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Digital Measuring Tape

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Abstract

Nowadays, all kinds of measurements require human aid in one form or the other for the accurate measurements to be performed, until the proposal of this device. The proposed device ultrasound sensing technology that transmit ultrasonic waves and receive them with the ability to output the time delay between the transmission and reception of the ultrasound. Hence using this method, one is able to measure the distance between two objects without physical means of measurements. The device automatically calculates the distance as per the programmed code and displays the distance measured in meters. The SI unit can be changed if needed for more precision.

Keywords: *Circuits, digital, distance, embedded, measurement, sensing, sensor, system, tape*

INTRODUCTION

Accurate measurement of distances is very valuable information in the engineering industry. Hence, there is a need for an accurate method of measuring distances easily. This must be in a way that is different from the conventional measurement system that requires the need of an extra person to position the measuring tape to the level to which the measurement is to be taken. Digital measuring tape is a single person device that solves this problem. Digital measuring tape is the proposed device that enables the area of measuring distances with the help of an ultrasound sensor. The product contains an Organic Light Emitting Diode display which displays the measured distance. The measurement calculation works on the distance time formula. The ultrasound sensor sends ultrasound waves that obstructs the object placed in front of it, to which the distance is to be measured. The time required for the ultrasound wave to reflect back is calculated by the ultrasound receiver. Half of this time is used to find the distance between the obstruction and the digital measuring tape. This time is taken as the input for the arduino program which calculates the distance between the device and the obstruction and displays the distance in real time on the OLED screen.

SYSTEM DESIGN

Ultrasonic distance detection is the method capable of measuring the distance between two points using ultrasound waves. The device uses a 9V battery rather than a chargeable lithium ion battery to reduce the size of the device as well as the weight. This made the device a small light weight device that can easily be held in hand. The body of the device is made of 3D printed plastic PLA and is highly durable. The design was made to accommodate all the hardware parts of the device with the least vacant space. Hence, the device is compact and smaller making its usage and handling much easier than other devices. There are separate slots within the body of the device for the ultrasound module, the arduino Nano and the battery to be held in position. This is done so that the parts do not shake or wiggle around causing any hardware damage. The body of the device is a two-

piece body which is tightened down using screws. The device is water tight but not water proof. This is due to the need if the exposed ultrasound sensor part along with the programmable port of the arduino.

The device consists of an ultrasound sensor that works as the wave generator and sends out ultrasound waves to the distant object. Here, the distant object is the obstruction to which the distance is to be measured. The wave gets obstructed by the object and is then reflected back to the ultrasound wave receiver. The receiver receives the reflected waves. The time taken by the wave to reach back to the receiver is calculated and is given as the input value to the arduino code. The distance is then calculated by the distance time formula to get the distance which is the speed of sound multiplied by the time taken by the wave to reach back to the receiver ultrasonic sound–transmission and reception.

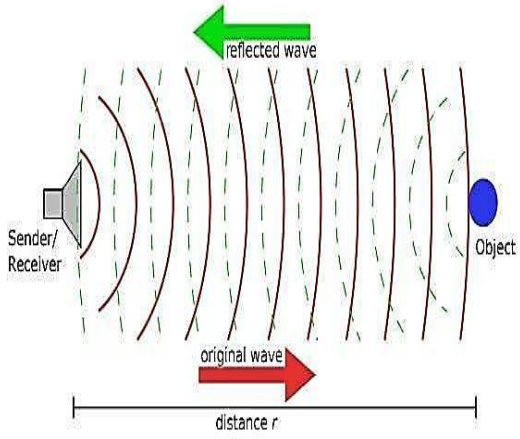

Figure1: *Ultrasound Wave Propogation*

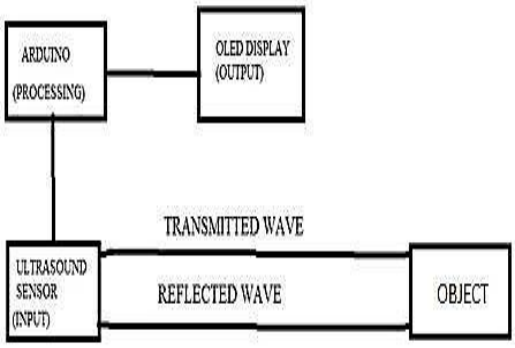

Figure 2: Device Block Diagram

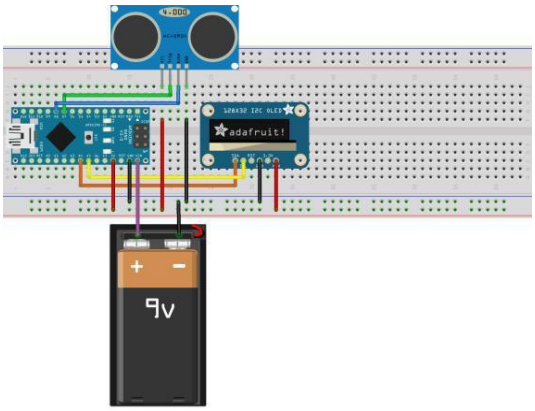

Figure 3: *Schematic Diagram*

HARDWARE USED

The heart of the product as it is the brain to calculate the distance as per the time taken to send and receive the ultrasound waves. This compact board ensures the minimum size and power requirement for the device helping in its battery life. The processing speed is also faster and hence it provides accurate values within the minimum time.

Arduino Nano

The arduino Nano is the brain of the device. It is the digital microprocessor that is used to perform the logic calculation required. It is a programmable board that uses high level language to be programmed in an IDE namely the arduino IDE. The board uses very little power and this again ensures the maximum performance and lifetime for the device. The program is easy and can be edited. Once edited, the SI unit of the measurements can be changed also provisions to store the distance of previous measurements can also be added.

Figure 4: *Aurdino Nano*

Power Source–Battery

The device is powered using a 9V dry cell battery. The battery supplies 5V to the connected devices through a 5V power regulator. Since the device uses very little power, the battery can last up to 2 years or more considering the normal usage.

Figure 5: *Battery*

Figure 6: *2. HC-SR04 ultrasonic sensor.*

ultrasonic sensor is a device that transmits and receives ultrasonic sound waves. It has a sensor and a transmitter region for their active operation. The trigger and echo are the two pins besides the ground and VCC (Voltage supply). The sensor works on 5V and uses minimum amount of current down to a few milli amps. Hence, the sensor is suited for the device as it ensures maximum battery life to the device.

OLED Display Module

The OLED display module uses i2c protocol to display the measured analog distance value as a digital output in meters. The SI unit can be changed to meters, millimeters or centimeters for more precise measurements. The display is in white and is clearly visible even at high bright daylight.

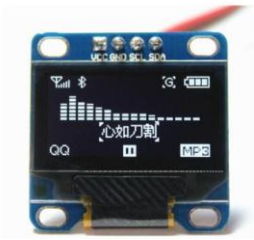

Figure 7: *OLED Display*

RESULT

The models of the device were designed in Autodesk 360 and was checked for errors and accurate measurements for the model was studied and verified. After which the 3D models were sliced and printed to form the case of the product. Then the ultrasound sensor, OLED display and arduino nano were collected and the connections were done as per the given schematic diagram. The connections were verified and the program for the device to work the digital measuring tape code was programmed in arduino IDE and uploaded to the arduino. Next the device was tested for accuracy. A known measurement was calculated using the device to ensure accurate readings and measurements. Now, the maximum measurable distance for the digital measuring tape was found by moving the device accordingly. Hence, the maximum range was found to be 6 meters.

Next the power requirement for the device was measured and was found to be in the hundred milli ampere range. The device requires a few seconds to measure the distance and calibrate, hence, the power requirement is very low. This ensured the long life and working time of the device roughly till three years. The device was made to measure distances and the accuracy of the device was calculated to be one hundred percent accurate till its maximum range of 6 meters. Now the device was finally assembled and the components were placed inside the 3D model and was secured in place to finish off the device.

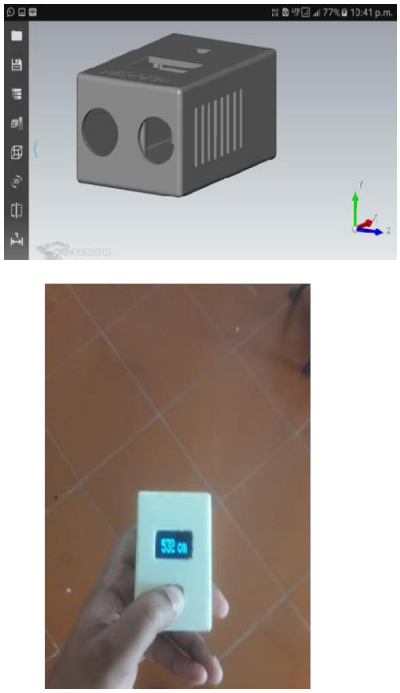

Figure 8: *Model of the device.*

CONCLUSION

A better method of measuring the distance between two objects were obtained by the creation of the product. In future, the device is to be upgraded to a laser system by which the range of the device can be increased to 100 meters. A laser transmitting and receiving system is needed for this and can work on the same principle and logic of the current device. In this system, the laser light or radiation replaces the ultrasound waves. This ensures the low cost of the product as well as the efficiency and range is at maximum level at affordable prices. This product can also be modified either for domestic or industrial use as per the needs of the user.

LITERATURE REVIEW

Our project title is "Digital Measuring Tape", accurate measurement of distance is very valuable information in the engineering industry. Mainly, our problem was the inability to measure distance easily with a conventional measuring tape and to produce accurate and precise lengths. We have found the problem's solution. We went through the books named as reference no (3), fundamental and application of ultrasonic waves by J. David N. Cheeke. We found that the easiest way to calculate distance was to measure the time interval between the transmission and reception of the ultrasound wave. Since the only unknown is the distance, we were able to calculate it by the time found. Hence, this is an efficient way to measure small distances precisely.

ACKNOLEDGEMENT

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