Design and Implementation of Digital Distance Measurement System Using Ultrasonic Sensor

Jashan Sharma[1], Preeti Abrol[2]
[1, 2]*Centre for Development of Advanced Computing, Mohali, Punjab, India*

Abstract: Distance measurement is required in every field. Generally there are two methods for distance measurement contact and non-contact. A non-contact method using ultrasonic sensor is described in this paper. Ultrasonic transducer uses the time of flight technique for distance measurement. This circuit calculates the time interval between the transmitted and reflected signal which is further evaluated for distance measurement. It has been tested successfully for measuring distance of an object up to 5m and corresponding area and volume has been calculated. The proposed technique arrogate ameliorate range and accuracy than the previous projects known. The experimental set up and results are depicted and formulated.

Keywords: *Sensors, Transceivers, Ultrasonic, Range, Acoustic velocity.*

I. INTRODUCTION

Ultrasonic Sensors provides the idyllic solution for non-contact distance measurement in all areas. These are the transceivers which are used to transmit and receive signals simultaneously. They are also known as transducers because they convert electrical energy into sound energy at transmitting end and vice versa at receiving end. It generates high frequency sound waves and assesses the echo which is received back by the sensors. The sensor calculates the time interval between the transmitted and received signal. . Distance is calculated by measuring the interval of time starting the moment at which the transmission of pulses start via intermediate to the reception of bounced back wave from the obstacle. The transit time which is assessing of temp rely upon the acoustic velocity. It consist of two modules, the sensing module which measures the distance of an object and then displays the result in centimeters and a calculative module wherein the output of first module is used for conversion of units (cm to inches or cm to feet). It can also be used for computing specific calculations like area and volume of an object.

II. RELATED WORK

A lot of research has been carried out on digital distance measurement system in the past. Following papers describe the earlier work done. Md. ShamsulArefin, TajrianMollickhad designed a Ultrasonic distance meter which uses 40 kHz wave to measure a distance up to 5meter but due to some constraints it was tested only up to 2 meter[1]. This method has distance limitation and has blind area when distance is too small. A.K.Shrivastava, A.Verma and S.P. Singh had worked on Distance measurement of object or obstacle by ultrasound sensor using P89C51RD2 in which distance of obstacle is measured by using separate ultrasonic transmitter and receiver. There are so many errors in proposed system due to generation and processing times of burst pulse signal [2]. Tarek Mohammad, in his research paper Using Ultrasonic and Infrared Sensors for Distance Measurement shows two sensors which is used one is infrared sensor and other is ultrasonic sensor. The reflectance properties decide the amplitude response of infrared sensors. Consequently, in sort to make use of IR sensor for distances measurement correctly, former information of the nature or type of object ought to be identified. Ultrasonic sensor can endow with the preliminary knowledge of temperature to attain the parameters for this technique. Ultrasonic sensors are also broadly used to calculate distances. Thus they have provided consistent foundation of detections of object. As they are not based on vision, they are helpful below circumstances of deprived illumination and see-through matter [3]. Alessio Carullo and Marco Parvis had developed Distance measurement system for automotive applications. In this an ultrasonic sensor is described which is used to calculate distance between two points in medium. A reflected pulse from the obstacle is effortlessly demonstrated by a comparator with a threshold value. The sensor used in this system is piezo-electric based and have ambiguity of 1 mm at stumpy speed or when it is at stationary position, the sensor immobile works at speeds of up to 30 m/s, even though at advanced indecision [5].P.K Chande, P.C.Sharma had studied A Fully Compensated Digital Ultrasonic Sensor for Distance Measurement in which a distance measurement system is explained. Technique used in this paper is based on evaluation of unidentified temperature with an average span. The dimension made is autonomous of warmth, moisture, stress, and every additional distinctive situation. A declaration of 0.25 mm, by an utmost fault of 0.5 percent, is attained. This method is based on relationship with a customary span and measurement made is independent of atmospheric conditions. It requires improved accuracy [7]. Hongjiang, He Jianyi Liu had worked on Design of Ultrasonic Distance Measurement System Based on

S3C2410 in which a 40 KHZ square wave is sent by transducer drive of S3C2410 it opens the external interrupt and triggers the timer interrupt. An echo signal is received by the external interrupt and it immediately triggers the timer to obtain the value. The output of sensor is real time and is displayed on LCD. Linux platform was used to implement software and hardware design of distance measurement system [4]. Canhui Cai and Paul P. L. Regtien describe a new method for Accurate Digital Time-of-flight Measurement Using Se1 f-Interference in which a new technique is described in this paper for time of flight calculations. In this two intrusive ultrasonic waves are formed by piezoelectric transducer. Each wave consists of four periods of square wave signal. The time interval between the two pulse is chosen such that zero is halfway between the waves of ultrasonic sensor. Now, the instant of zero envelopes is noticed to a certain extent than the instant at which the echo received. The experiments showed that exactness can be obtained which is enhanced than one-tenth of a cycle period, subsequent to 0.4mm, over a range from 15 cm to 100 cm [6]. Iuka Ihara evaluated applications of ultrasonic sensing and in this paper describes the rudiments of ultrasonic sensing techniques that can be used in the assortment of fields of production and discipline. It also takes account of some superior procedures used for non-destructive computations. Primary, essential uniqueness of ultrasonic waves spreading in medium are explained in brief. In addition to this, indispensable ideas for determine ultrasonic waves are explained with initial topics of ultrasonic transducers that spawn and take delivery of ultrasonic waves. Finally, particular results representing the potential of using a buffer rod sensor for ultrasonic watching at elevated temperatures are offered [8].

III. OBJECTIVE

There are three main objectives of this proposed thesis work which are described below –

1. To make a Digital Measurement System with minimum no. of errors and improved range up to 5meter.
2. This system can also be used to convert reading into Feet and Inches.
3. Unlike other Digital Measurement System, this can calculate specific calculations like Area and Volume of an Object.

IV. METHODOLOGY

The first step is to initialize the ultrasonic sensor, so very high frequency waves are transmitted from transmitter and its echo is being received at receiver. Microcontroller calculates the time interval between the two waves for computing distance and gives some result before data from ultrasonic sensor is decoded. Again microcontroller will process and show the data on display in" cm" and data for decoding is stored with keypad and result is displayed on LCD. Furthermore the same data is converted into sq ft and sq inch before showing result on LCD. Then there is an option key for area and volume calculation and input is given according to the preferences and microcontroller converts the data into cubic feet for volume and sq ft for area before displaying it on LCD.

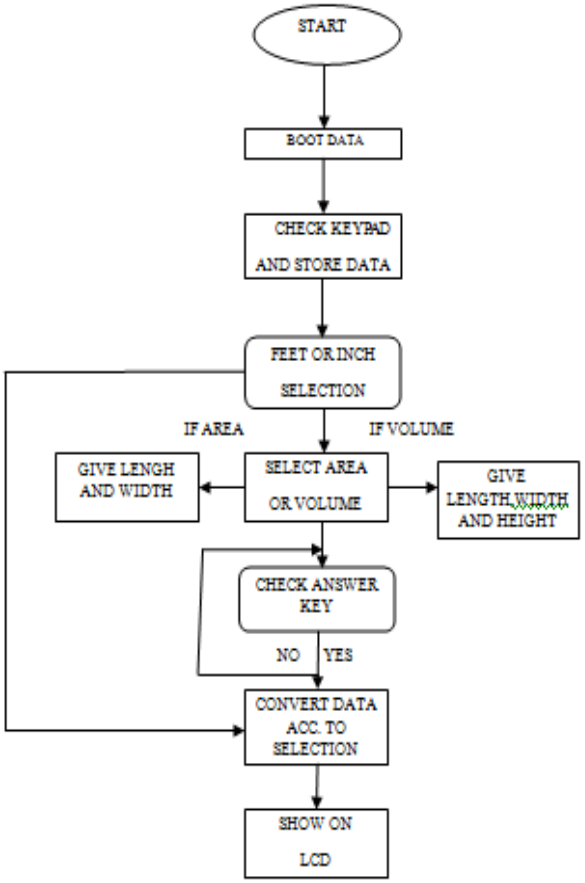

Fig.1: Flow chart of work done

V. BLOCK DIAGRAM

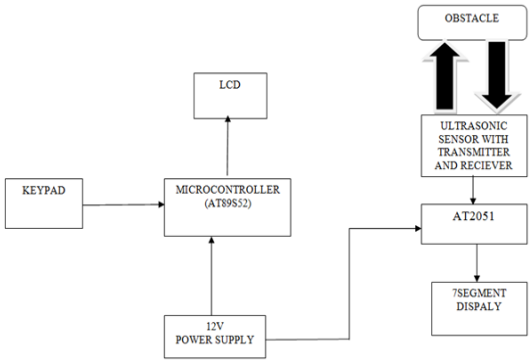

Fig.2: Block Diagram of developed system

VI. PRODUCT DEVELOPED

Fig.3: Digital Distance Measurement system

VII. EXPERIMENTAL RESULTS

Distance measurement system has been tested out to and its result is being shown in table I. We monitored that the substantial error are being reduced as compared to previous work in distance measurement. Results obtained are compared with the actual distance and shown in graphical form in Fig.4.

Table 1: Distance calculated vs Actual Distance

Sr. No.	Distance calculated (cm)	Actual distance (cm0
1	10	10
2	20	21
3	30	30
4	40	40
5	49	50
6	61	60
7	70	70
8	80	81
9	90	90
10	100	99

The above experimental results can be shown in graphical form in Fig.4

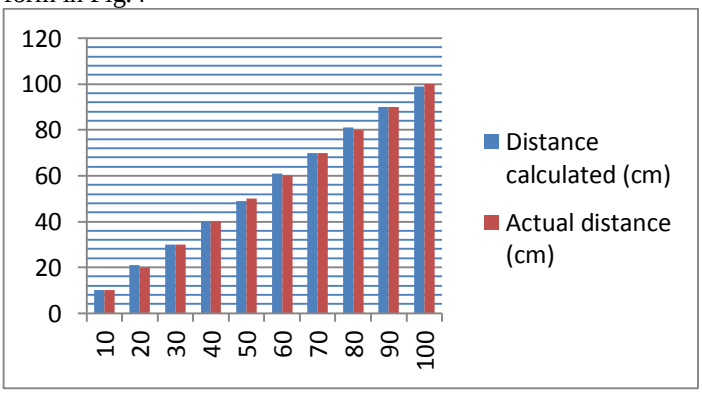

Fig.4: Graphical representation of distance calculated (cm) vs. Actual distance (cm)

The second objective of this digital distance measurement system is to calculate area and volume of an object using the above distance calculated. Digital distance measurement system is tested to calculate area of an object. The area calculated is shown in tabular form in Table 2.

Table 2: Area Calculated

Sr. No.	Area calculated		
	Length (ft)	*Width (ft)*	*Area (sq ft)*
1.	7	10	70
2.	11	9	99

Similarly distance measurement system is tested for calculating volumes of different objects which are shown in Table III.

Table 3: Volume Calculated

Sr. No.	Volume calculated			
	Length (ft)	*Width (ft)*	*Height (ft)*	*Volume (cu ft)*
1.	8	7	9	192
2.	10	4	11	184

VIII. CONCLUSION

This project facilitates to assimilate the non- contact distance measurement system which can compute a distance up to a range of 500 cm which can be displayed on seven segment display. Along with his the distance calculated can be further used for conversion of units that is cm into inches or feet which are commonly used in day to day life. Furthermore distance calculated can be used for area and volume calculation and final result is displayed on LCD. The basic parameters for calculating distance for an obstacle are known to be range, low cost and accuracy. Ultrasonic's are yet concluded to be the best method to measure distance. Because they give good results for range and accuracy as compared to other methods and also they are cost efficient. Though this emerging area, a lot more can be done to this field. Till date, it has been experimented on a limited range and however we can make it go for longer distances.

IX. FUTURE SCOPE

Nonetheless, there are still new ideas to improve it and to add new functionality to it. However, non-contact distance measurement system has shown best results in this field, but still more can be done. The range can be extended and thus more accuracy can be determined for even longer distances.

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Jashan Sharma was born on 17th May 1990 at Nangal Dam (Punjab). He had done his graduation in Electronics and Communication from B.H.S.B.I.E.T Lehragaga (Punjab) in 2012. After that he had done his masters from Center for Development of Advance Computing (CDAC, Mohali) in 2014.

Mrs Preeti Abrol is working as Principal Design Engineer at C-DAC, Mohali. Her proficiency is in embedded systems and C, C++, JAVA, UNIX programming.