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Measurement of Semi-Finished Components Using Sensors

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Abstract: This paper presents the design and manufacture the instrument which can measure geometrical parameters (length, width, height) of component without using traditional or current measuring techniques. This instrument has various advantages over the traditional measuring instruments. It has less number of moving parts and requires less physical efforts to operate it. The instrument consists of most crucial part known as ultrasonic sensor, LED display, a circuit which is used to control the various components known as Arduino and set of wires. The measurement of the component is calculated by the total time taken from sending the waves and receiving it with respect to the velocity of sound. The calculation is done by an algorithm generated in the microcontroller and displays it on LCD screen.

Keywords: Ultrasonic Sensor, Measuring techniques, Arduino, LED display, Measuring instrument

I. INTRODUCTION

In the manufacturing industries it becomes mandatory to verify the components for its dimensional parameters, volume, surface finish and strength, after it is manufactured. This is to make sure that the components being manufactured comply with the design and are within the manufacturing tolerance and do not fall beyond it. Should the components be beyond the tolerance band, it would refuse to assemble while mating with other parts. And also, as more and more customers are becoming quality conscious, every manufacturing industry is following stringent quality inspection process and methods to make sure that not a single defective component comes out of the plant. Measurement is the most fundamental concept of science and technology that leads to innovations. According to the general concept, measurement is just a tool to determine quantity, whereas in reality, measurement is a fundamental facet to control and improve various parameters associated with different technical affairs. In the present practices, Distance measuring without physical contact is always a challenge.

Measurements of semifinished components play a crucial role in the manufacturing and production processes. These measurements are necessary to ensure the quality, accuracy, and proper fit of the components within the final product. measurements of semifinished components are crucial for ensuring quality, accuracy, and functionality throughout the manufacturing process. Especially in prefinished machining precise measurements of semifinished components ensure uniformity and compatibility across different batches or suppliers. They enable manufacturers to maintain consistent quality standards, achieve proper fit and assembly, meet performance requirements, and adhere to regulatory and customer demands.

Distance measuring using ultrasonic sensor is an effective way. A measured value is represented in the form of digital information with the help of a LED screen or monitor. The traditional way of calculation of the entities involved human intervention with a high error margin. Use of digital measurement instruments removes the error margin and provides the user with accurate results. Manual checking will not give quality output and also it is not possible to check all the parameters of all the components produced in a single day. So, it is intended to develop an precise inspection system for non-contact measurement and process control. One such non-contact-based measurement is known as height detection instrument.

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II. INSTRUMENTATION

Here in this section discussing about the main components of instrumental setup like ultrasonic sensor, LCD display, Arduino board and other parts are discussed in detail below.

i. Ultrasonic Sensor

Ultrasonic sensor is also known as transceiver device. Ultrasonic sensor generates high frequency sound waves and it works by transmitting an ultrasonic burst and providing an output pulse that corresponds to the time required for the burst echo to return to the sensor. By measuring echo pulse width, the distance to target can easily be calculated. It is very easy to connect to microcontroller. Ultrasonic sensor is shown in following figure.1

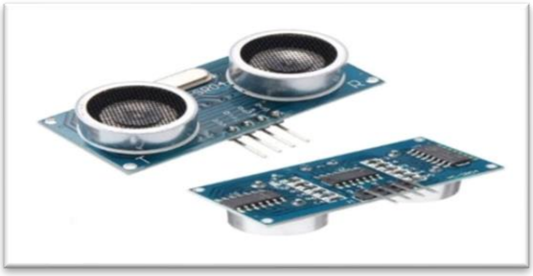

Figure 1.Ultrasonic Sensor

Specifications:

1. Working Voltage :5V(DC)
2. Static current: Less than 2mA.
3. Output signal: Electric frequency signal, high level 5V, low level 0V.
4. Sensor angle: Not more than 15degrees
5. Detection distance :2cm-450cm
6. Precision: Up to 0.3cm

ii. Alphanumeric LCD display

The most common construction of the Alphanumeric LCD display is known as a COB or chip on Board. This is where there is a PCB attached to the LCD glass. The name Chip on board means that the controller driver chip is located on the back of the Printed circuit board. This type of module handles vibration very well
Alphanumeric LCD displays are built in standard configurations such as 16x2, 8x1 and 40x4. The identification of these displays is broken down into the number of characters in each row and then the number of rows. An example of this is a 16x2. That means there are 16 characters in each row. There are two rows of these characters. That means the alphanumeric LCD can display a total of 32 characters at a time. Alphanumeric LCD display is shown in following figure.2

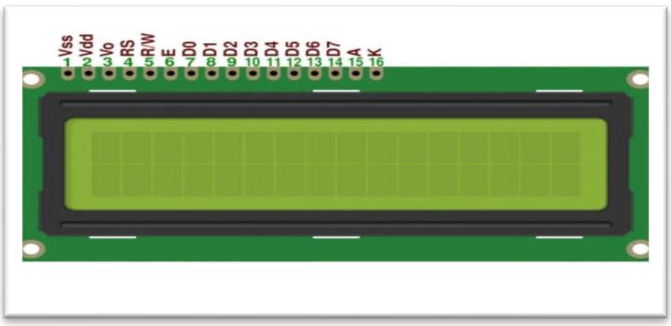

Figure 2 Alphanumeric LCD display

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iii. Arduino Nano board

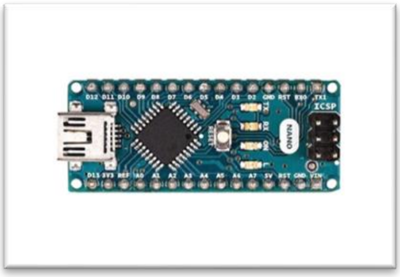

Figure 3 Arduino NANO Board

Above fig.3 shows Arduino NANO board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (for prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs. The microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the Arduino Programming Language, inspired by the Processing language and used with a modified version of the Processing IDE. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE)

Specifications:

1. Microcontroller: ATmega328P
2. Operating Voltage: 5V
3. Input Voltage (recommended): 7-12V
4. Digital I/O Pins: 14 (of which 6 provide PWM output)
5. Flash Memory: 32 KB (ATmega328P) of which 0.5 KB used by bootloader
6. SRAM: 2 KB (ATmega328P)
7. EEPROM: 1 KB (ATmega328P)
8. Clock Speed: 16 MHz

The Arduino Nano board is used because of the following reasons.

1. As the board can be easily connected to the other computer system via USB port. The USB port fixed in the board serves two purposes. It can be used to supply the power supply to the board and can act as a serial device to connect the board to a computer system.
2. The board is capable to get the power supply from DC adaptor having a voltage of 12 V. The board can be charged from this external power supply.
3. The microcontroller used in the board I.e., ATmega328 has the flexibility provided to the board. It means the controller chip can be replaced, removed from the board in case of damage or improper functioning of the chip. This flexibility functionality is not provided in other Arduino boards.
4. As the board design is simple it can be used by multiple users and the community support for the Arduino NANO board.
5. The Arduino NANO board has a list of several hardware components and has the capability to interact with those devices. The device includes Bluetooth, internet, motor control, and many more.
6. The Arduino NANO board have 14 digital input pins and 32KB flash memory of which 0.5 used by bootloader and Arduino MEGA board comes with 16 digital input pins and 256KB flash memory of which 8KB used by bootloader. Specifications of Arduino NANO board are sufficient for our instrument's processing purpose.

Software Specifications:

1. Keil µVision IDE
2. MC Programming Language: Embedded C

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III. BLOCK DIAGRAM

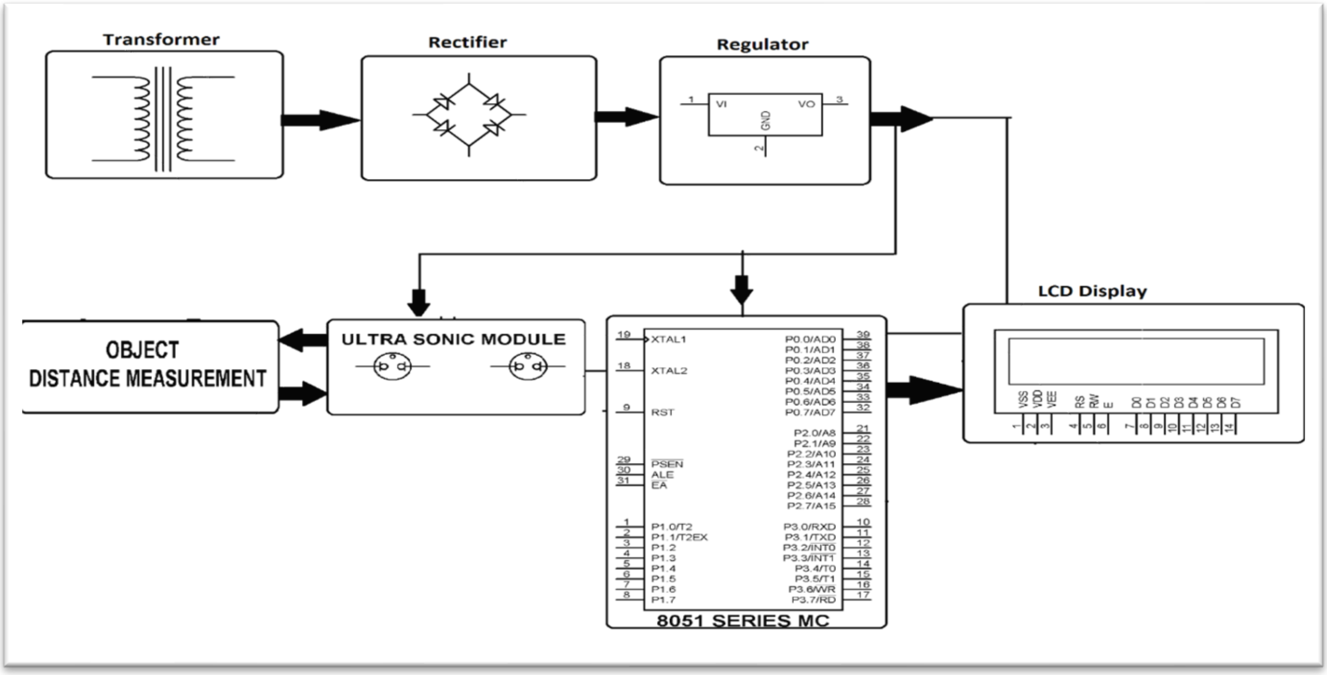

Figure 4 Block diagram

Above figure.4 shows block diagram of instrument

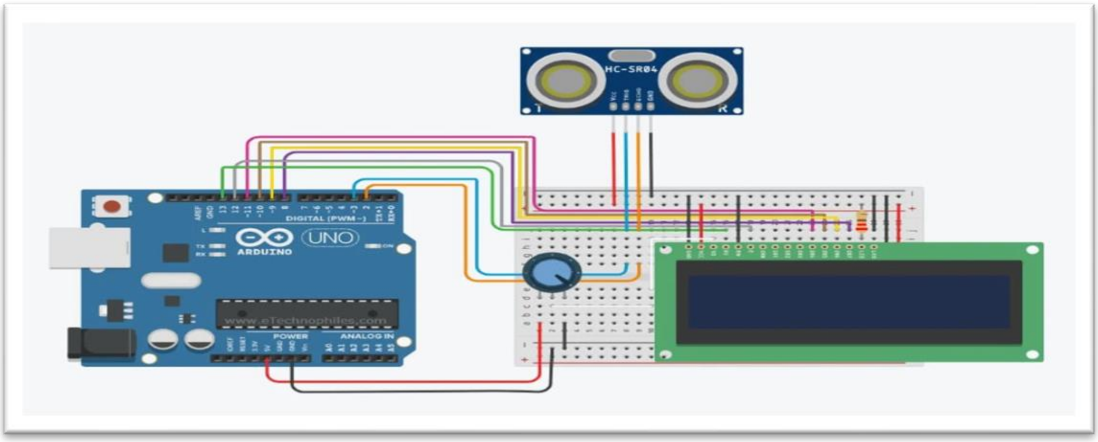

Figure 5 Circuit Diagram

The 12v power supply is given to the Arduino NANO Board. The connection from Arduino NANO Board is given to the Ultrasonic sensor and Alphanumeric LCD display. This whole circuit operates on 5V. The Ultrasonic sensor has four terminals - +5V, Trigger, Echo, and GND connected as follows −

1. Connect the +5V pin to +5v on your Arduino board.
2. Connect Trigger to digital pin 7 on your Arduino board.
3. Connect Echo to digital pin 6 on your Arduino board.
4. Connect GND with GND on Arduino.

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Working Principle:

It works on the principle of measuring the variation in dimensions of semi-finished components using an ultrasonic sensor. the ultrasonic sensor transmits sound waves this wave get reflected whenever an object comes into vicinity of the sensor. this generates an electrical signal which converted and used to detect the variation in dimensions.

SR.NO.	NAME OF COMPONENT	FUNCTION
1	Plane A	To measure total length and diameter
2	Plane B	To measure step length and step diameter
3	Slider A	Linear movement of Plane A and Plane B
4	Slider B	Vertical movement of Plane B
5	Slider C	Vertical and horizontal movement of sensor assembly

Table 1. List of Components

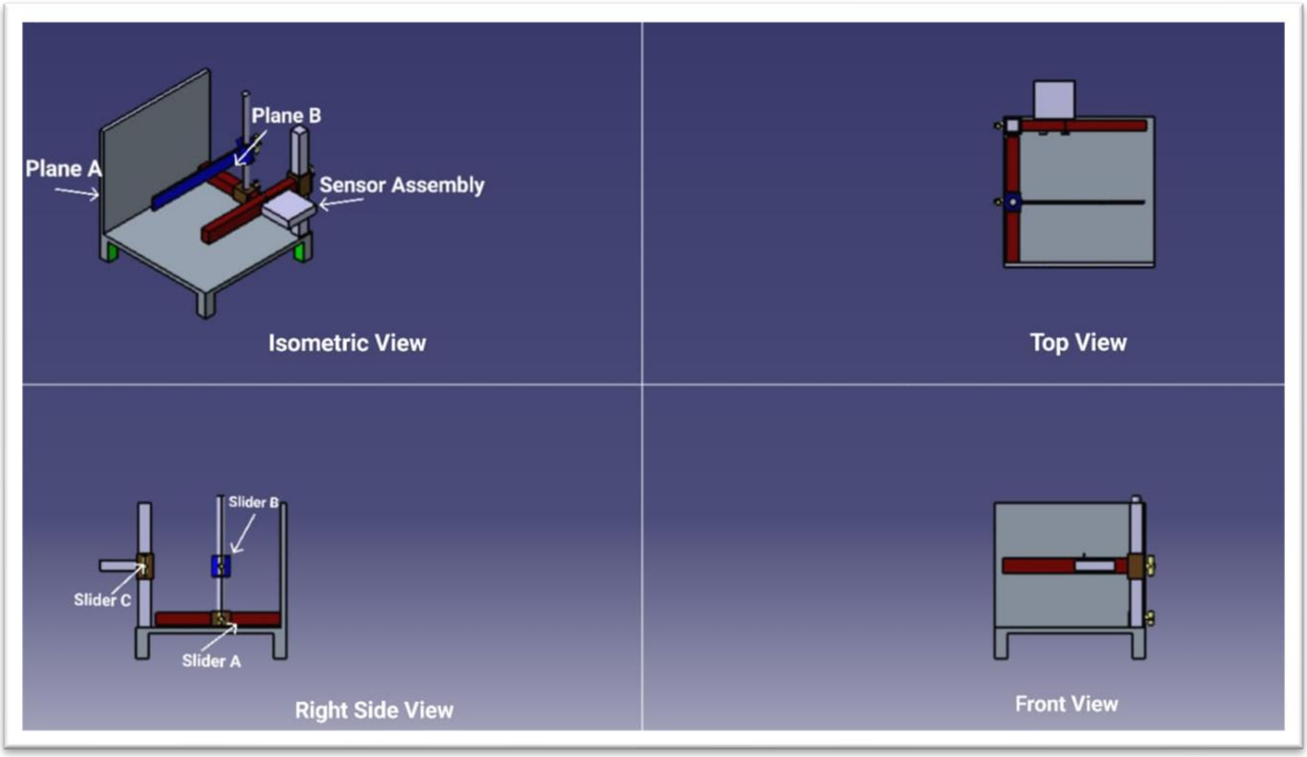

Figure 6 Design

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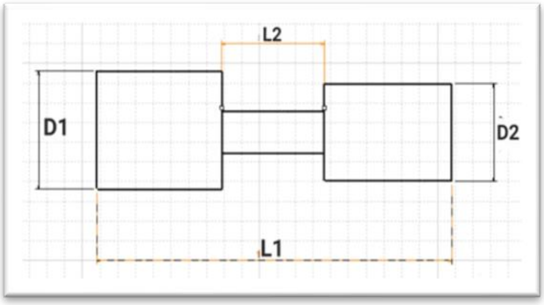

Figure 7 Measuring Component

Specifications of measuring components:

D_1 = Larger diameter
D_2 = Step diameter
L_1 = Total length
L_2 = Step length

Procedure for determining various dimensions:

1. To determine total length:
   I. Place the workpiece on the fixture horizontally as the front end of it on the given mark.
   II. Slide the plane A up to end of workpiece as plane A and workpiece comes in contact with each other.
   III. Now, slide the ultrasonic sensor as it comes in front of plane A take it as first reading (L1).
   IV. The difference between first reading and given marking line (L1 - L2) is actual total length of workpiece.

2. To determine diameter:
   I. Place the workpiece on the fixture vertically as the front end of it on the given mark.
   II. Slide the plane A up to end of workpiece as plane A and workpiece comes in contact with each other.
   III. Now, slide the ultrasonic sensor as it comes in front of plane A take it as reading (D1).
   IV. The difference between reading and given marking line (D1 - D2) is actual overall diameter of workpiece.

3. To determine step length:
   I. Place the workpiece on the fixture horizontally as the front end of it on the given mark.
   II. Slide the plane B up to end of step whose dimension is going to determine as plane B and step comes in contact with each other.
   III. Now, slide the ultrasonic sensor as it comes in front of plane B take it as reading (L3).
   IV. The difference between reading and given marking line (L3 - L2) is step length of workpiece.

4.To determine step diameter:
   I. Place the workpiece on the fixture vertically as the front end of it on the given mark.
   II. Slide the plane B up to front end of step diameter whose dimension is going to determine as plane B and workpiece comes in contact with each other.
   III. Now, slide the ultrasonic sensor as it comes in front of plane B take it as reading (D3).
   IV. The difference between reading and given marking line (D3 - D2) is first multiply by 2 and then subtracting it from larger diameter (D1 - D2). {[D1 - D2] - [2 × (D3 - D2)} this is the step diameter of given workpiece.

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Figure 8.Reading on Instrument

Calibration of an Instrument:

In order to calibrate this instrument, we need to take a ruler with 0.1cm least count and place the ultrasonic sensor a set distance from a object, such as any sample component. Then record the value that appears. Repeat this process each time moving the sensor 1-2 inches farther away from the object until getting 8-10 values.

IV. CONCLUSION

Distance measurement by using ultrasonic sensor and Arduino consist of a transmitter part of ultrasonic module units ultrasonic high frequency waves in the form of polices after collision of these waves with any object, these waves detected by microphone time taken by this waves from transmitter and receiver is used to measure distance from any object. In this instrument a ultrasonic sensor module is used of HC-SR04, because this ultrasonic module is initiated with pulse of 10us. The distance from any object is calculated from –
Distance = speed * time

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