Object Detection using Ultrasonic Mapping with MATLAB

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Abstract: The aim of our project is to design a device capable to detect objects where non-contact distance measurement is required. In this project we will use ultrasonic sensor with configured arduino as a primary component for object identification and matlab software as a secondary for output mapping. Matlab is a high-performance language for technical computing like image processing and used as a graphical user interface. The reason behind the use of Ultrasonic sensors is to overcome the problems by IR proximity sensors and these sensors are well suited for object sensing applications like UAV navigation in drones, liquid level control in containers and anti-collision detection.

KEYWORDS:*Ultrasonic sensor, Matlab, Arduino, 3d-plotting.*

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INTRODUCTION

Object detection is defined as detecting the object presence or its state in unaccessible areas like high temperature areas,pressure zones etc.It will be the crucial task for industries in the above mentioned areas. Ultrasonics is one of the emerging technologies that were widely developing in industrial applications Ultrasonic devices are used to detect objects and distance measurement. This kind of measurement is particularly applicable to inaccessible areas where traditional measurement methods cannot be implementedUltrasonic sensors generates sound waves to detect the object. The sound waves from Ultrasonic sensor strikes the object and reflected back to the sensor. The receiver in the sensor receives the sound waves and convertsreflected sound to electric signal. Ultrasonic sound waves are travelled through air ,water and metals. These sound waves has frequency higher than the human hearing (20HZ-20KHZ).Ultrasonic sensors are classified into two types based on the material used for sensing. In this Project we are using ultrasonic sensorwhich works based on piezoelectric material. These sensors have more accuracy for measuring the thickness and depth of parallel surface. These sensors could easily sense the nature , shape ,orientation of specific objects which is within the area of these sensors and also able to measure approaching or receding object.

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided. In Section 2 we discuss related work. In Section 3 we have the complete information about hardware and software requirements.Section4 shares information about the existing system . Section 5 describes the Propsoed system and process involved. Section 6 shows the figures of experimenta results. Section7 tells us about the future scope and concludes the paper with acknowledgement and references.

OBJECTIVES

The main aim of our project is to design a device capable for object detection and distance measurement for various positions and tracking the object positions using matlab. In this project we are using ultrasonic sensor with configured Arduino as hardware and software side we are using Arduino IDE to upload control code to the Arduino and get detection data from the ultrasonic sensor through serial port .Matlab is used to receive data from the serial port and plots the graph.

RELATED WORK

There are numerous works that have been done related to object detection using ultrasonic sensors.

1. "Ultrasonic anti crashing system for automobiles" IEEE paper published in 2013, attempted to develop an anti-crash warning system combined with ultrasonic ranging technology and sensor technology for automobiles. It mainly focusses on potholes in the road and its detection and hence automatic or manual reduction in the speed of the vehicle in order to avoid crashing.

2. In "Cooperative vehicle collision avoidance using inter-vehicle packet forwarding" IEEE paper publishes in 2005, proposes a broadcast oriented packet forwarding mechanism for intra-platoon cooperative collision avoidance (CCA) using dedicated short range communication (DSRC) based wireless networks. Using an implicit acknowledgement strategy it is shown that with inter-vehicle spacing of nearly one second, the proposed mechanism is capable of saving up to 90 percent of vehicles in a platoon from chain crashes following emergency events at the front of the platoon.

3. Ultrasonic sensor for distance Measurement". Ultrasonic sensors operate at frequencies in the neighborhood of 50 kHz. They simultaneously transmit and also receive short ultrasonic pulses by the means of a piezoelectric membrane element. Signal processing circuitry is integrated in the sensor. The detection range of ultrasonic sensor is about 2.5m. Many researches are being conducted to expand the range up to 4.0 m. The calculation of the time interval between sending the signal and receiving the echo is done by the sensor in order to determine the distance to an object.

HARDWARE AND SOFTWARE REQUIREMENTS

A brief description of the components that used in the implementation of the design is covered in this section. It includes the hardware components (Arduino Uno board, ultrasonic sensor, and buzzer) and also the MATLAB software.

1. Arduino UNO

Arduino is a physical computing platform that released under open-source license and based on a simple microcontroller board (Figure 1). Integrated Development Environment (IDE) is devoted for coding the device. In most applications, the Arduino board is used as a controller. Initially, the device requires a direct connection to a computer at the first setting steps. However, it can function efficiently without this connection according to the application requirements.

Fig. 1: Arduino Uno Board

2.HC-SR04 Ultrasonic sensor

The HC-SR04 uses non-contact ultrasound sonar to measure the distance to an object, and consists of two ultrasonic transmitters (basically speakers), a receiver, and a control circuit. The transmitters emit a high frequency ultrasonic sound, which bounce off any nearby solid objects, and the reciever listens for any return echo. That echo is then processed by the control circuit to calculate the time difference between the signal being transmitted and received.

Fig. 2: The Ultrasonic Sensor(HC-SR04)

3.Buzzer

Buzzer produces sound which is based on frequency tuned to it.In this project the buzzer sound increases when the object comes close to sensor and decreses sound when object goes away to the buzzer.

Fig. 3 :Buzzer

4.Matlab Software

Matlab software enables us to perform plotting of functions and data. In this project we accessed the distance data to matlab and aligned the distance values to a 3d object which gives the movement of object infront of sensor.

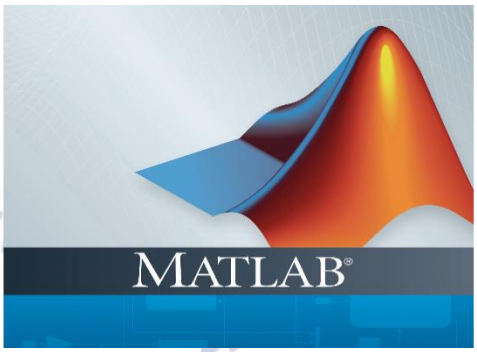

Fig. 4:Matlab Software

EXISTING SYSTEM

The existing design consists of ultrasonic sensor (HC -SR04) that coupled with the servomotor. The combination is controlled by Arduino board to identify the distance between an object and the sensor. In this work, the materials: wood, sponge and Aluminum are chosen for the objects to validate the design operation.

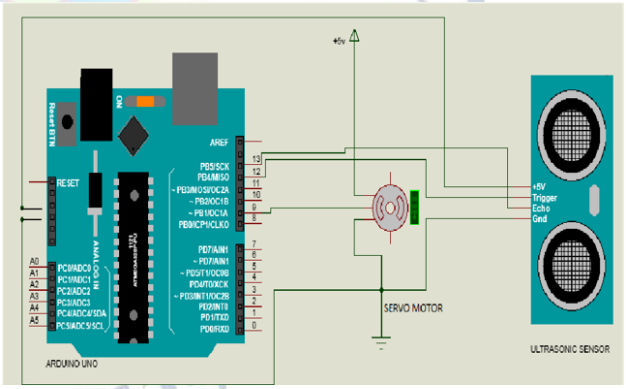

Fig 5: Electronic circuit for ultrasonic radar

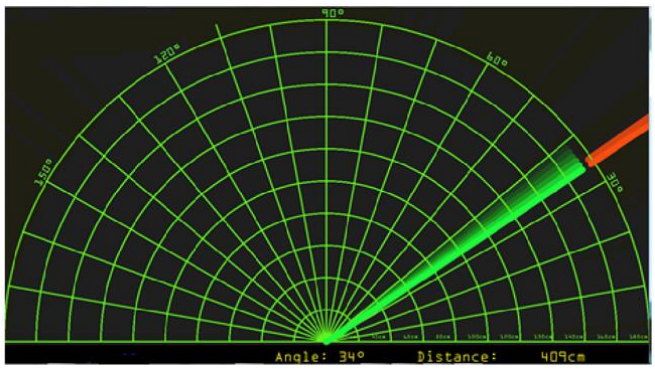

Fig 6: Ultrasonic radar

The existing system gives the detection map for stationary objects which are placed before the Ultrasonic sensor which is a big drawback for objects which are in motion. Here the problem arises for tracking and detecting the objects which has motion.

PROPOSED SYSTEM

The proposed system consists of ultrasonic sensor(HC-SR04), Buzzer, Arduino Uno and matlab installed pc.

The sensor and buzzer will be controlled by Arduino microcontroller .Ultrasonic sensor generates sound signal to desired target which is not stationary and receives echo from it. So the distance value varies when the object moves closer or away to sensor.The distance data is taken from Arduino to matlab through serial port. Here the distance values will be continuously varied due to object motion,thesevaluesare given to 3d object translation. So when the object moves infront of sensor ,the 3d object created in matlab also gives the same movement and distance values also shown in 3d plot.

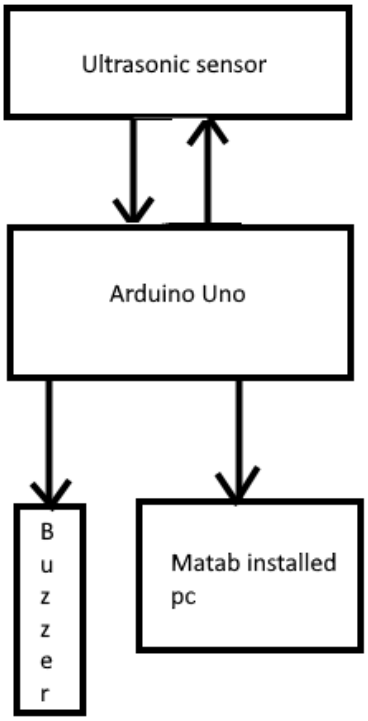

Fig7: Block diagram of the proposed system

EXPERIMENTAL RESULTS

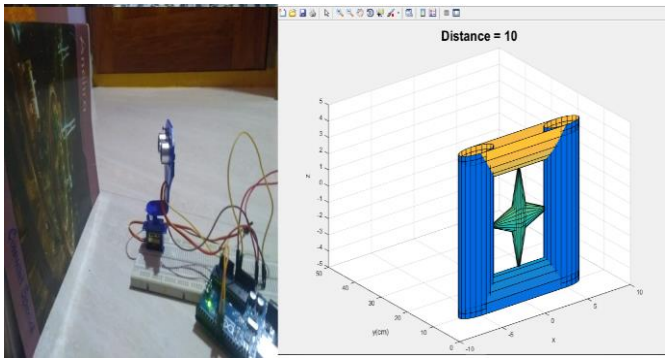

Fig 8: Experiment result for object moves closer to sensor.

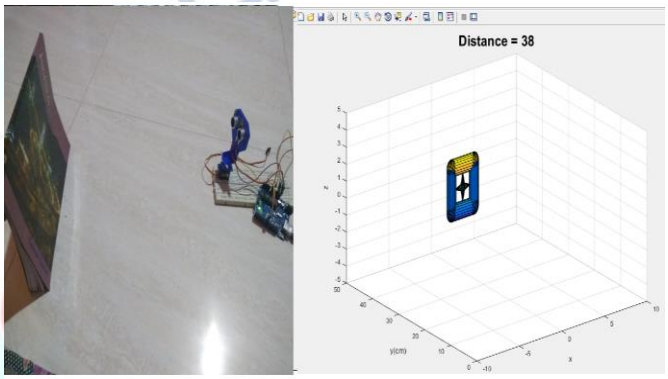

Fig 9: Experiment result for object moves away to sensor.

Here the 3D plot is looped which continuously displays the desired target presents in sensor range.

FUTURE SCOPE AND CONCLUSION

This paperpresents a new way of detecting objects using matlab which overcomes the drawback of existing ultrasonic radar system that wont work for detecting non-stationary objects. This project can be used for security purpose for the safety of humans by detecting stataionary or non-stationary object interference in a given range of distance. Since this project has many security values, the future scope for this project is high in industrial works and millitaries.For many applications, this can be used as the base material.

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