Design and Development of Test Bench for Ultrasonic Sensor Quality Control

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Abstract— Ultrasonic devices are used to detect objects and measure distances of many objects. Quality of ultrasonic sensor should be high in order to provide better accurate measurement. Manufacturing industries provide this sensor along with quality certificate depending on accuracy. This paper proposed suitable technology for quality control of ultrasonic sensor. It makes a test bench using some mechanical support, stepper motor and camera. Once this sensors will be checked using this system, it will supply to the market. So, result of this system helps for generating certificate for sensor's quality. Two types of test were conducted to compare distance measurement results and understand how to improve the distance measurement accuracy. These two types are test bench and camera attached to stepper motor for vernier caliper scale. The advantage of this project is low cost manufacturing, minimum process time and better accuracy.

Key words: ultrasonic sensor, sensor accuracy, quality control, testing, test bench, stepper Motor

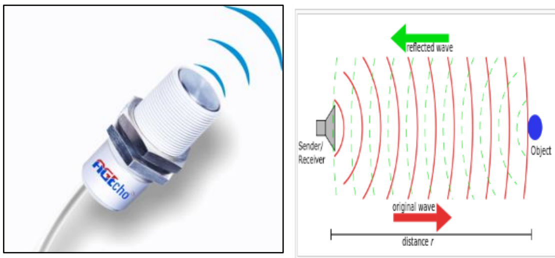
I. INTRODUCTION

In many industries, ultrasonic sensor[3] is widely used to measure distance between object, water level measurement, height of tree and so on. This sensor must be very accurate in order to provide appropriate measurement. If its accuracy decreased then industry will be in huge loss. So it is very important to check sensor's quality or accuracy. Ultrasound is an oscillating sound pressure wave. Its frequency is greater than the upper limit of the human hearing range. Thus, it is not separated from 'normal' sound by differences in physical properties, only by the fact that humans cannot hear it. Its limit varies from person to person and it is approximately 20 kilohertz (20,000 hertz). Ultrasound devices operate with frequencies from 20 kHz up to several gigahertz[4].

Ultrasonic imaging is used in medicines. In the non-destructive testing of products and structures, ultrasound is used to detect invisible flaws. Industrially, ultrasound is used for cleaning and for mixing, and to accelerate chemical processes. Also this sensor is used in Anti-Collision Detection on Aerial Work Platforms, Distance Measurement and so on.

Ultrasound sensor is used to find underwater range and depth. An ultrasonic pulse is generated by sensor in a particular direction. If any object is available in the path of this pulse then a part or all of the pulse will be reflected back to the transmitter as an echo and can be detected through the receiver path. It is possible to determine the distance by measuring the difference in time between the pulse being transmitted and the echo being received. Some paper studied practically about quality control of sensor [1][2].

After the observation of existing system as shown in [1][2], it is important that measurement quality of ultrasonic sensor must be high. Study showed in [1][2] provide importance of ultrasonic sensor's quality by applying certain measurement technique. [1] Provides measurement of olive tree by using ultrasonic sensor and manual method. Same technique were used in [2], for the canopy volume measurement. These systems is more time consuming, complex and provide less accurate result in the quality control of ultrasonic sensor. In order to overcome this parameter, system proposed in this paper used vernier calliper mechanism.



(a) (b)

Fig. 1: (a)Ultrasonic Sensor,1 (b) Working

Ultrasound sensor is a sensor which detects distance of an object and also distance between two objects. As shown in fig.1 below, sensor transmits ultrasound rays and if object is available in the same path then these rays will reflect back.[8]

II. WORKING METHODOLOGY

In order to overcome disadvantages of existing system, a relevant system is proposed for quality control of sensor as shown in fig.2. A low cost controller is used to interface between stepper motor and software containing graphic user interface (GUI). Main system contains GUI which allows user to apply range of distance for moving target board horizontally. It is interface with camera which also measures distance of movable object. Stepper motor is used to move target board horizontally. Actual operation is discussed in next section which describes two techniques for measuring sensor's accuracy.

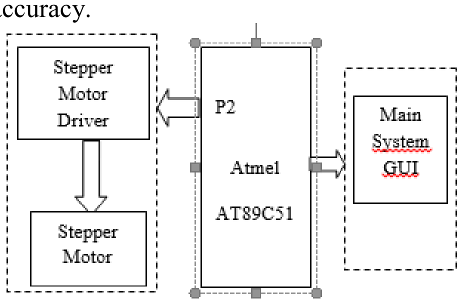


Fig. 2: Functional Block Diagram

III. METHODOLOGY

Ultrasound sensor is widely used in industrial application and its accuracy is very important for industry. This section describes methods used for accuracy measurement of ultrasound sensor. It provides total two techniques, due to which there is no risk for finalizing the sensor product. Those techniques are explained below.

A. *Test Bench For Ultrasonic Sensor:*

The main Objectives of this test bench are:

- To check the reading captured by ultrasonic sensor.
- To cross check the reading observed by ultrasonic sensor with reading acquired by test bench. Reading is nothing but sensors obtained value for the distance measurement from object.

A test bench or testing workbench is an environment which is used to verify the correctness or soundness of a design or model, as shown in fig. 3

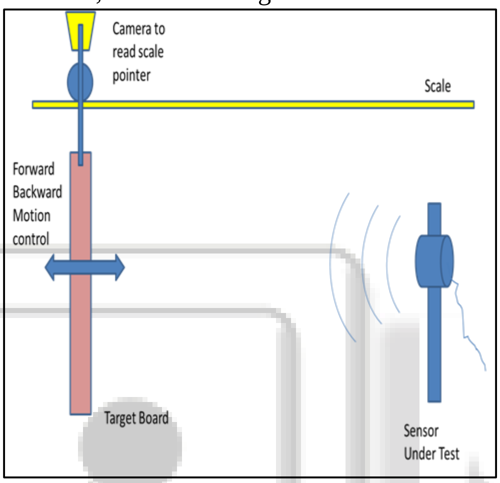


Fig. 3: Test bench for ultrasonic sensor quality control

For the distance measurement from object, stepper motor is used. Basically, motor is used to move object (target Board) horizontally as shown in fig. 2. So, motor described two values; initial and final by moving target board horizontally. At the same time, sensor records initial and final position value. Both readings of stepper motor and sensor are compared in GUI. Thus Sensor's quality is checked in GUI as shown in fig. 4

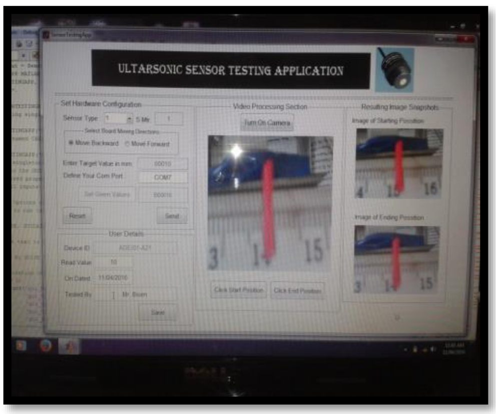


Fig. 4: GUI of Test Bench based System

Small exercise is done by using test bench

B. *Camera Attached To Stepper Motor:*

In this method, values obtained by camera attached to stepper motor is compared with reading obtain from sensor. Both the reading are taken with the help of Software containing GUI Interface camera and stepper motor. Interfacing is done by using Serial communication which is handled by GUI.

Small exercise is done by using camera and Sensor as shown in fig. 5

Fig. 5: Hardware Setup of Camera attached to Stepper Motor

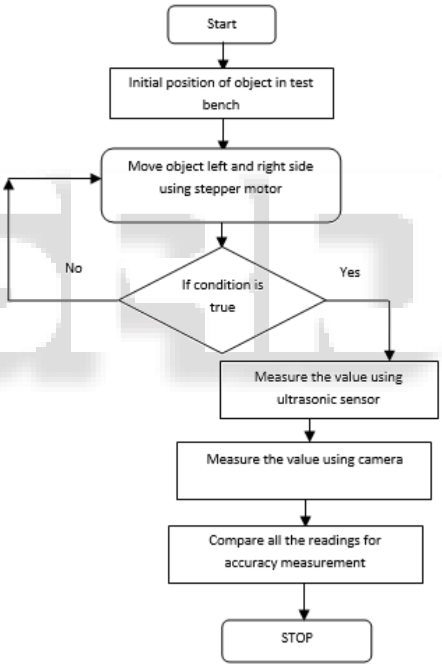


Fig. 6: Flow Chart for test bench

Initially stepper motor moves the lead screw as per the dimension given to it and noted down the initial and final dimension [5]. Then with the help of ultrasonic sensor its motion will be check from initial position to end position. Then compare both the reading obtained in above two methods. If 1% error is obtained then that sensor will be accepted otherwise not. Existing system provides the quality checking ultrasonic sensor. But this paper provides system for quality control of ultrasonic sensor with accurate measurement. The proposed system works as per flow chart shown in fig. 6.

System will capture the initial and final position of vernier calliper scale and will save as proof certification. This is possible using matlab which reduces manual work, therefore the system is fully automated and response time is very less as compare to existing method.

IV. Result Analysis

After performing operation as per the proposed system, both the techniques provide accurate results. Target board is moved horizontally for 10 cm to 100 cm for the accuracy measurement. Fig 5 shows how GUI manipulates all the results and comparisons for both techniques are shown in table 1 and 2.

Sr. no.	Stepper Motor Reading (CM)	Sensor Reading (Output)
1	10	10
2	20	20
3	30	30
4	35	34.90
5	40	40
6	50	49.85
7	55	54.75

Table 1:Result for technique 1

Sr. no.	Camera Reading (CM)	Sensor Reading (Output)
1	10	10
2	20	20
3	30	30
4	35	34.9
5	40	40
6	50	49.9
7	55	54.9

Table 2: Result for Technique 2

V. Conclusion

This paper proposed suitable system for accuracy measurement of ultrasonic sensor which proves to be best and cheap system. This system also required low power supply for operation. Different tests were performed to evaluate the capability of an ultrasonic sensor to measure the distances using test bench for quality control, its accuracy [5]. Result shows how accurately both techniques are performed for accuracy measurement. Methodology of system provides more relevant system as compare to existing system. Also advantages will be low cost, minimum processing time, portable device, ease of implementation and low power consumption.

Acknowledgment

I would like to take this chance to express my gratitude to all those who extended their support and have guided me to complete this paper. First and foremost, I would like to thank Asst. Prof. J. J. Shah for her kind support and encouragement. Also I am thankful, Department of Computer Science Engineering, for their motivation, inspiration and co-operation towards completion of this paper. Finally, I sincerely thank to my parents, family and associates who provide me advice and financial support. The product of this paper would not have been possible without all of them.

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