the ultrasonic sensor range does not exceed 10 meters, which is suitable for work however. Ultrasonic sensor inherits sound features. It does not depend on the light conditions or the color of the obstacles. It can also distinguish reflective objects, such as glass, that are invisible to most light-based machines. And the low noise speed and the simple system allow the ultrasonic sensor to provide excellent accuracy without complex calculations. In the commercial market, ultrasonic range detectors are not expensive. The drawback of the ultrasonic sensor is that it cannot detect noise disturbances. The situation occurs in two cases: either the object has a complex spatial structure, for example a sponge or theater wall, or a very large angle between the sensor and the object.

CHOICE OF SENSE-HAPTIC

The sound is not perfect for the blind, however. Although the oral message is a strong point, its length often results in a longer response. There is also great concern that noise may interfere with other important local sounds. Haptic, referred to as any kind of non-verbal communication that involves touch. Probably the best inheritance of haptic understanding - only the user feels the impact of the touch. The skin is ready for rejuvenation as the skin area is larger and less used during travel. Haptic view is fast and allows the user to respond in a natural way. Although sighteders seldom see the importance of haptic, blind people should take full advantage of it. The blind community is believed to find many benefits in haptic research.

LIST OF COMPONENTS USED

1) Ultrasonic Sensors - PING 28051 x2
2) Vibration Motors PJFVMA011001B-B0 x2
3) Piezoelectric speaker
4) Arduino Nano / UNO
5) Breadboard
6) Tinkerkad and Proteus-Software

OVERALL DESIGN

System can be divided into three modules

- □ Sensing module: includes all sensors and related electronic circuit to collect environment data.
- □ Controller: deals with acquired signals from sensors - signal processing, calculates distance information, applies algorithms, sends command to haptic module and perform other functions.
- □ Haptic module: handles command signals from host controller and display corresponding tactile experience. The HOD hardware is composed of an Ultrasonic sensor with the aim of intercept obstacles with different surfaces, a vibrating actuator to give the signals to the user and a controller board (Arduino Uno) to process the input and output signals. In order to sense an object with two sensors, the sensors are arranged so that they are as close as possible to each other and have parallel view axes. The vibration motor is embedded in a hand grip module connected to the main board. In the early-stage prototype, the rest of the modules are located in a portable platform so that user can hold and carry around, point to objects of interest and feel the distance.

WORKING PRINCIPLE

The Ultrasonic sensor sends high frequency pulses, these pulses reflect from the object and take the form of an Echo, the time between the echo and the Trig is measured by a microcontroller or an Arduino directly proportional to the distance (figure 1). The sound speed is 341 meters per second in the air, and the distance between the sensor and the object is equal to twice the speed of sound. We used Proteus to design a circuit (figure 2a) and Tinker cad to mimic a system (figure 2b), in which high pulses were sent by an ultrasonic sensor from an echo object, the time between transmissions and waves received. measured with a small controller directly proportional to the distance.
Distance = (Time * Speed Of Sound) ÷ 2

As the distance between the sensor and the object reduces, the time between the transmitted and the received waves decreases hence the distance measured also decreases in the same ratio which is then checked by the microcontroller as per the condition set up that is, as the distance reduces a higher output is provided to the vibration motors and hence the vibration increases as the object comes to a closer proximity.

The detection of the object depends on the placement of the sensors and the angle. The sound waves sent by the sensor may interfere with the adjacent sensor hence the placement of the sensor highly contributes to the detection of an obstacle. In (fig. 3a) it represents how the signals cam interfere with the adjacent sensors. Separating them experimented angles we can get the maximum range out of the sensors to make the system efficient.

The shape and size of the cylinder used in the ultrasonic sensor can highly affect therange of the ultrasonic sensor. A slight increase in the dimension of the cylinder of thesensor, the transmission range highly increases hence it can over a large angle of theplane. These features can be used to develop the device on real scale with all the necessary components within the usable range of the subject using the device (figure 3b). The device as of now provides detection of the head-height region. The device can cover 180º in the x-y plane due to head movement of the user which the user can move as per their convenience .

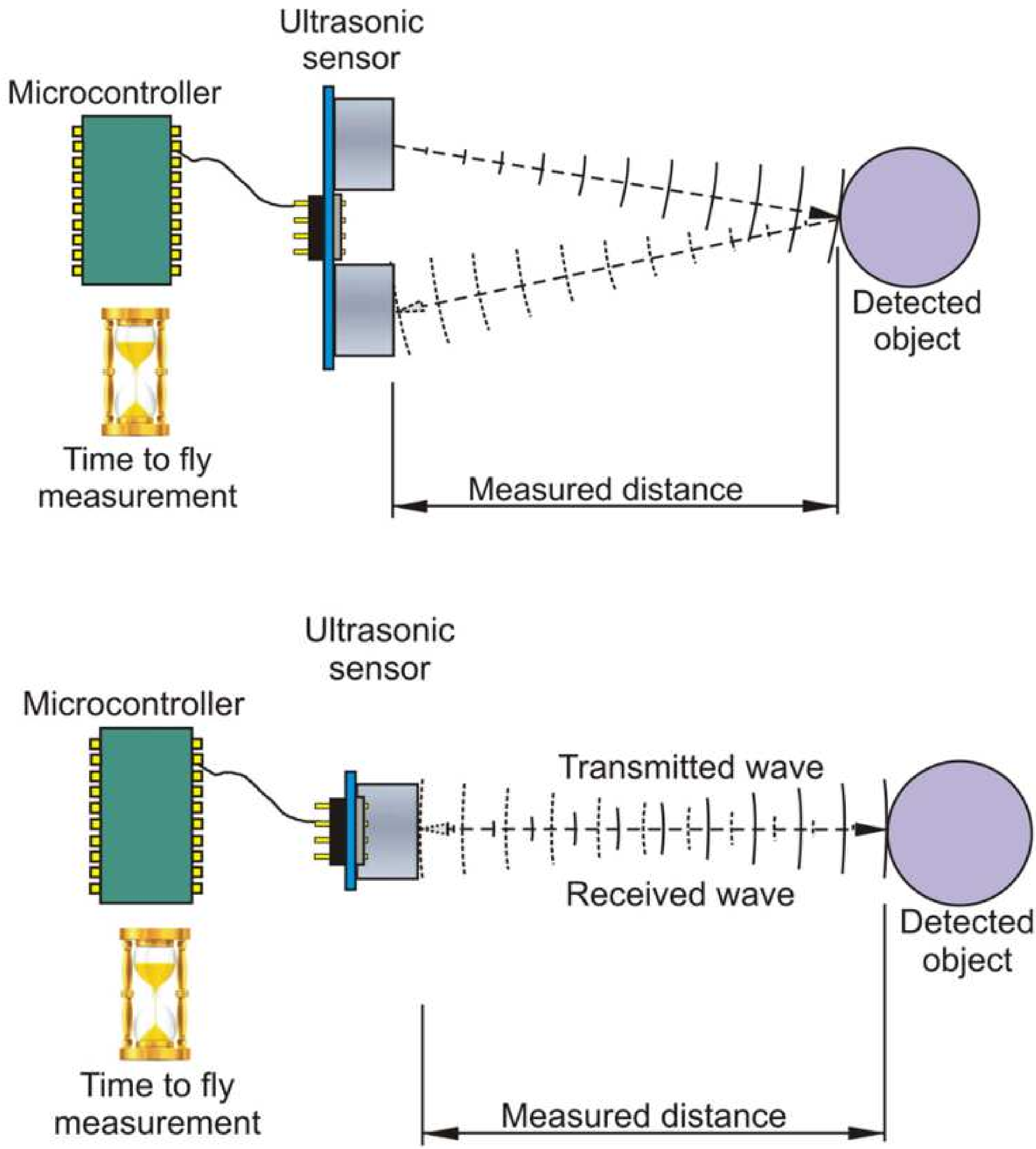

Figure. 1 – Ultrasonic sensor working principle[7]

CONCLUSION AND FUTURE SCOPE

Experiments performed have proven that Haptic Obstacle detector can detect sharp and complex objects like glass. Results suggest Haptic Object Detector is easy to use and shows a promising concept to help the visually impaired avoid obstacles .The overall system makes use of ultrasound to detect object and notify the user about the upcoming obstacle through haptic here the sense of touch where the vibrations of the motor increase as the objects approaches closer to the user and therefore giving the user an idea about how far the object is from the user. The sensor for object detection needs to be put to test but sonic based sensors have given best result for this purpose. The future scope of this project can be that entire setup can be used as a wearable device like spectacles. We have built a three dimensional model for camera and ultrasonic vision using Tinkercad software (figure 4).

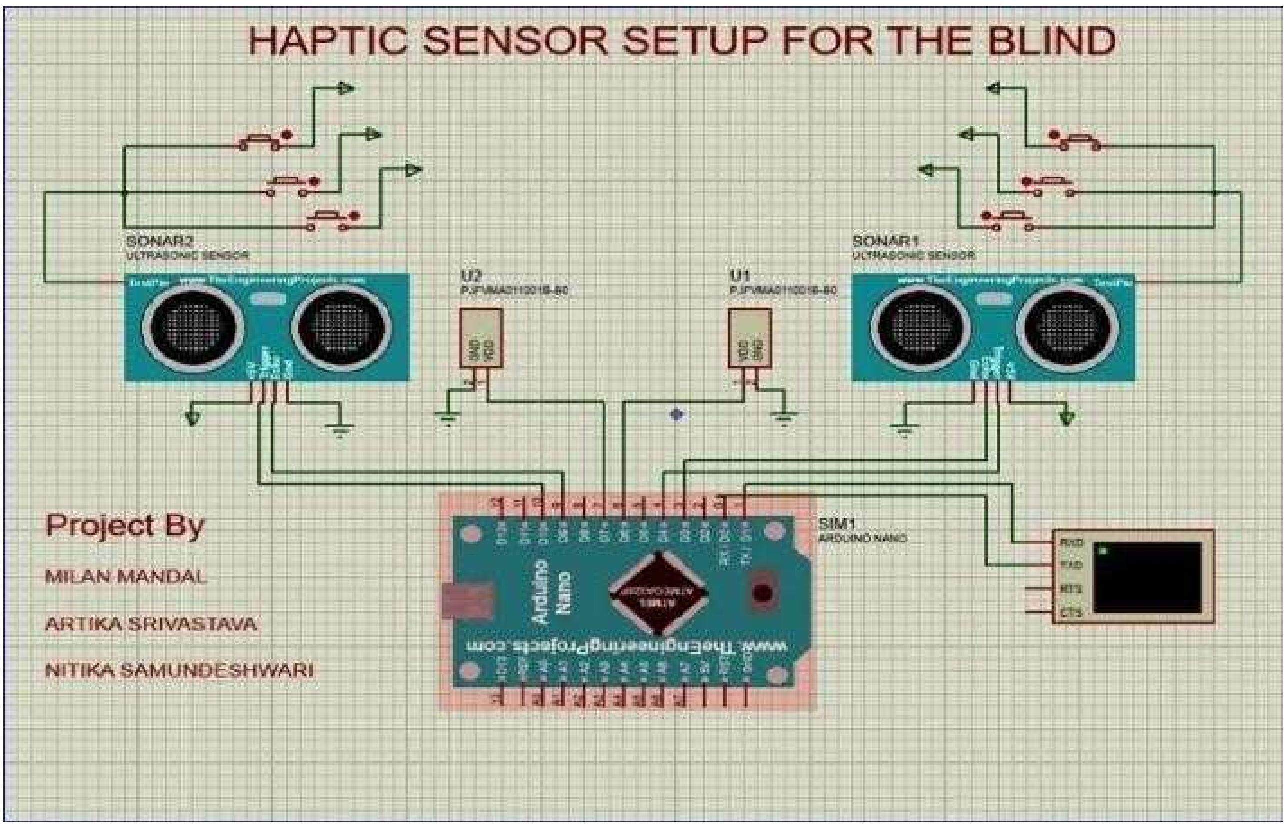

Figure 2a - PROTEUS CIRCUIT DESIGN

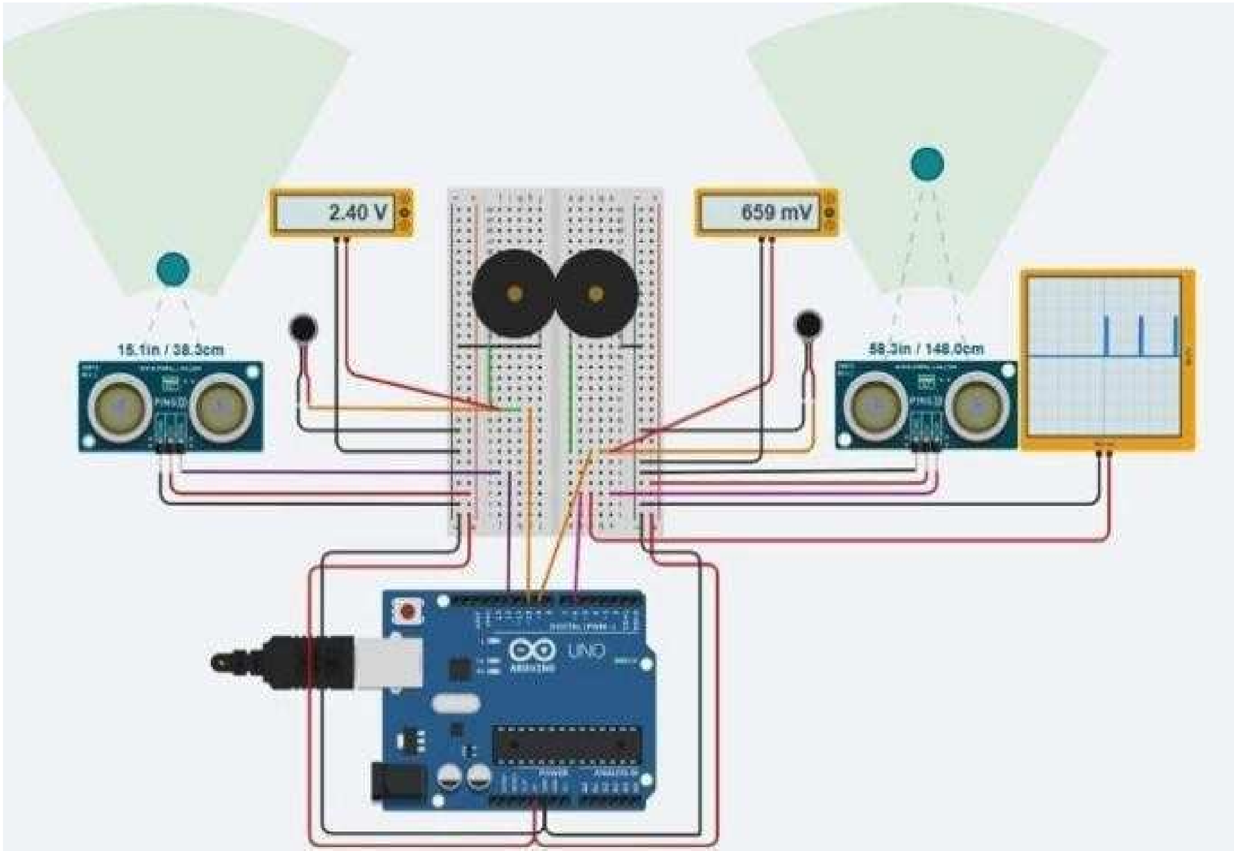

Figure 2b - TINKERCAD SYSTEM SIMULATION

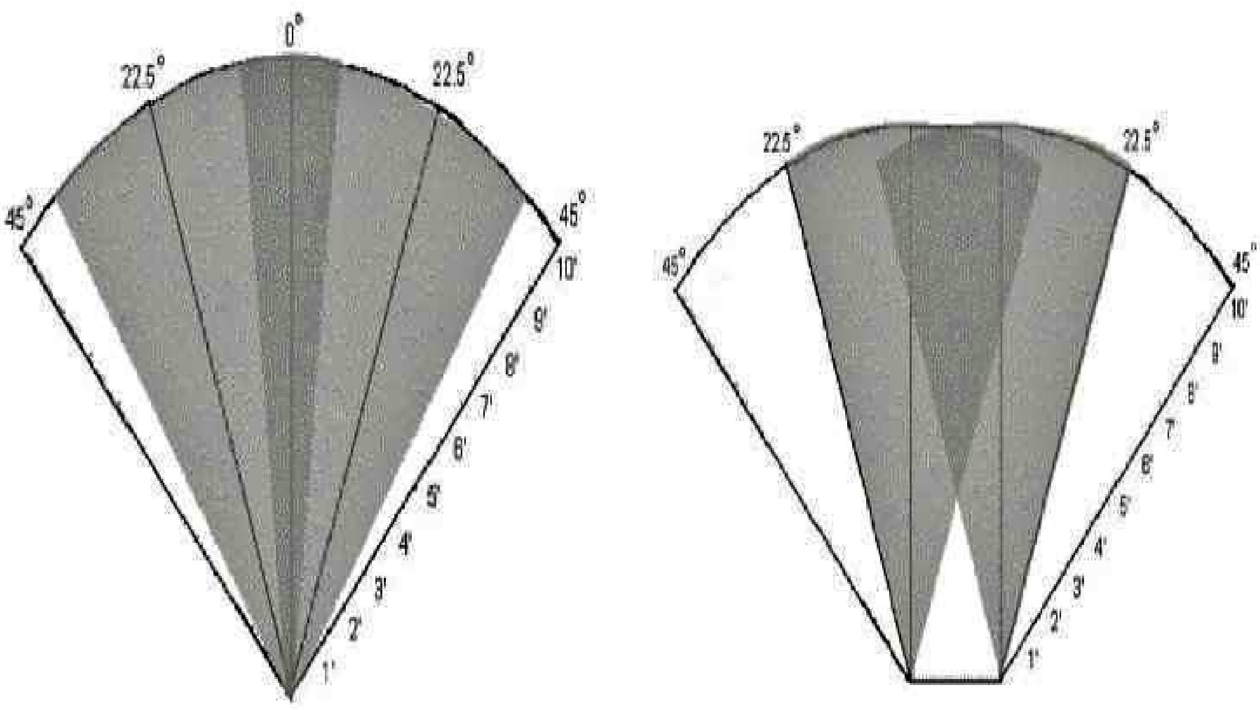

Figure 3a- Efficiency based on angle of placement

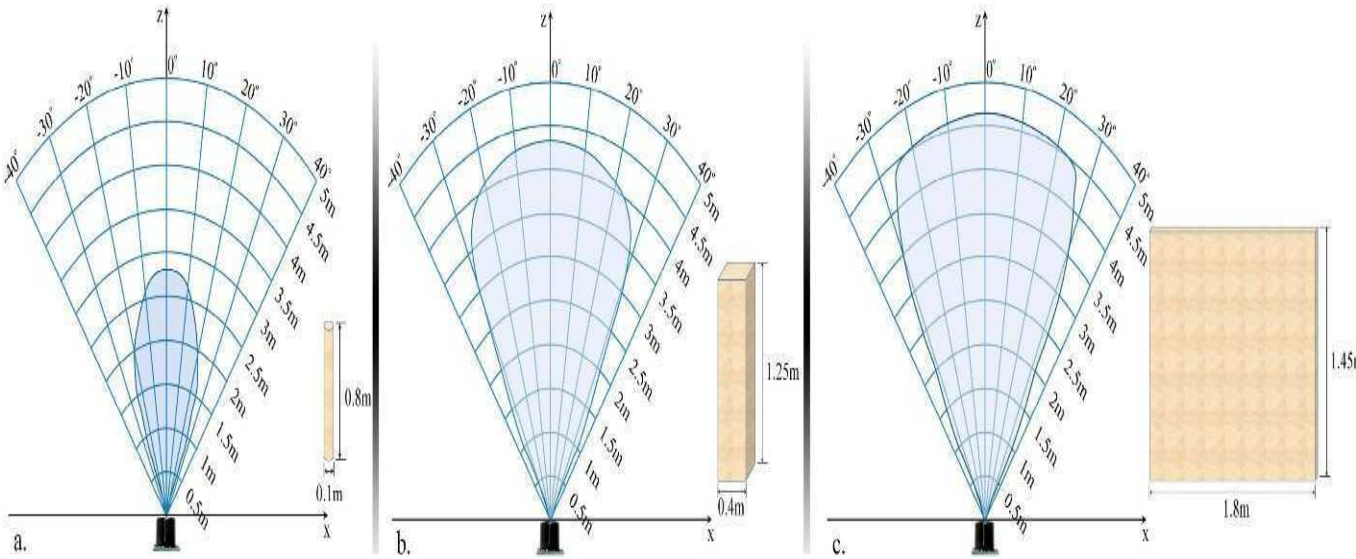

figure3b- modification to ultrasonic sensor for variable range and accuracy

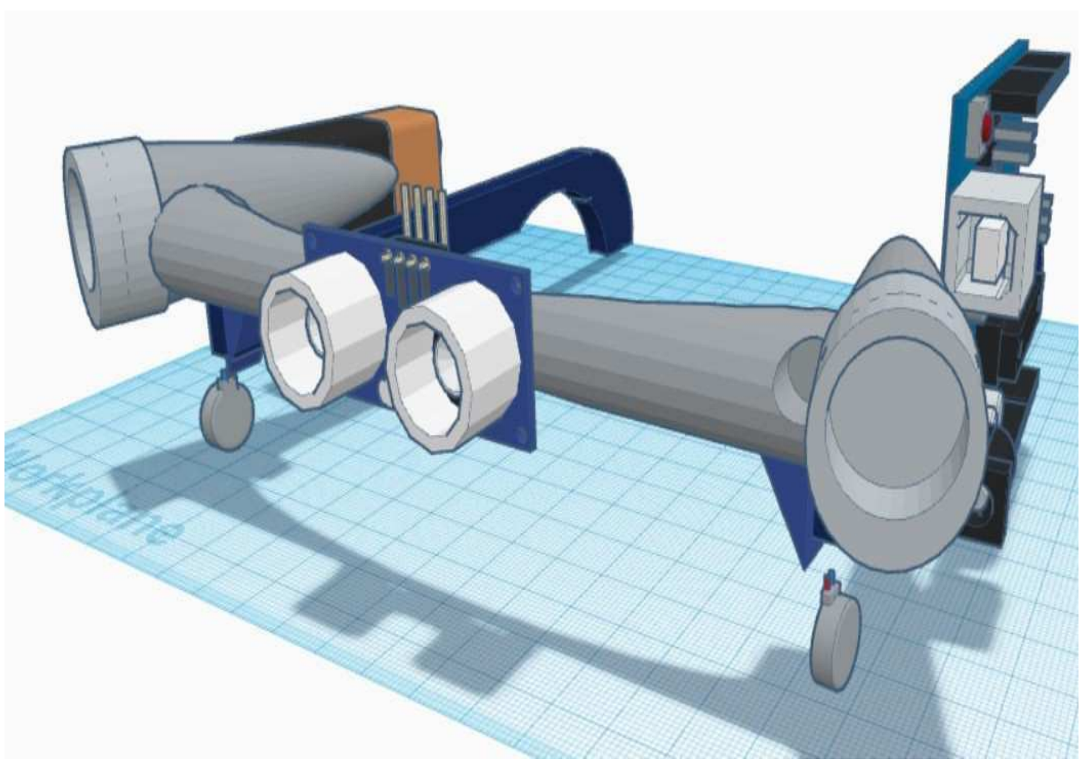

Figure 4 -Future Scope for camera vision and ultrasonic vision (Tinker cad 3D)

The frame of the spectacles can be used for the placement of the ultrasonic sensor and the microcontroller where the ultrasonic sensor can be placed at different angles to gain wider range. The frontal frame can make use of a camera module and with the help of object detection the system can notify if the object is something the user needs to be concerned of or not hence help in distinguish between various objects and which object is at what distance from the user giving the maximum perception of his surrounding and making him aware of the proximity world. We have additionally developed a hardware prototype in which the ultrasonic sensors detect the object in front of them and produce resulting vibrations in vibration motor (figure 5).

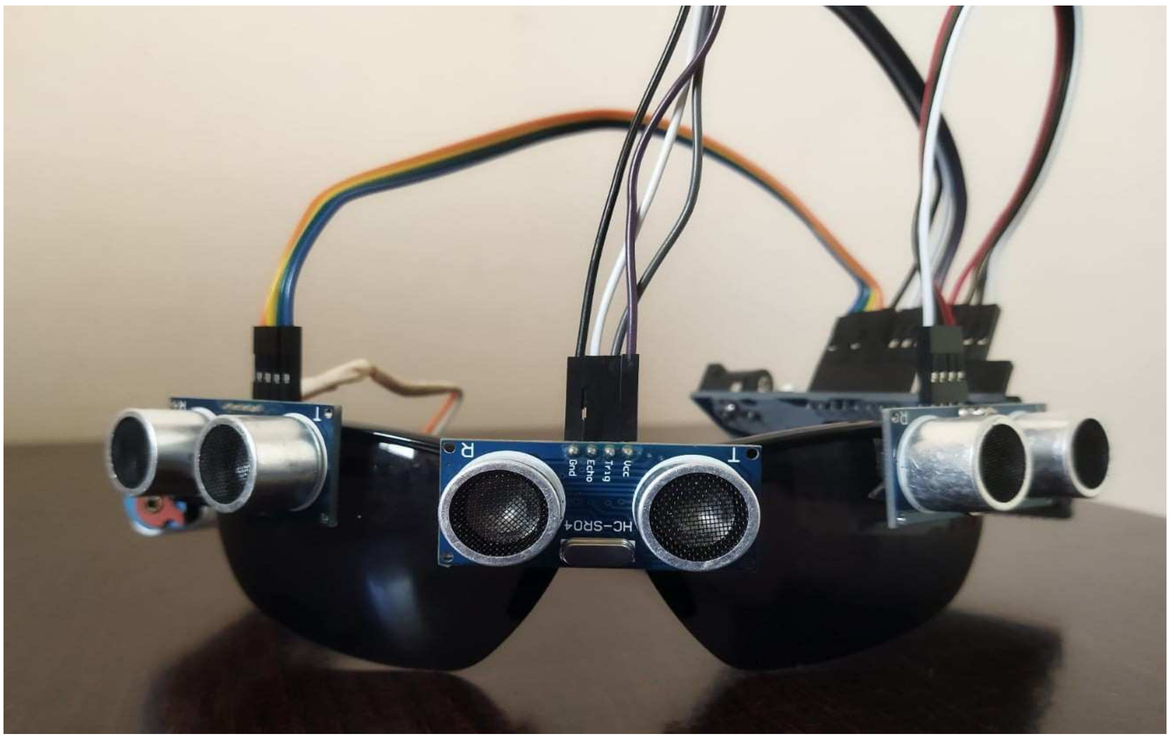

Figure 5– Haptic sensor prototype

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