An Embedded System for Measurement of Ultrasonic Distance Meter for Biomedical Applications

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Abstract: ***The present paper describes how the embedded system is used for measurement of ultrasonic distance meter with few biomedical applications. Ultrasonic has become important in various fields such as in biomedical field, industries, communication system etc. They can be easily focused with little spreading. This application describes a distance measuring system based on ultrasonic sound. The system transmits a burst of ultrasonic sound waves and receives the echo. The time taken for the ultrasonic burst to travel the distance from system to subject and back to the system accurately measured by this system. Assuming the speed of sound in air at room temperature to be 1100 ft/sec. The given circuit computes the distance between the system and subject and displays it using a 2 digit static LCD driven by its integrated LCD driver. This application is based upon the reflection of sound waves. If the speed of sound in the medium is known and time taken for the sound waves to travel a distance from the source to subject and back to the source is measured, the distance from source to subject can be computed accurately. This is the measurement principle of this application. Sound waves used here are ultrasonic and medium for sound waves is air. Therefore this work will be very useful for heating tissues to treat various ailments and it is used to sterilize surgical instruments. From this work we have also studied about some application in field of Medical like Heart beat monitoring, Surgeries, Blood Pressure measurement, temperature Measurement etc.***

Keywords: Sound waves, ultrasonic sound, distance meter, LCD, Biomedical

1. Introduction

The present work plays an important role and very useful for our services. Ultrasonic measurement technology is used for physical, electronic, mechanical, and materials science-based general-purpose system. Ultrasonic measurement technology is through ultrasound generation, transmission and reception of the physical process. Its basic principle is that ultrasonic wave propagating in the medium, when encountering different interfaces, will result in reflection, refraction, diffraction, attenuation and so on shown in fig (A). It is an oscillating sound pressure wave with a frequency greater than the upper limit of the human hearing range.

When the ultrasound propagation the changes occur in the several parameter. Determination of the changes in these laws will be entitled to some of the material situation of the nature and internal structure. Ultrasound has the features such as strong directivity, nondestructive testing, propagating a long distance in a suitable medium almost without attenuation, so it is often used for distance measurements. Ultrasound is thus not separated from normal (Audio) sound by differences by physical properties, only by the fact that humans cannot hear it. Although this limit varies from person to person, it is approximately 20Hz to 20000 Hz in healthy, young adults. Ultrasound devices operate with frequencies from 20 KHz to several gigahertz's shown in fig (b).

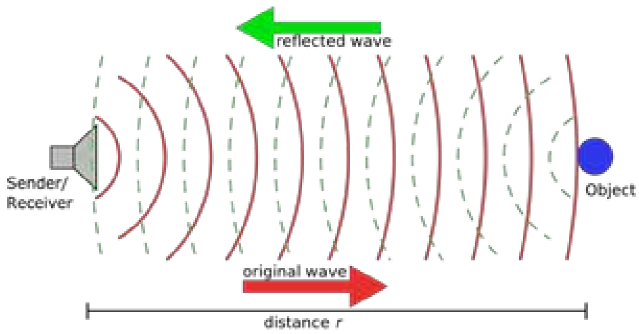


Figure a: transmitted and reflected Wave

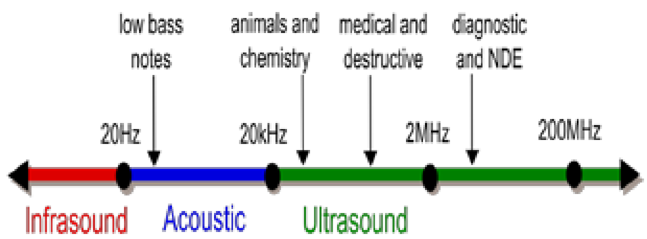


Figure b: Ultrasonic distance meter range

2. Block Diagram of Transmitter and Receiver

The block diagram of transmitter and receiver is as shown in fig (C).

The transduction element first emits a burst of 12 pulses at a frequency of about 40 KHz. This frequency is roughly identical with the resonance frequency of the two transducer;

so that some part of selectively is obtained at sensing element. As soon as the first burst is emitted, a bistable is actuated which enables the counter: Immediately after the burst has been emitted, the unit is switched to reception. The sensitivity of receiver is the function of time during and immediately after the emission of the burst, the sensitivity is low. Crosstalk between the transduction and sensing elements has therefore no effect on the operation of the unit. If echo is received very soon after the cessation of the emitted burst, it will then be sufficiently strong to be processed by the receiver in spite of very low sensitivity. An echo that takes longer time to reach the sensing element will be weaker, but by then the sensitivity of receiver has become higher. The upshot of this arrangement is that reliable measurements, unaffected by spurious reflections and cross talk, may be made with relatively simple means. At the instant the echo is sensed, the bistable is rest and counter state transferred to the output latch.

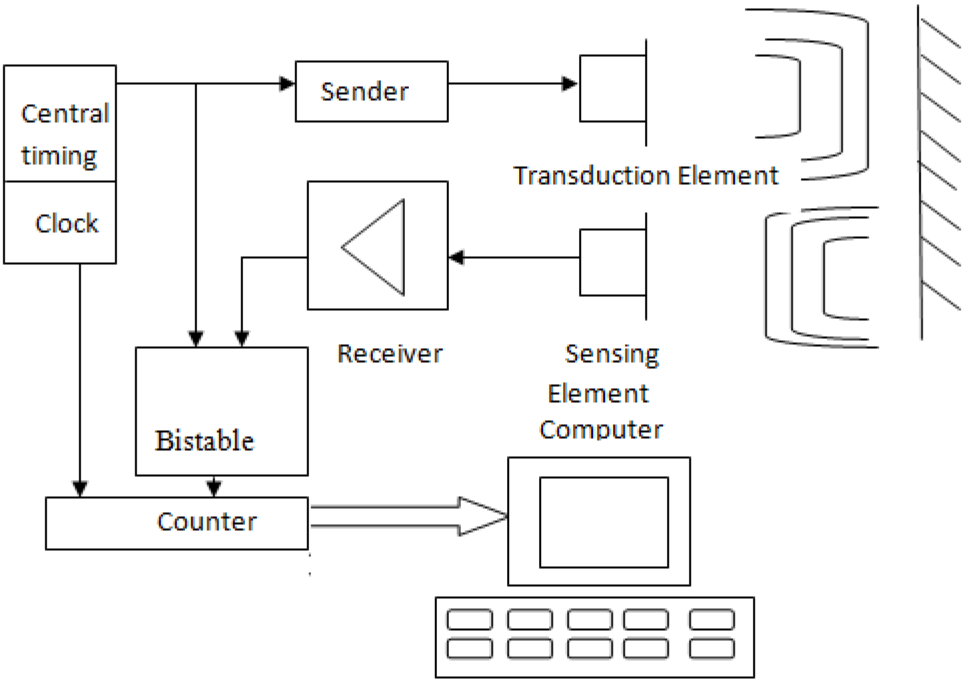


Figure c: Transmitter and Receiver circuit with Microcontroller

- A TransmitterA Receiver
- A timing and time reference section
- A counter display
- A Microcontroller

3. Ultrasonic Distance Meter

The Ultrasonic distance meter presented here is suitable for measuring distances between 25cm to 6 m is as shown in fig (d). Ultrasonic distance meter works on a principle similar to radar or sonar which evaluates attribution of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. This technology can be used for measuring: wind speed and direction (anemometer), fullness of a tank and speed through air or water. For measuring speed or direction a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water. To measure the amount of liquid in a tank, the sensor measures the distance to the surface of the fluid. Systems typically use a transducer which generates sound waves in the ultrasonic range, above 18,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed. The technology is limited by the shapes of surfaces and the density or consistency of the ma material. For example, from the surface of a fluid in a tank could distort a reading.

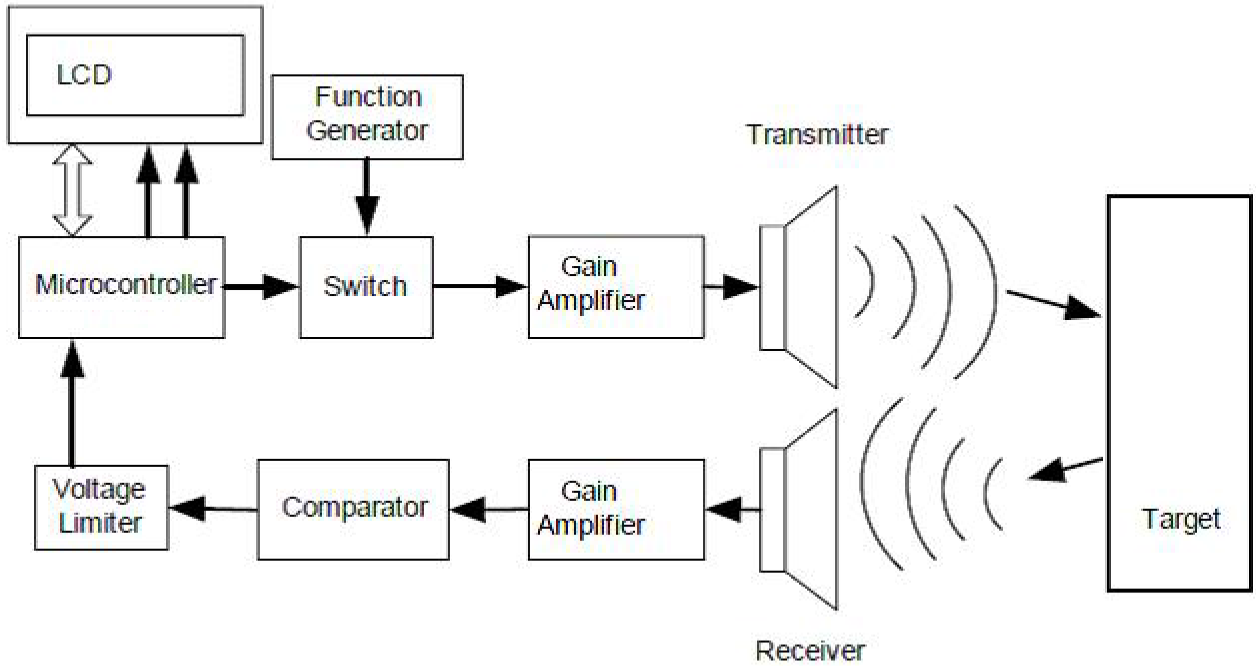


Figure d: Block diagram of Ultrasonic Distance Meter

4. Ultrasonic Sensors

Ultrasonic sensors (also known as transceivers when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. It is shown in fig (e) .Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. For measuring speed or direction a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water. Systems typically use a transducer which generates sound waves in the ultrasonic range, above 18,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed.

Figure e: Ultrasonic Sensor

5. Experimental Work

Ultrasonic ranging principle is to use ultrasound in the air velocity as the known and measure the time when sound waves reach obstacles and reflect back, then calculate the actual distance. Using 8-bit single-ship controlling echo wave reflection-time ranging method is widely used, whose accuracy is not very high because of the low system clock. With reference time fixed, and the echo peak time pour push forward to testing time, or there is a threshold, makes this method problem, it is hard to do it within half a wav-length error, this problem solved the key is to establish error correction mechanism and temperature compensate measures. The function of major components are as follows:-

A) PIC MICROCONTROLLER

PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC16F72ISP originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Peripheral Interface Controller". PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and reprogramming with flash memory) capability. They are also commonly used in educational programming as they often come with the easy to use PIC legislator' software.

B) LCD (LIQUID CRISTAL DISPLAY)

A liquid crystal display is a type of display used in digital watches and many portable computers. LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. Each crystal, therefore, is like a shutter, either allowing light to pass through or blocking the light. Monochrome LCD images usually appear as blue or dark gray images on top of a grayish-white background. Color LCD displays use two basic techniques for producing color: Passive matrix is the less expensive of the two technologies. The other technology, called thin film transistor (TFT) or active-matrix, produces color images that are as sharp as traditional CRT displays, but the technology is expensive. Recent passive-matrix displays using new CSTN and DSTN technologies produce sharp colors rivaling

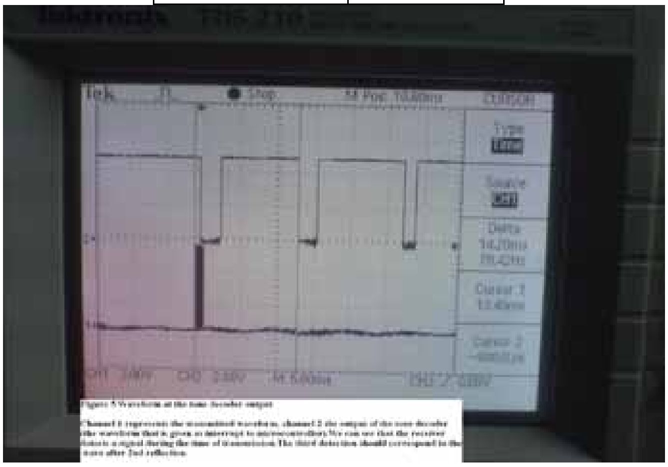
6. Methodology

The technique of distance measurement using ultrasonic in air include continuous wave & pulse echo technique. In the pulse echo method, a burst of pulses is sent through the transmission medium & is reflected by an object kept at special distance. The time taken for the pulse to propagate from transmitter to receiver is proportional to the distance of object. For contact less measurement of distance, the device has to reply on the target to reflect the pulse back to itself. The target needs to have a proper orientation that is it needs to be perpendicular to the direction of propagation of the pulses. The amplitude of the received signal gets significantly attenuated and is a function of nature of the medium and the distance between the transmitter and target. The pulse echo or time-of-flight method of range measurement is subject to high levels of signal attenuation when used in an air medium, thus limiting its distance range.

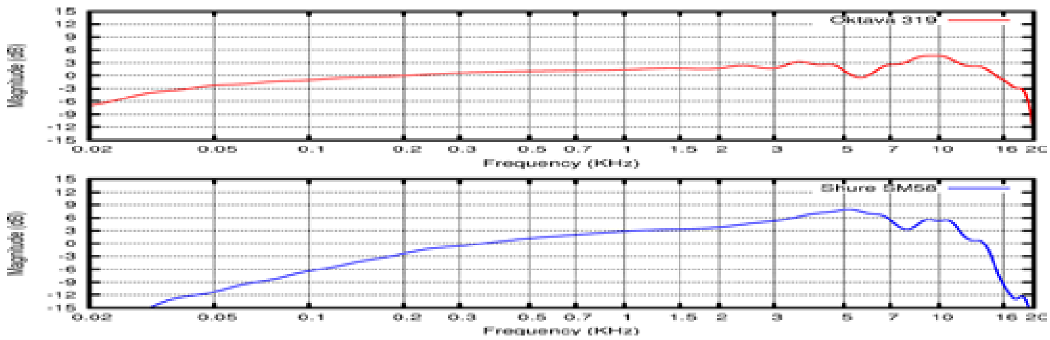
7. Result

Measurement data

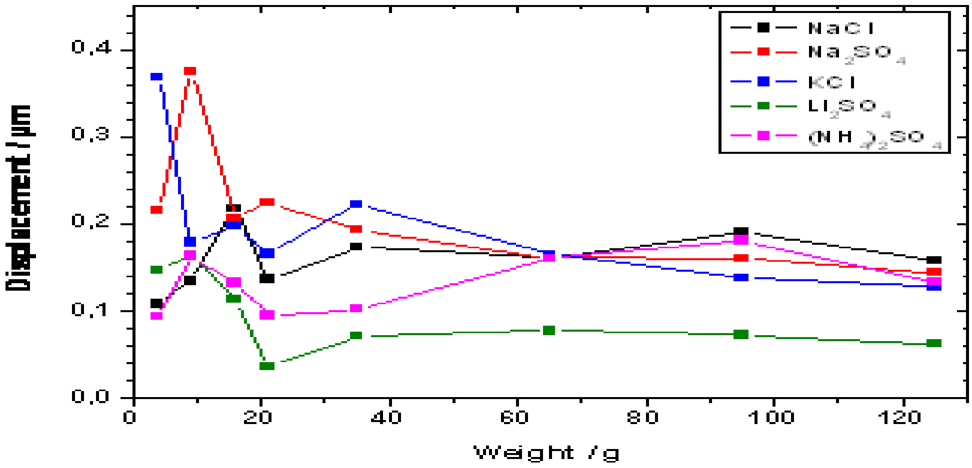
RANGER	SCALE
27cm	29cm
31cm	34cm
48cm	48cm
58cm	68.5cm



Graph A: Waveform of the tone decoder



Graph B: Frequency ranges of both transmitter and Receiver



Graph C: displacement and weight

8. Discussions

During the final research work, It is seen from graph (A),(B) and(C) the performance of ultrasonic distance measurement was conducted. However, the ultrasonic distance detector could measure a distance less than 490 cm. Due to space constrains, the device was only tested on 200 cm range without any obstruction. The observation was that, the ultrasonic distance detector gave an LED Indication when the object was too near around less than 10 cm. The long range of distance performance need to fine tune as the result performance is not good enough.

9. Conclusion

The feature of this research work was to design an Embedded System for measurement of ultrasonic distance meter with biomedical applications. With respect to the requirements for an ultrasonic rangefinder the followings can be concluded.

- The system can very useful in biomedical field.
- The system is able to detect objects within the sensing range.
- The system can calculate the distance of the obstruction with sufficient accuracy.
- This device has the capability to interact with other peripheral if used as a secondary device.
- This can also communicate with PC through its serial port.
- This offers a low cost and efficient solution for non-contact

It can be used for automatic guided vehicles, tracking system, car positioning, positioning of robots as well as measuring generic distances, liquid levels in tanks, and the depth of snow banks. It is very useful for heating tissues to treat various ailments and it is used to sterilize surgical instruments. From this work we have also studied about some application in field of Medical like Heart beat monitoring, Surgeries, Blood Pressure measurement, temperature Measurement etc.

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