Detection of Lock on Radar System Based on Ultrasonic US 100 Sensor And Arduino Uno R3 With Image Processing GUI

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Abstract - The development of electronics technology especially in the field of microcontroller occurs very rapidly. There have been many applications and useful use of microcontroller in everyday life as well as in laboratory research. In this study used Arduino Uno R3 as microcontroller-based platform ATMega328 as a sensor distance meter to know the distance of an object with high accuracy. The method used is to utilize the function Timer / Counter in Arduino UNO R3. On the Arduino Uno R3 platform, there is ATMEL ATmega328 microcontroller which has a frequency generating speed up to 20 MHz, 16-bit enumeration capability and using C language as its programming. With the Arduino Uno R3 platform, the ATmega328 microcontroller can be programmed with Arduino IDE software that is simpler and easier because it has been supported by libraries and many support programs. The result of this research is distance measurement to know the location of an object using US ultrasonic wave sensor US 100 with Arduino Uno R3 based on ATMega328 microcontroller which then the result will be displayed using Image Processing.

1. Introduction

The use of radar/sonar system is necessary in everyday life. Especially in the field of transportation, where the radar/sonar system is usually used in ships as a pointer or to tell whether there are obstacles from the path of the ship to be bypassed.

Can be imagined if a ship does not know what is in front of it or about the radius of the vessel then it can cause ship bodies hit foreign objects such as rocks or blocks of ice and other bad consequences. In this study used ultrasonic sensors US 100 used to measure distances, Arduino Uno R3 board with microcontroller ATmega328 products from ATMEL, and software used is Arduino IDE that uses C-based programming language with libraries that make it easier in making complicated programs and Processing as the final display (GUI) of the sonar / radar apps to be designed.

The purpose of this research is to make hardware and software to know the location of objects based on object distance with US 100 ultrasonic sensor using Arduino Uno R3 based on ATmega328 microcontroller then the result is shown in Processing software (GUI). benefit of this research is can be used as one of radar learning media and navigation that is by knowing distance of an object. By knowing the distance of an object then the location of the object can be known.

2. Literature Review

2.1. A. Ultrasonic sensor

Sensors are the "senses" for a system. The sensor obtains data from the environment in the form of mechanical quantities and displays them again in the form of electrical quantities. One type of sensor that is widely used today is the ultrasonic sensor. Ultrasonic sensors work by emitting a wave and then calculating the reflection time of the wave. Ultrasonic sensors work starting frequency 20 KHz up to 20 MHz.

Ultrasonic in its application can be generated using a PZT (piezoelectric) material that acts as a transducer. When the material is supplied with the voltage, it will vibrate and resulting ultrasonic waves (as transmitters). On the other side, the ultrasonic transducer as the receiver will convert ultrasonic waves into electrical quantities. Figure 1 shows the working principle of Ping ultrasonic sensor:
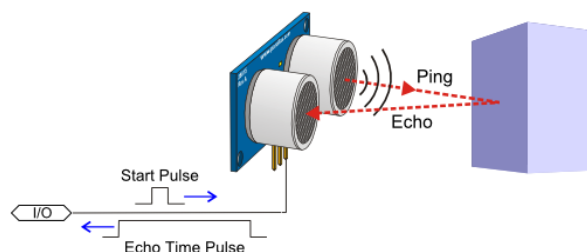

Figure.1 The working principle of ultrasonic distance sensor[8]

In general, based on the way of sending and receiving ultrasonic waves, ultrasonic sensors are divided into 2 kinds,

The results of this sensor measurement is determined by the time and amplitude of the ultrasonic waves. This sensor is usually used to measure the distance of an object, as shown in Figure 1. The results of this sensor measurement is determined by the speed of propagation, deflection or wave biasing, and the magnitude of ultrasonic wave propagation, because this sensor is widely used to measure flow rate, both liquid and gas.

2.2. B. Arduino Uno Board

Arduino is an electronic prototype device based on a flexible and open-source microcontroller. Where hardware and software are easy to use. For beginners using this board will facilitate control with the microcontroller. Arduino can be used to detect the environment by receiving input from various sensors e.g. ultrasonic sensors.

Arduino Uno is an Arduino board that uses ATmega328 microcontroller. Arduino Uno has 14 digital pins (6 pins can be used as PWM output), 6 analogue inputs, a 16 MHz crystal oscillator, a USB connection, a voltage source connector, an ICSP header, and a reset button. Arduino Uno contains everything needed to support a microcontroller.
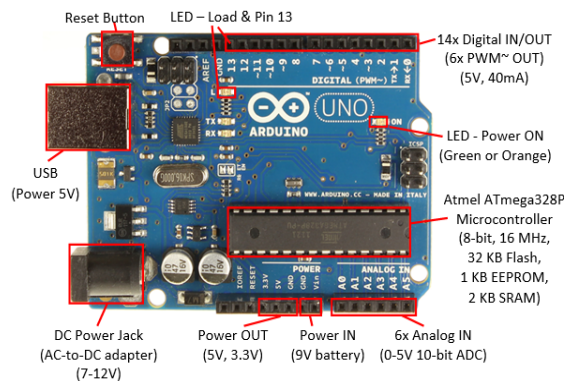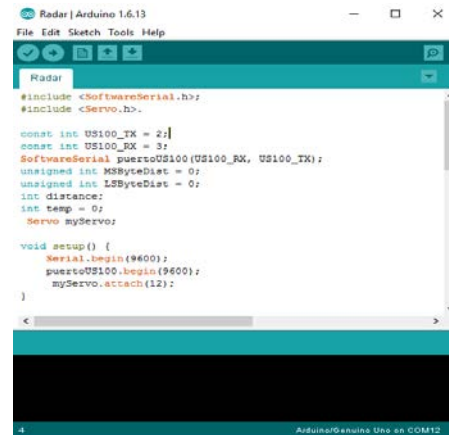
Figure 2 Arduino Uno R3[6]

Figure 3. Program example US100

The technical data board Arduino UNO R3 is as follows:

Table 1. Data board Arduino Uno R3

Microcontroller	ATmega328
Operating Voltage	5Volt
Input Voltage (recommended)	7-12 Volt
Digital Pin I / O	14 (6 of them are PWM pins)
Pin Analog input	6
Flash Memory	32 KB with 0.5 KB used for bootloader
Timing Speed	16 Mhz

2.3. C. Ultrasonic Sensor US 100

The Ultrasonic sensor module is a convenient way for measuring distances from objects. This module has a lot of applications such as parking sensors, obstacle and terrain monitoring systems, industrial distance measurements, etc. It has a stable performance and high accuracy ranging from 2cm to 450cm. The module sends an ultrasonic signal, eight pulses of 40kHz square wave from the transmitter; the echo is then picked up by the receiver and outputs a waveform with a time period proportional to the distance. The connected microcontroller accepts the signal and performs necessary processing.

Table 2. Specification Ultrasonic sensor US 100

Input voltage	5V
Detection distance	cm-450cm
Dimensions	4.4cm x 2.6cm x 1.4cm
Quiescent current:	less than 2mA

Figure 4 Ultrasonic sensor US 100

Information:
1. VCC: 5 Volt
2. Trig: trigger input
3. Echo: pulse output
4. GND: Ground
5. GND: Ground

2.4. D. Software Processing

In object-detection research on Arduino Uno-based radar and US 100 sensors, the software used to display graphs results from ultrasonic sensor readings, the authors use the 3.2.1 Processing software. Software processing 3.2.1 has advantages that can directly receive input from Arduino Uno R3 board via USB cable. Serial input from ultrasonic sensor readings will be uploaded to the processing software which will be displayed in the form of graphics to be more user-friendly. By using this software, the location of an object along with the distance of the object from the ultrasonic sensor can be detected. The advantages of this software is it is open-source, interactive: it can display output in the form of 2D, 3D and pdf, and can operate on some operating systems such as Windows, Mac, and Linux, and most importantly is the software is supported with libraries that make it easier for us to do programming
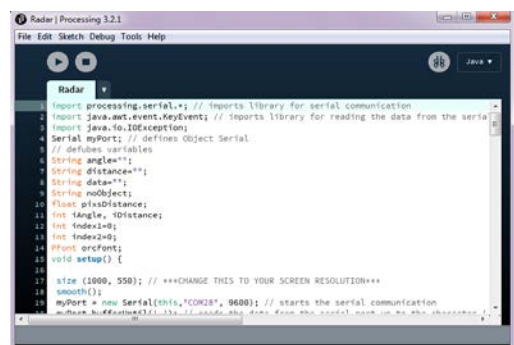

Figure 4. Example program in processing 3.2.1

3. System Model

The overall system block diagram of the design of this tool can be seen in Figure 5
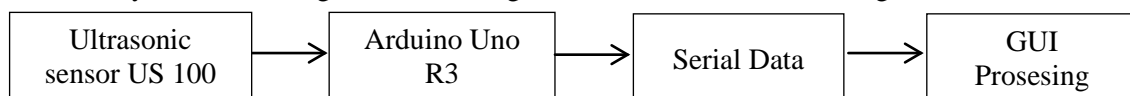

Figure 5. Block diagram system

In this study, US 100 sensors are used to measure the distance through the waves emitted by the sensor US 100. Data from the sensor is processed by Arduino data to get the picture data. Then it will be transferred to GUI processing, the it can be displayed through the GUI
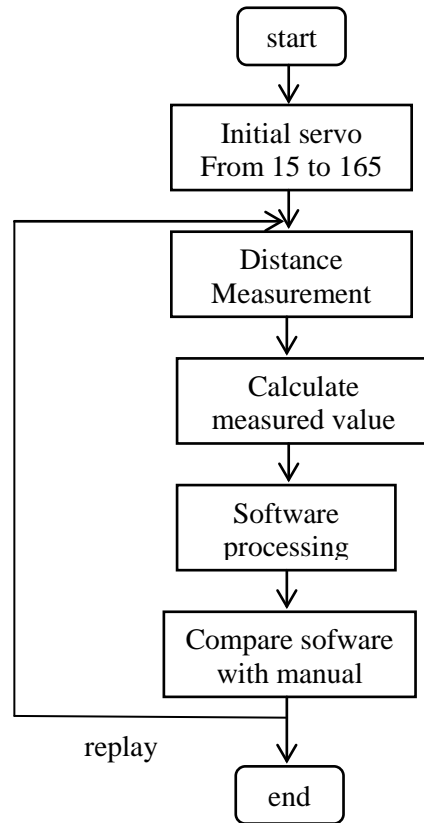

Figure 6. radar flow diagram using US 100 sensors and software processing 3.2.1

Based on the picture 6 it can be seen the initial step is the initialization of servo and programming on the Arduino to determine the distance using the ultrasonic sensors us 100. After the program is completed, then the program is applied. To see the radar display, this study uses US 100 software processing. The results of display the calculation of the distance through software processing then compared with manual calculations and ended by drawing conclusions.
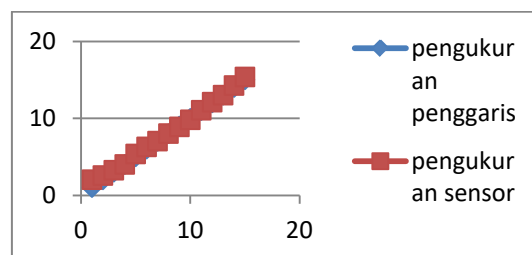
4. Research Result

The testing and analysis chapter of this tool is tested on the system by measuring the distance and the results will be compared through measurement using a regular measuring instrument (meter). In the chapter of testing and analysis is done testing the measurement of the distance of the object from the front of the sensor. After that will be sweeping from 15 - 165 degrees angle which later the data is directly sent to the program display GUI Processing 3.2.1 through serial data communication USB.

In this test, the magnitude of the measured distance on the sensor will be displayed on the LCD screen of the Laptop via Serial Monitor. Then the result of this measurement is compared to the measurement result with the meter measured horizontally toward the front of the sensor. The result of distance measurement from forward direction is shown in table 3.

Table 3. Measurement results with measuring instruments

The measured distance with ruler (cm)	The measured distance in Serial Monitor (cm)	**Difference distance (cm)**	**error (%)**
1	2,03	1,03	103
2	2,57	0,57	28,5
3	3,26	0,36	8,66667
4	4,01	0,01	0,25
5	5,37	0,37	7,4
6	6,29	0,29	4,83333
7	7,04	0,04	0,57143
8	8,02	0,02	0,25
9	8,89	0,11	1,222222
10	9,81	0,19	1,9
11	11,05	0,05	0,45455
12	12,10	0,10	0,83333
13	13,01	0,01	0,07692
14	14,26	0,26	1,85714
15	15,37	0,37	2,46667

Figure 7 Graph of ultrasonic distance measurement results with actual distance

The measurement results from table 3 can be seen in figure 7. From the calculation can be seen that for very close calculations, under 3 cm measurement using radar has a high error rate. this is due to sensors US 100 has a sensitivity of 2-450 cm. for values above 3 cm the measurement results with the sensor almost closer to the true value. So the US 100 sensor can be recommended as one of the learning media radar system. To display this ultrasonic distance measurement it will sweeping from an angle of 15 - 165 degrees and back again to the beginning as well as repeated continuously and the results will be displayed in graphical visual form. Ultrasonic sensors will detect the presence of objects that exist in front of a radius of 3 - 40 cm during sweeping. The visual appearance of this test is shown in Figure 8 as follows:
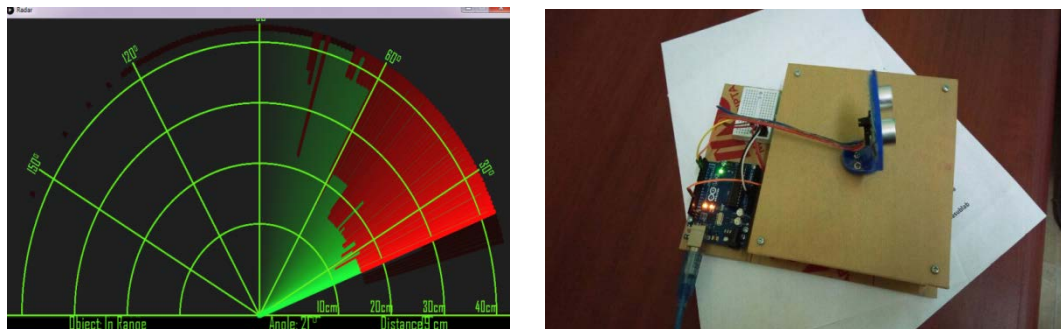
Figure 8. Display of radar applications with US ultrasonic sensors 100

5. Conclusion

On horizontal distance testing the US 100 sensor compared to the measured distance with the meter is relatively close. The percentage error is large if the distance is less than 3 cm. GUI with Image processing able to display the distance with a good illustration and give the appearance in accordance with the Radar. The image illustration gives a good and accurate response when there is an object detected according to the distance and location of the detected object.

6. Suggestion

The recommendation during developing the GUI view with Image Processing is pay attention to computer's screen resolution, BaudRate and COM Port.

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