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Objects Monitoring RADAR using Bluetooth Ultrasonic

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Abstract: Currently the development of information technology is very fast in its development. Up to all fields can not be separated from information technology. In the industrial era 4.0, there are also a lot of Internet of Things devices. Almost every field has used many IoT devices. The presence of IoT-based devices is very helpful in modern human life today. Moreover, with the development of microcontrollers and open source makes someone create a device quickly. One of them is making a prototype for sensing objects. By utilizing the Arduino Uno microcontroller and Ultrasonic sensors to create a sensing prototype. The results of this sensing can be displayed on notebooks and mobile phones. The microcontroller also sends sensing sensor data via Bluetooth as a wireless communication medium. Called Internet of Thing if a device can send signals to other devices. Various data communications can be via wireless or wire. Mobile app that is used to display sensing results from Ultrasonic sensors. Use of the App Inventor platform as a front end for mobile apps. This device is only limited to a short distance. Due to the limitations of the Ultrasonic sensing sensor it does not exceed 1 meter. The results of this ultrasonic sensor detect objects that are 35 centimeters away and after being measured with a manual ruler, the results are exactly 35.01 centimeters. This shows an accuracy rate of 99.97%.

Keywords: Arduino Uno, Bluetooth, Internet of Things, Ultrasonic, Wireless

INTRODUCTION

Radio Detection and Ranging (RADAR) is a device that determines the distance, direction or speed of moving and fixed objects. Radar has been widely applied to various sensing devices. Radar can also be used to help navigate moving objects. Limitations of view in determining the existence of objects as a result of limited visibility, this is due to light conditions and obstacles from monitoring the object. The use of radar is one solution to overcome these conditions. The workings of radar utilize the principle of emission and reflection of electromagnetic waves at energy levels within a certain period of time. The use in the field of mathematical computing can be obtained visually capturing signals from the monitored object. Large conventional radars are widely used in the aeronautical industry to detect aircraft and aerospace equipment, marine equipment for detect ships, geographic equipment for mapping and detection weather. Radar with various sensors is able to detect objects with various distances. Some cover short distances, medium distances and even long distances. Long distance can detect thousands of kilometers. Object detection can detect metal, water and even plastic and objects of various materials. The transmitter is an ultrasonic sensor, microwave.

In the frequency range from 20 Hz to 200 MHz, it has been divided into several parts. Infrasound is at a frequency of < 20 Hz or low bass notes. The frequency range of 20 Hz to 20 kilo Hz is used for Acoustic. While Ultrasonic with a frequency of 20 kilo Hz to 2 MHz, and is used by such as animal sounds, chemical equipment, medical and destructive equipment.

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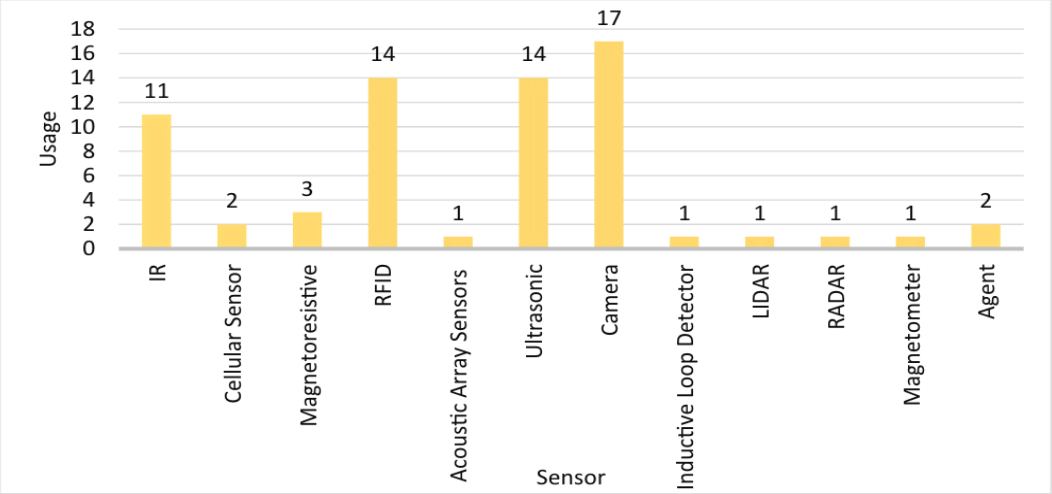

Fig 1. Trending topic on the use of sensors in detecting objects (Fahim et al., 2021)

This study detects objects by using object sensors using ultrasonic sensors. The reason underlying the use of ultrasonic sensors is because the use of ultrasonic sensors is a trending topic in many studies. As shown in Figure 1, it shows that the use of Ultrasonic sensors is one of the most widely used in previous studies.

Several previous studies that have discussed radar as a sensing tool are as shown in table 1. This study discusses sensing devices using ultrasonic sensors as a tool for detecting objects.

Table 1. Studies that have discussed ultrasonic sensors

No	Topic Research	Advantages	Weakness
1	Development of a low cost open-source ultrasonic device for plant height measurements (Montazeaud et al., 2021)	The use of ultrasonic sensors to measure plant height.	The use of the device or prototype that is used does not use communication sensors to send data to users.
2	Ultrasonic sensor based traffic information acquisition system: a cheaper alternative for ITS application in developing countries (Appiah et al., 2020)	The use of ultrasonic sensors is applied to the traffic system, to detect the presence of a smooth flow or in a traffic jam.	The use of the device or prototype that is used does not use communication sensors to send data to users.
3	Intelligent tracking obstacle avoidance wheel robot based on arduino (Li et al., 2020)	The use of ultrasonic sensors on cars with ultrasonic sensors in detecting obstacles, so that the car does not hit obstacles. If it encounters an object that is blocking it, the car stops and turns.	The use of the device or prototype that is used does not use communication sensors to send data to users.
4	RADAR based Object Detector using Ultrasonic Sensor (Kulkarni et al., 2019)	The use of ultrasonic sensors with Arduino, Raspberry Pi 3, communication via GSM SIM808 module, Servo Motor, Screen, Keyboard and Mouse. Use of software that is displayed on the screen on Arduino.	Does not use bluetooth sensors.
5	Object identification using super sonic sensor: Arduino object radar (Gupta & Kumar Agarwal, 2018)	The use of arduino sensors using an arduino uno microcontroler, stepper motor. Program for display on the monitor screen.	Do not use communication media such as bluetooth, WIFI.

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From previous research, there are several weaknesses, namely not using communication sensors. Based on the weaknesses of previous studies, this study complements previous research. The use of communication sensors, especially bluetooth communication sensors as a method of sending ultrasonic sensor results. State of the art of this research by adding a communication module, especially bluetooth. The purpose of this study is to design and build a detecting prototype using an ultrasonic sensor. The results of object detection will be visualized on the monitor screen and mobile devices. And the use of a bluetooth communication module is an added value in building a radar prototype. In connection with the description above, a problem arises. These problems can be described as a research question. How to develop a device for radar that can send ultrasonic signals into the monitor screen, so that the waves can be visualized clearly? (RQ1). How does the result of the radar wave know the object being visualized? (RQ2).

LITERATURE REVIEW

Microcontroller Arduino Uno, this board contains electronic circuits and accommodates coding programs that aim to control the hardware as needed. This platform is very robust which is useful in developing a microcontroller design. Arduino Uno is based on the ATmega328P chip, which consists of 14 digital input/output pins (6 are used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator and other functions. Arduino Uno also has a main component, namely the ATmega328P which has high performance and low power (Oltean, 2019). There are already useful holes for plugging cables without soldering. The EEPROM in the ATmega328P is 1kb in size, the program can be saved and not deleted if the power is turned off. Power consumption used ranges from 7 - 12 Volt DC current. This arduino uno platform is a very easy and very common microcontroller platform used in designing Internet of Things devices (Kadhum & Abdulhussein, 2021).

Arduino IDE is open-source software that writes, compiles and uploads code directly to the microcontroller. The version used in this paper is version 1.8.9. The Arduino IDE environment is used to write the desired software code and for compilation, upload the code to the given Arduino board. The environment supports C and C++ languages. Usage for debugging, editing, compiling, and uploading code in its environment to physical hardware modules (Amoran et al., 2021). Arduino IDE, arduino provides tools for uploading programs into the Arduino board's EEPROM. These tools are provided by Arduino for the purpose of creating control scripts that are tailored to the needs of the designer. The designers only run by compiling, if there are no errors then the results of the compilation can be uploaded to Arduino. Many libraries are also available in the Arduino IDE environment. Port recognition is also available, if the upload cable is plugged into the notebook's USB media, Arduino can recognize it. Results monitoring is also available in the IDE.

Sensor Ultrasonic HC-SR04 is a sensor with a range of up to 40 KHz. HC-SR04 is an ultrasonic sensor used as a medium to measure the distance of the object being measured. HC-SR04 has two main components as ultrasonic transmitter and ultrasonic receiver. Its function is to emit waves with a frequency of 40 KHz then the ultrasonic receiver captures the results of the reflected waves hitting an object. The travel time of the transmitting wave to the receiver is proportional to 2 times the distance between the sensor and the reflecting field. The principle of distance measurement, when a trigger pulse is given to the sensor, the transmitter will start emitting waves. At the same time the sensor will produce output. The change in signal indicates that the sensor begins to calculate the measurement time after the sensor receiver receives the reflection generated by the object. Timing will be stopped by producing a transition change output. The principle of operation of the HC-SR04 computer sensor begins by giving a Low pulse (0) when the module starts to operate, then giving a High pulse (1) to the trigger for 10 s so that the module starts emitting 8 square waves with a frequency of 40 KHz, wait until the up transition occurs. at the output and start timing calculations until a down transition occurs.

Module Bluetooth, Classic Bluetooth as well as BLE use Spread Spectrum Technology Frequency Hopping (FHSS) in the 2.4 GHz unlicensed Industrial, Scientific and Medical (ISM) band and share some other characteristics but are not operable at all. Although the frequency range used is 2400 to 2485 MHz for the two different channel allocation technologies. Classic Bluetooth uses 79 frequency channels separated by 1 MHz while 40 channels separated by 2 MHz are used in BLE. Classic bluetooth module translates frequency channels per packet, typically 1600 times per second or at least 320 times per second (for 5 slots packets) - whereas connected BLE devices switch frequency channels per Connection Event with a maximum duration of 4 seconds (Todtenberg & Kraemer, 2019). Bluetooth beacons are small and less expensive devices used for indoor positioning. Monitoring objects from one location and detecting their presence in different places. In order to properly listen to a beacon, location is a very important feature and must be placed correctly (Surendran & Rohinia, 2019).

Stepper Motor (Gundogdu & Celikel, 2021) can be thought of as a synchronous motor that rotates separately and step by step. These actuators are the ideal choice for where accurate position control is desired. Comparison

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of other synchronous motors, they have high torque but low speed due to structure and are used in various applications such as robots and CNC machines. Stepper motors (Churkin et al., 2021) come in 3 types including variable reluctance, permanent magnet, and hybrid stepper motors. The variable stepper motor has a toothed lightweight rotor and a toothed stator. The permanent magnet stepper motor has no teeth on its rotor which is made of magnetic material. The HSM has a toothed rotor with a magnet inside. This type has high torque and small stroke (Hojati & Baktash, 2021).

MIT App Inventor , android development platform MIT app inventor 2 is the latest version of the online application used in developing android applications. It contains blocks that are dragged and dropped on the desired block in the appropriate place. The developed application can be installed on Android phones/tablets with Bluetooth module (Mikolajczyk et al., 2018).

Processing software (Ben Fry; Casey Reas, 2012), is software that displays signals or data contained in Arduino. This software is a very powerful third party software in data visualization. The main platform for library processing uses java. Development and distribution of related software, including Processing (Java), p5.js (JavaScript), and Processing.py (Python), and facilitating partnerships and collaborations with relevant organizations and individuals, to build a more diverse community around software and art.

METHOD

The design of the prototype for object detection using ultrasonic and bluetooth sensors can be seen in Fig 2.

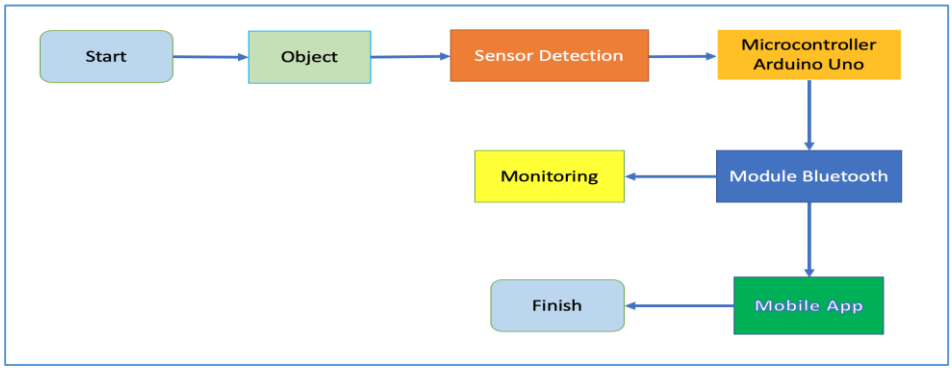

Fig 2. Design prototype for ultrasonic sensor

Objects are detected using the ultrasonic sensor detection sensor HCR05. This sensor has a signal sending sensor and a sensor receiving sensor. The working principle of this sensor is to send waves to the object. The reflection from the object will be received by the wave receiver. This process results in the detection of the object. After the signal data is sent to the Arduino, it is then sent to the monitor screen. The results are also passed via bluetooth to be displayed in the mobile app. The use of processing software helps to display object detection through the screen monitor.

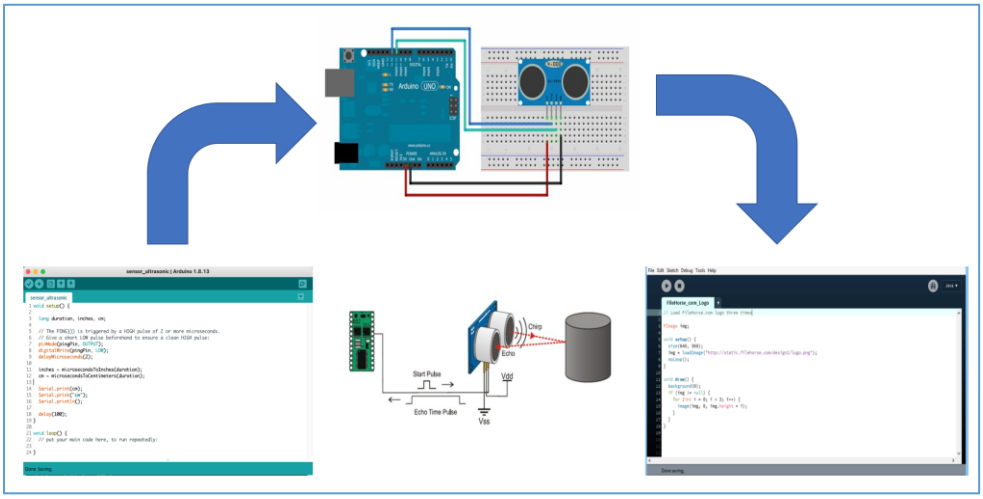

Fig 3. Ultrasonic sensor results are read by software processing

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Figure 3, is the upload process from the control script to the Arduino Uno, all processes regarding the signal data from the ultrasonic sensor will be compiled after the upload process is carried out. After the upload process is complete, Arduino will provide detection sensor signal data to be sent via bluetooth or via cable to be visualized on the monitor screen. For bluetooth communication media, it will be forwarded to the mobile app, and displayed into the mobile app. Use of the MIT app inventor platform to produce mobile apps.

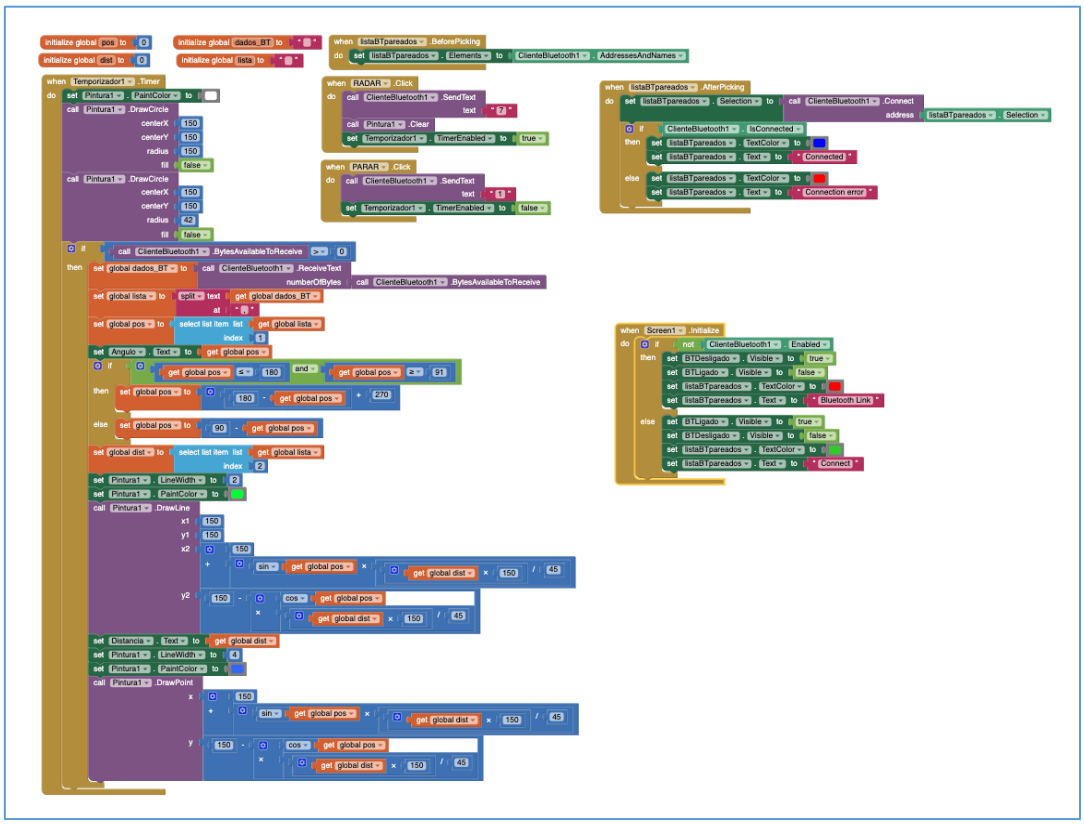

Fig 4. App Inventor script to visualize to mobile app.

Figure 4, is the source code of ultrasonic sensor detection whose data signal is taken from bluetooth media and visualized into a mobile app. Making coding is not by writing the code, but just clicking and dragging from the library provided by the app inventor. This kind of development is quick to produce applications, where the manufacturing process is faster and costs less.

RESULT

The results of the development using the design have produced a device and have issued results with various sensors and the appearance of the ultrasonic sensor which is visualized on the notebook monitor screen. As in picture 4.

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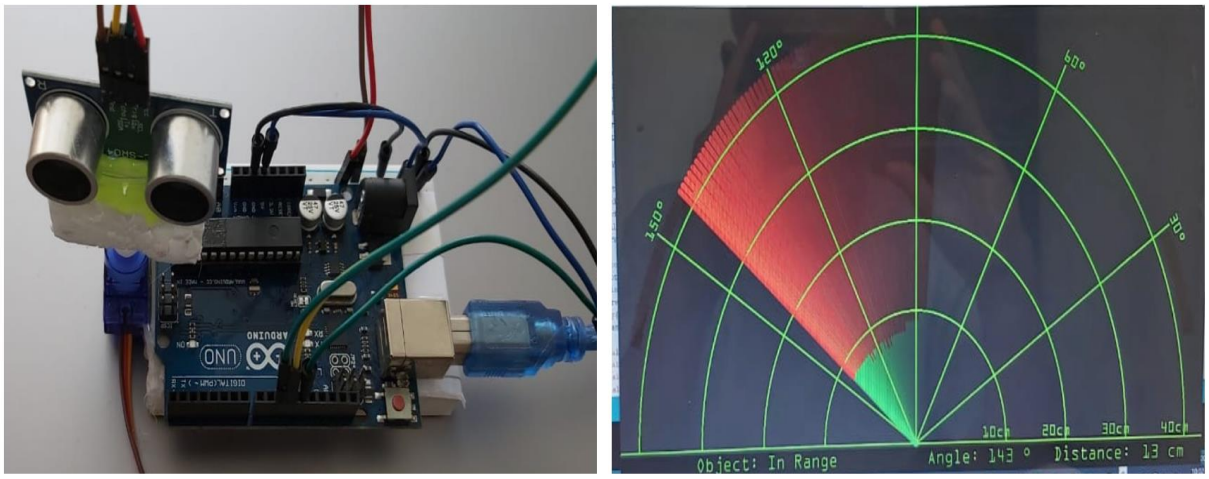

Fig 4. Prototype untuk sensor ultrasonic deteksi object.

The sensing design of the object produces is shown in Figure 4. The object can be identified by visualizing the distance, angle of the object being detected. This prototype refers to the ultrasonic radar design with Arduino Uno, as a process for control of object detection. The ultrasonic sensor works by sending a signal to the object, then the reflected signal will be captured and translated into the ultrasonic sensor. The catch is in the form of digital data. The digital data is visualized into Processing software. Ultrasonic data will be sent to the Processing Software. And the Processing Software will visualize it into a graphical display as in Fig 4.

Script processing for ultrasonic, ultrasonic signal is read from the Ardunio microcontroller to use serial communication in port 3. Then draw a green line as no object detected. A red line if the ultrasonic sensor detects an object. The stepper motor is useful for rotating the ultrasonic sensor with a rotation of 180%. Configuring this system, the Processing software is installed on the computer and the Arduino Radar Processing Script is run into the computer to capture the ultrasonic sensor signal. Searches for and finds the character ',' then inputs the variable. Reads data signal from Arduino port at position "0" to variable position. Angle value derived from Arduino Microcontroller from Serial Port. While the process of reading data from the variable position to the last signal data is called the sensor distance to the object. The maximum distance from the object to the ultrasonic sensor is 40 centimeters.

DISCUSSIONS

This device has been tested with 10 times of testing to measure the distance between the ultrasonic sensor and the object being tested. The results can be seen in table 2, where there is a measurement of the actual distance that will be compared with the distance measured from the device. This difference can be used as a reference in calculating the accuracy of the radar device.

Table 2. Test result

Testing	Actual distance	Detected distance	Difference
1	13,00	13,00	0
2	12,00	12,00	0
3	5,00	5,01	0,01
4	7,00	6,99	0,01
5	10,00	10,00	0
6	4,00	4,00	0
7	6,00	6,00	0
8	8,00	8,01	0,01
9	10,00	10,01	0,01
10	11,00	11,00	0
11	4,00	4,00	0
12	6,00	6,01	0,01
13	8,00	8,00	0
14	15,00	15,01	0,01

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15	12,00	12,00	0
16	15,00	15,00	0
17	20,00	20,01	0,01
18	11,00	11,00	0
19	17,00	17,01	0,01
20	19,00	19,01	0,01

The average difference of these measurements is 0.0045, the result is satisfactory. Because the average of the measurement difference is very small below 1%. This shows that the radar device is right in detecting the object's distance to the ultrasonic sensor. Hasil pengukuran serta akurasi pada penelitian ini sekitar 99,9955%.
The following is a comparison of the results of previous studies using Arduino sensors.

Research 1, Topic "Development of a low cost open-source ultrasonic device for plant height measurements", Measurements on the sorghum bicolor plant, using ultrasonic sensors to measure length, there is a difference of 1 centimeter (Montazeaud et al., 2021). The accuracy is about 99.65%.

Research 2, Topic "Ultrasonic sensor based traffic information acquisition system". Measurements on vehicle objects, using ultrasonic sensors, have a tolerance or difference of 10% (Appiah et al., 2020). Prototype accuracy is about 90%.

Research 3, Topic "Intelligent Tracking Obstacle Avoidance Wheel Robot Based Arduino", Does not take measurements so there is no accuracy (Li et al., 2020).

Research 4, Topic "RADAR based Object Detector using Ultrasonic Sensor", Measurement of ultrasonic sensor accuracy, was not carried out so that accuracy does not exist (Kulkarni et al., 2019).

Research 5. The topic "Object identification using super sonic sensor: Arduino object radar", Ultrasonic sensor accuracy measurement, was not carried out so that the accuracy did not exist (Gupta & Kumar Agarwal, 2018).

CONCLUSION

The design of the ultrasonic sensor design in detecting objects can determine the distance from the object point and the ultrasonic sensor. The determination of the distance has been tested with 20 times of testing and produces an accurate rarity. With an error or difference below 1%. This proves that 20 times of testing has resulted in a good ultrasonic design. There are several limitations, this device is designed with a short distance, because in this study only to build a limited prototype and only a prototype. The use of processing software is third party software from the Arduino IDE software. This Processing Software is in addition to visualizing the ultrasonic sensor detection results. The development of this ultrasonic sensor will later be developed or applied with robotics to detect the presence of objects.

Suggestions for further research is to develop an object detection system with longer distances LiDAR (Light Distance And Ranging). The use of this sensor is able to detect remote objects. Then display object detection with visualization on the computer screen.

REFERENCES

Amoran, A. E., Oluwole, A. S., Fagorola, E. O., & Diarah, R. S. (2021). Home automated system using Bluetooth and an android application. *Scientific African*, *11*, e00711. https://doi.org/10.1016/j.sciaf.2021.e00711

Appiah, O., Quayson, E., & Opoku, E. (2020). Ultrasonic sensor based traffic information acquisition system a cheaper alternative for ITS application in developing countries. *Scientific African*, *9*, e00487. https://doi.org/10.1016/j.sciaf.2020.e00487

Ben Fry; Casey Reas. (2012). *Processing Software*. https://processing.org/

Churkin, A. V., Ganziy, Y. V., & Dementev, V. B. (2021). Stepper motor control system based on the ZET 7160-s module and the ZETLAB SCADA system. *Procedia Structural Integrity*, *32*(C), 277–283. https://doi.org/10.1016/j.prostr.2021.09.039

Fahim, A., Hasan, M., & Chowdhury, M. A. (2021). Smart parking systems: comprehensive review based on various aspects. *Heliyon*, *7*(5), e07050. https://doi.org/10.1016/j.heliyon.2021.e07050

Gundogdu, A., & Celikel, R. (2021). NARMA-L2 controller for stepper motor used in single link manipulator with low-speed-resonance damping. *Engineering Science and Technology, an International Journal*, *24*(2), 360–371. https://doi.org/10.1016/j.jestch.2020.09.008

Gupta, N., & Kumar Agarwal, A. (2018). Object identification using super sonic sensor: Arduino object radar. *Proceedings of the 2018 International Conference on System Modeling and Advancement in Research*

*name of corresponding author

e-ISSN : 2541-2019
p-ISSN : 2541-044X

Trends, SMART 2018, 92–95. https://doi.org/10.1109/SYSMART.2018.8746951

Hojati, M., & Baktash, A. (2021). Design and fabrication of a new hybrid stepper motor with significant improvements in torque density. *Engineering Science and Technology, an International Journal*, *24*(5), 1116–1122. https://doi.org/10.1016/j.jestch.2021.01.016

Kadhum, A. A., & Abdulhussein, M. M. (2021). Implementation dc motor as servomotor by using arduino and optical rotary encoder. *Materials Today: Proceedings*, *xxxx*, 4–8. https://doi.org/10.1016/j.matpr.2021.03.576

Kulkarni, A. U., Potdar, A. M., Hegde, S., & Baligar, V. P. (2019). RADAR based Object Detector using Ultrasonic Sensor. *1st IEEE International Conference on Advances in Information Technology, ICAIT 2019 - Proceedings*, 204–209. https://doi.org/10.1109/ICAIT47043.2019.8987259

Li, Z. F., Li, J. T., Li, X. F., Yang, Y. J., Xiao, J., & Xu, B. W. (2020). Intelligent tracking obstacle avoidance wheel robot based on arduino. *Procedia Computer Science*, *166*, 274–278. https://doi.org/10.1016/j.procs.2020.02.100

Mikolajczyk, T., Fuwen, H., Moldovan, L., Bustillo, A., Matuszewski, M., & Nowicki, K. (2018). Selection of machining parameters with Android application made using MIT App Inventor bookmarks. *Procedia Manufacturing*, *22*, 172–179. https://doi.org/10.1016/j.promfg.2018.03.027

Montazeaud, G., Langrume, C., Moinard, S., Goby, C., Ducanchez, A., Tisseyre, B., & Brunel, G. (2021). Development of a low cost open-source ultrasonic device for plant height measurements. *Smart Agricultural Technology*, *1*(November), 100022. https://doi.org/10.1016/j.atech.2021.100022

Oltean, S. E. (2019). Mobile Robot Platform with Arduino Uno and Raspberry Pi for Autonomous Navigation. *Procedia Manufacturing*, *32*, 572–577. https://doi.org/10.1016/j.promfg.2019.02.254

Surendran, D., & Rohinia, M. (2019). BLE Bluetooth Beacon based Solution to Monitor Egress of Alzheimer's Disease Sufferers from Indoors. *Procedia Computer Science*, *165*, 591–597. https://doi.org/10.1016/j.procs.2020.01.053

Todtenberg, N., & Kraemer, R. (2019). A survey on Bluetooth multi-hop networks. *Ad Hoc Networks*, *93*, 101922. https://doi.org/10.1016/j.adhoc.2019.101922

*name of corresponding author