Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 4, October 2022
DOI : https://doi.org/10.33395/sinkron.v7i4.11883
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Performance Comparison of Ultrasonic Sensor Accuracy in Measuring Distance

Edward Sze[1)*], Djarot Hindarto[2)], I Ketut Adi Wirayasa[3)], Haryono[4)]
[1,2,3,4)] Universitas Pradita, Serpong, Banten, Indonesia
[1)]edward.sze@student.pradita.ac.id,[2)]sosbuk@gmail.com,[3)]adi.wirayasa@gmail.com,[4)]haryono@pradita.ac.id

Submitted : 25 Oct 2022 | **Accepted** : 29 Oct, 2022 | **Published** : Oct 31, 2022

Abstract: Digital technology is now very sophisticated. Its use is widely applied in all areas of human life. Starting from waking up, human activities and others always use technology. In carrying out their activities, modern humans now almost all use vehicles as a mode of transportation. Today's vehicles use a variety of sensors as a sixth sense. The results of detection using sensors on the vehicle are usually displayed on the dashboard of the vehicle. Modern humans currently use sensors to complete their needs. Besides that, the internet of things technology is growing rapidly in its role and development to support the needs of modern humans. Micro-controller technology is also experiencing rapid and massive development. One of the most common and most popularly used microcontrollers is Arduino. In many streets in Indonesia, people still use vehicles not equipped with many sensors. One of them is a simple parking sensor that many old vehicles don't have. Parking sensor problems are needed at the time of parking so that the vehicle that will be parked does not hit other objects or vehicles. There are many types of ultrasonic sensors. The purpose of this research is to make a prototype ultrasonic sensor that is applied to vehicles and compare some of the most accurate ultrasonic sensors in measuring the distance between the vehicle and the object being measured.

Keywords: Arduino; Parking Sensor; Microcontrollers; Ultrasonic Sensor; Prototype

INTRODUCTION

The Internet of things Technology is currently growing rapidly and has almost fulfilled human needs. Various equipment based on the internet of things has been circulating in the community. But there is also a lot of simple equipment that can be made or produced by hand at home, also called "home industry. One of them is the use of parking sensors on vehicles. This tool is very simple, but produces a very powerful product. The internet of things is currently considered a cheap solution to meet the needs of the community. Unconsciously, people today use sensors a lot in their daily operations. Every daily activity uses sensors, such as the sensors in smartphones. Lighting sensors using LEDs, gyro sensors, and accelerometers are also used for various games. And there are many more uses of sensors in smartphones. Because smartphones must be maintained both physically and non-physically. Currently, there are many distributions of malware that are very disturbing, but many people do not protect their smartphones. There are a lot of malware detection devices (Hindarto & Santoso, 2022) and many don't use them, resulting in a lot of data leaks from smartphone devices. Many smartphone users are harmed because of various kinds of malware, and smartphones are not equipped with malware detection devices (Hindarto & Handri Santoso, 2021), (Hindarto, 2022).

Vehicles produced by the large automotive industry have implemented a lot of parking sensors using ultrasonic sensors or even better capabilities than ultrasonic sensors. This is done by the automotive industry with the aim of sustaining the vehicle industry's products. One of them is sustainability by making breakthroughs using a variety of very sophisticated technologies. The sustainability of the automotive industry certainly applies to enterprise architecture (Hindarto et al., 2021). There are still many vehicles that are not equipped with parking sensors. In fact, many vehicles that are not equipped with parking sensors (Moholkar & Bangare, 2022) are still driving on the highway, but it is still not dangerous if the vehicle does not have parking sensors (Perković et al., 2020). The problem is that when parking, the driver tries harder by monitoring through the side mirror. This is quite responsive if the vehicle is parked in the rain. Where the driver's vision becomes limited if there are obstacles, such as rainwater, fog, and other obstacles.

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 4, October 2022
DOI : https://doi.org/10.33395/sinkron.v7i4.11883
e-ISSN : 2541-2019
p-ISSN : 2541-044X

The purpose of this research is to make a simple parking sensor prototype that is useful for vehicle completion. Based on the problem that the vehicle is difficult to park if there are obstacles. This parking sensor prototype raises several research questions. Research question 1, how do ultrasonic sensors work? Research Question 2, What is the design of the ultrasonic sensor prototype? Research question 3, Is there a comparison to ultrasonic sensors of various types?

LITERATURE REVIEW

Many previous studies have discussed ultrasonic sensors, but their use or prototypes are still just to meet research needs. But this research is useful for vehicles that do not have parking sensors. In addition to research, this prototype is very useful for vehicle owners. This is not only for research needs; this research is useful for society.

Ultrasonic sensor research to detect objects. The title of Ultrasonic Sensor Implementation to Measure Sound Wavelength Research has been carried out based on the microcontroller (Budiarso, 2015). Measurement of the object is carried out at the closest distance of 2.34 cm and the furthest distance is 374 cm. This research does not explain the sensors used. The sensor used is actually not able to detect long distances, because ultrasonic sensors are usually used at close range. LIDAR (Light detection and ranging) (Thornton et al., 2014), (Zováthi et al., 2022) sensors are used. The weakness of this research is that it does not mention accuracy in object distance detection. So this research only displays ultrasonic sensors, micro-controllers, and LCDs.

Comparison of HC-SR04 and JSN-SR04T Ultrasonic Sensors for Water Level Detection System Applications (Heru Purwanto, Malik Riyadi, Destiana Windi Widi Astuti, 2019). This research measures the object distance by comparing the ultrasonic sensors HC-SR04 and JSN-SR04T. The accuracy of the JSN-SR04T sensor shows an average error of 1.28%, while the HC-SR04 sensor shows an average error of 2.48%. The weakness of this research is that it has not been used as a prototype that is useful for the community. There should be a test tool attached to the river location as a prototype to measure the height of the river water, and it would be very useful if the measurement was made at the river location so that it could be useful for the community around the river location.

Ultrasonic Sensor As An Air Flow Velocity Measurement Device In The Pipe (Suastika et al., 2014). The measurement principle used in this study uses the ultrasonic wave travel time method (time of flight) by utilizing changes in the characteristics of ultrasonic waves when passing through different airflow conditions, namely upstream and downstream. Based on these results, the correlation coefficient obtained is 0.99, which means that the two variables have a very high correlation. In addition, the value of the coefficient of determination obtained is 99%. In other words, the size of the measured speed of 99% can be explained by a linear relationship in the equation below, while the rest is determined by other conditions. The results of this study, showed that the error was only 1% of the anemometer. This means that air flow velocity data measured by ultrasonic waves can show results that are almost similar to actual data with anemometers. In other words, the ultrasonic sensor in this research device can be used to measure the air flow in the pipe.

Application of the HC-SR04 Ultrasonic Sensor to Detect the Distance of Train Passengers in the New Normal Era (Nur R. et al., 2020). This research discusses the detection of train passengers using ultrasonic sensors using the HC-SR04. This simple prototype is good for detecting so that every passenger keeps a safe distance. Using Arduino, ultrasonic sensor HC-SR04, buzzer, and Arduino IDE as tools for programming the micro-controller and as a tool for uploading scripts to the micro-controller. The weakness of this research has not yet been applied to trains, so this prototype is still only for research needs..

Utilization of Temperature Sensors DHT-22, Ultrasonic HC-SR04 To Control The Pool With Email Notifications (Siswanto et al., 2019). The purpose of this study is to create an application to monitor and control the water level in rainwater storage ponds with a DHT-22 temperature and humidity sensor, an HC-SR04 ultrasonic sensor, and an Arduino Uno R3 microcontroller, so that they can report quickly to staff via email notifications, making it easier for staff to monitor changes in water level in rainwater storage ponds remotely. The results of this research, as many as 90% of users said the system was very helpful in controlling the water level of the water reservoir and worked in real time, and as many as 10% of users said the system was less helpful in controlling the water level of the water reservoir.

Create an Automatic Braking System with an Arduino Uno and Ultrasonic Sensors (Alam & Maulana, 2020). From the results of the research that has been done, a prototype car with an automatic braking system has been successfully designed with the best average stopping distance at 28.75 cm from the target of 30 cm for a delay setting time of 200 ms. The prototype designed has an average error value of 4.17% and an accuracy rate of 95.83%. The prototype is still under development for research purposes, so it cannot be used on vehicles.

From previous research that discusses ultrasonic sensors and has many advantages and disadvantages. The State-Of-The-Art of this research makes a prototype that can be used on vehicles that do not have parking sensors, where this research can be directly applied to vehicles. In addition, this research also requires accuracy of the sensor distance to objects or obstacles in the surrounding vehicle. In addition, the accuracy of the

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 4, October 2022
DOI : https://doi.org/10.33395/sinkron.v7i4.11883
e-ISSN : 2541-2019
p-ISSN : 2541-044X

measuring distance and also the reliability of the ultrasonic sensor to the environment. This sensor is used outdoors, requires a sensor that is resistant to dust, water and solar heat.

METHOD

The workings of ultrasonic by emitting waves and reflecting waves in a certain time. Ultrasonic waves work from a frequency of 20KHz to 20 MHz. The working frequency used in ultrasonic waves varies greatly depending on the medium through which the medium is usually passed on gas, liquid and solid media. Therefore, ultrasonic sensors can be used to detect any medium. Ultrasonic consists of a 40 KHz signal generator chip, an ultrasonic speaker and an ultrasonic microphone. The ultrasonic speaker converts the 40 KHz signal into sound and the ultrasonic microphone functions to detect the reflection of the speaker's sound. The ultrasonic sensor sends ultrasonic sound after the trigger pulse from the microcontroller. Ultrasonic sound with a frequency of 40 KHz will be emitted for 200 s. This sound will propagate in the air with air propagation speed of 340 m/s or 29.412 s every 1 cm, hit the object and will be reflected back to the ultrasonic sensor. While waiting for the reflection, the ultrasonic sensor will generate a pulse. This pulse will give a value of “low” or 0, when the reflected sound is detected by the ultrasonic sensor. In calculating a distance by means of the pulse width of the ultrasonic sensor on the object. Rumus jarak pada The ultrasonic sensor seperti pada (1) .

$$\text{Distance} = \frac{\left[\frac{(pulse\ width)}{29.412}\right]}{2\ (cm)} \qquad (1)$$

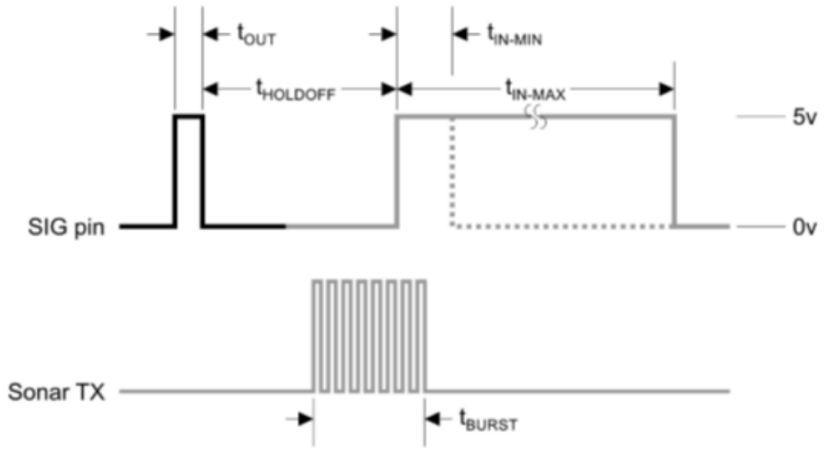

Fig 1. Digram Sensor Ultrasonic dengan “PING”
Source: (Rob et al., 2018)

The datasheet for the ultrasonic sensor can be described in fig 1 and table 1. PING())TM ultrasonic sensor measures distance simply (Wang et al., 2015), (Nnabuife et al., 2022), (Asgari et al., 2022), (Fiore et al., 2021). This sensor is ideal for a variety of applications that require measurements between moving or stationary objects. It is simple to communicate with a microcontroller. A single I/O pin is used to initiate an ultrasonic burst (well above human hearing range) and then "listen" for the echo return pulse. The sensor measures the time required for the echo return and sends this value to the microcontroller via the same I/O pin as a variable-width pulse.

Table 1. Sensor ultrasonic “PING”
Source: (Rob et al., 2018)

Pin Number	Pin Name	Description
1	Vcc	The sensor is powered by the Vcc pin, which is typically powered by +5V. Current consumption 30mA (maximum 35 mA).
2	Trigger	An component pin is a trigger pin. This pin must be held high for 10us in to start measurement by sending a US wave.

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 4, October 2022
DOI : https://doi.org/10.33395/sinkron.v7i4.11883
e-ISSN : 2541-2019
p-ISSN : 2541-044X

3	Echo	An output is an echo pin. This pin goes high for the duration that it takes for the US wave to return to the sensor.
4	Ground	This pin is linked to the system's Ground.

The design is carried out in several stages. The need to enter all inputs on this parking sensor, so that the results of this study, if applied, the prototype can produce useful devices. The problem of accuracy is very necessary, the outdoor environment must also think about so that this sensor is not obstructed by rain, dust and sunlight.

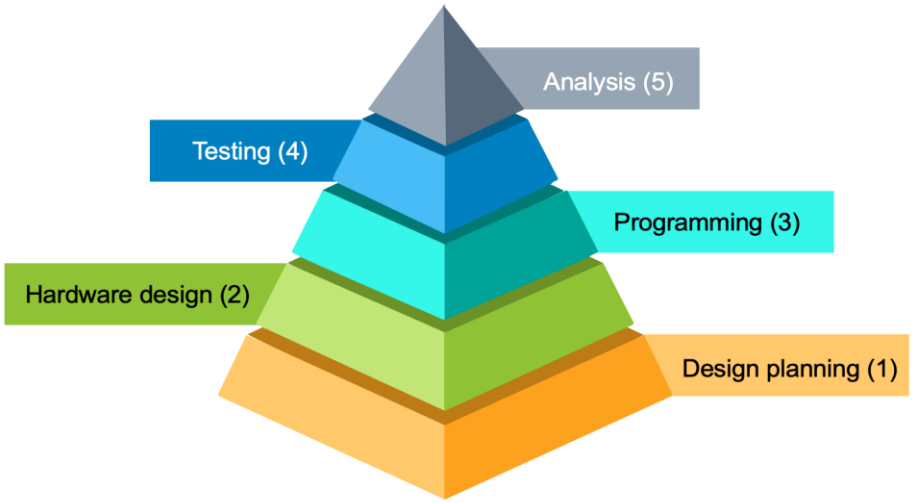

Fig 2. Methodology for resetting parking sensors
Source: Property researcher

The explanation of the five stages is as follows. Fig 2 is an illustration of the process below.

1. Design planning. The initial design can be made either in the form of schematic drawings before being designed in the form of hardware in order to obtain a concept picture of the prototype to be made.
2. Hardware design. Hardware design is made after the design is completed. Hardware design includes testing the performance of sensors, microcontrollers and motor drivers used.
3. Programming. The program is made to run the prototype, the program design is simulated and if it is successful it can be directly uploaded to the microcontroller used by the prototype.
4. Tool testing. Tool testing is done by placing the prototype on the prepared path and providing obstacles as braking indicators. The braking distance read by the sensor will be displayed by the LCD display. The target braking distance is 30 cm from the obstacle
5. Analysis. After testing the tool is successful, then proceed with analyzing the accuracy of the distance from automatic braking. The braking distance read by the sensor and displayed by the LCD display is compared with the actual measurement distance.

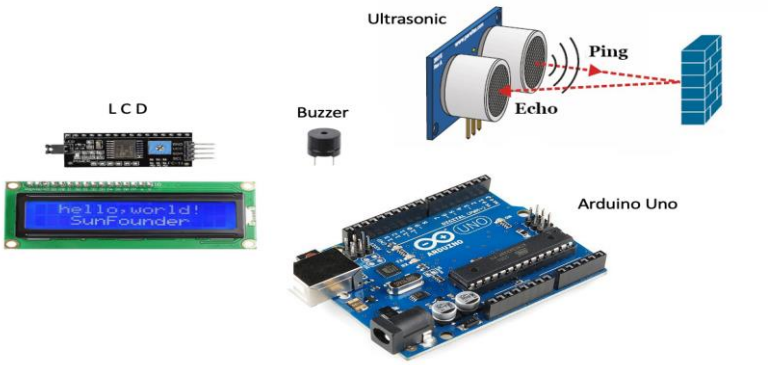

Fig 3. Component Sensor Parking
Source: Google image

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 4, October 2022
DOI : https://doi.org/10.33395/sinkron.v7i4.11883
e-ISSN : 2541-2019
p-ISSN : 2541-044X

This research requires several devices that are used in implementing the design of parking sensors. The micro-controller used is Arduino uno as a controller of the parking sensor prototype. If the vehicle approaches an obstacle or vehicle object, this micro-controller will command the buzzer to sound. In addition, this micro-controller also provides distance information from the object to the Liquid Crystal Display (LCD). LCD is used to display distance measurement with object detection. The power supply is also used to supply power to the parking sensor prototype.

RESULT

The results of this research can be seen in fig 4 and fig 5. The design planning stage has been carried out, the results of the planning produce a blue print. The blue print starts with testing object detection. The results of several measurement tests with 10 times for the AJ-SR04M Pakir ultrasonic sensor with the HC-SR04 ultrasonic sensor will be displayed in this research. Sensor accuracy and distance will also be displayed in table 2.

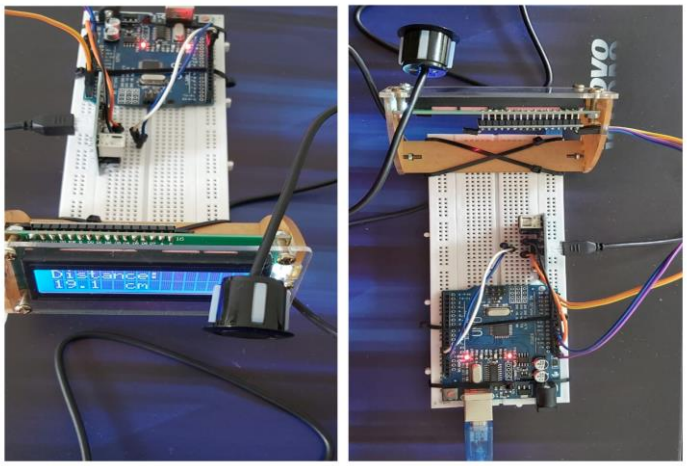

Fig 4. Protoype parking sensor
Source: Researcher Property

Fig 5 Application of parking sensors on vehicles
Source: Researcher Property

Measurement results with the ultrasonic sensor HC-SR04 and measurements with the ultrasonic waterproof sensor AJ-SR04M.

Table 2. HC-SR04 sensor test results with 10 test data

Test #	Sensor HC-SR04 (centimeter)	Actual distance (centimeter)	Result (centimeter)	Difference	Error
1	15	15	15,51	0,51	0,034
2	20	20	22,10	2,10	0,105
3	25	25	26,00	1,00	0,040
4	30	30	33,20	3,20	0,107
5	50	50	52,35	2,35	0,047

*name of corresponding author

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

6	60	60	62,01	2,01	0,033
7	150	150	152,01	2,01	0,013
8	175	175	180,01	5,01	0,023
9	200	200	205,11	5,11	0,025
10	250	250	254,01	4,01	0,016

The average error from the test results is 10 times, then obtained 0.0443. While the accuracy rate is 99.95%. The ultrasonic sensor type HC-SR04 is still good at testing accuracy.

Table 3. AJ-SR04M sensor test results with 10 test data

Test #	Sensor AJ-SR04M (centimeter)	Actual distance (centimeter)	Result (centimeter)	Difference	Error
1	15	15	15,04	0,04	0,0030
2	20	20	20,01	0,01	0,0005
3	25	25	25,20	0,20	0,0008
4	30	30	30,13	0,13	0,0043
5	50	50	50,30	0,30	0,0060
6	60	60	61,01	1,10	0,0183
7	150	150	152,10	2,10	0,0140
8	175	175	177,00	2,00	0,0057
9	200	200	201,92	1,92	0,0096
10	250	250	252,05	2,05	0,0082

The average error from the test results is 10 times, then obtained 0.007 ≈ 0,01. While the accuracy rate is 99.99%. The ultrasonic sensor type AJ-SR04M is good at testing accuracy.

DISCUSSIONS

This research can answer the questions that have been submitted. Research question 1, how do ultrasonic sensors work?. The workings of the ultrasonic sensor have been discussed in fig 1. The sensor will emit ultrasonic waves using an ultrasonic speaker, then the ultrasonic microphone will receive ultrasonic waves. Trigger is done in the micro-controller to generate a signal to the ultrasonic speaker. Research Question 2, What is the design of the ultrasonic sensor prototype? In fig 2. This is the stage of the prototype design in this research. These stages are used as a step in producing a prototype of the ultrasonic sensor. These stages are sequential, where stage 1 is complete, then proceed to stage 2. But at the programming stage is complete, if testing is carried out on prototypes that are not as expected, they will enter the previous stage. So this process is like the waterfall process in project management. The project management process is waterfall, if at the testing stage it does not match the test results, the process can be started from the initial stage. It is hoped that by retreating the process to an early stage, we can find errors from the early stages. Research question 3, Is there a comparison to ultrasonic sensors of various types? The research uses two ultrasonic sensors to make comparisons. The goal is to find out the capabilities and weaknesses of the sensor, so that in the test it gets the best results in testing. Because this parking sensor prototype is used for vehicles, accuracy needs to be considered. So that later there will be no errors in the resulting device. The results can be seen in table 2, for accuracy test results.

CONCLUSION

From the explanation of the research "Performance Comparison of Ultrasonic Sensor Accuracy in Measuring Distance", it can be concluded that accuracy is still high. Ultrasonic sensor HC-SR04, still produces 99.95% accuracy. Sensor AJ-SR04M, 99.99% accuracy in distance measurement. Another reliability of the ultrasonic water resistant sensor is that this sensor is more resistant to weather, such as rain water, dust. The prototype can be used on vehicles so that this research is immediately beneficial to the community, not just as an article. Research can be developed by using additional brake devices on the vehicle, so that when the vehicle is too close, the detection sensor will provide information to the micro-controller to perform automatic braking.

REFERENCES

Alam, S., & Maulana, G. A. (2020). Rancang Bangun Sistem Pengereman Otomatis Menggunakan Arduino Uno Dan Sensor Ultrasonik. *JTT (Jurnal Teknologi Terapan)*, *6*(1), 69. https://doi.org/10.31884/jtt.v6i1.241

Asgari, M., Saboor, F. H., Amouzesh, S. P., Coull, M. W., Khodadadi, A. A., Mortazavi, Y., Hyodo, T., & Shimizu, Y. (2022). Facile ultrasonic-assisted synthesis of SiO2/ZnO core/shell nanostructures: A selective ethanol sensor at low temperatures with enhanced recovery. *Sensors and Actuators B: Chemical,*

*name of corresponding author

368(June), 132187. https://doi.org/10.1016/j.snb.2022.132187

Budiarso, Z. (2015). Implementasi Sensor Ultrasonik Untuk Mengukur Panjang Gelombang Suara Berbasis Mikrokontroler Sensor merupakan sebuah peralatan yang diperlukan untuk mendukung penerapan teknologi digital besaran-besaran analog menjadi tantangan dengan menggunakan sensor . *Jurnal Teknologi Informasi DINAMIK*, *20*(2), 171–177.

Fiore, L., Mazzaracchio, V., Galloni, P., Sabuzi, F., Pezzola, S., Matteucci, G., Moscone, D., & Arduini, F. (2021). A paper-based electrochemical sensor for H2O2 detection in aerosol phase: Measure of H2O2 nebulized by a reconverted ultrasonic aroma diffuser as a case of study. *Microchemical Journal*, *166*(February), 106249. https://doi.org/10.1016/j.microc.2021.106249

Heru Purwanto, Malik Riyadi, Destiana Windi Widi Astuti, I. W. A. W. K. (2019). Komparasi Sensor Ultrasonik HC-SR04 Dan JSN-SR04T Untuk Apikasi Sistem Deteksi Ketinggian Air. *Jurnal SIMETRIS*, *10*(2), 717–724.

Hindarto, D. (2022). Perbandingan Kinerja Akurasi Klasifikasi K-NN, NB dan DT pada APK Android. *JATISI (Jurnal Teknik Informatika Dan Sistem Informasi)*, *9*(1), 486–503. https://doi.org/10.35957/jatisi.v9i1.1542

Hindarto, D., & Handri Santoso. (2021). Android APK Identification using Non Neural Network and Neural Network Classifier. *Journal of Computer Science and Informatics Engineering (J-Cosine)*, *5*(2), 149–157. https://doi.org/10.29303/jcosine.v5i2.420

Hindarto, D., Indrajit, R. E., & Dazki, E. (2021). Sustainability of Implementing Enterprise Architecture in the Solar Power Generation Manufacturing Industry. *Sinkron*, *6*(1), 13–24. https://jurnal.polgan.ac.id/index.php/sinkron/article/view/11115

Hindarto, D., & Santoso, H. (2022). *NON-NEURAL NETWORK AND NEURAL NETWORK Jurnal Nasional Pendidikan Teknik Informatika*. *11*, 49–62.

Moholkar, K., & Bangare, J. L. (2022). Measurement : Sensors IoT based smart parking model using Arduino UNO with FCFS priority scheduling. *Measurement: Sensors*, *24*(October), 100524. https://doi.org/10.1016/j.measen.2022.100524

Nnabuife, S. G., Kuang, B., Rana, Z. A., & Whidborne, J. (2022). Classification of flow regimes using a neural network and a non-invasive ultrasonic sensor in an S-shaped pipeline-riser system. *Chemical Engineering Journal Advances*, *9*, 100215. https://doi.org/10.1016/j.ceja.2021.100215

Nur R., M., resha A., I., & Dian A., R. (2020). Aplikasi Sensor Ultrasonik HC-SR04 Guna Mendeteksi Jarak Penumpang Kereta Api di Era New Normal. In *National Conference PKM Center Sebelas Mare University* (Vol. 1, pp. 236–240). https://jurnal.uns.ac.id/pkmcenter/article/view/51362

Perković, T., Šolić, P., Zargariasl, H., Čoko, D., & Rodrigues, J. J. P. C. (2020). Smart Parking Sensors: State of the Art and Performance Evaluation. *Journal of Cleaner Production*, *262*. https://doi.org/10.1016/j.jclepro.2020.121181

Rob, R., Panoiu, C., Rusu-Anghel, S., & Panoiu, M. (2018). A comparison between using distance sensors for measuring the pantograph vertically movement. *IOP Conference Series: Materials Science and Engineering*, *294*(1). https://doi.org/10.1088/1757-899X/294/1/012089

Siswanto, Ikin Rojikin, & Windu Gata. (2019). Pemanfaatan Sensor Suhu DHT-22, Ultrasonik HC-SR04 Untuk Mengendalikan Kolam Dengan Notifikasi Email. *Jurnal RESTI (Rekayasa Sistem Dan Teknologi Informasi)*, *3*(3), 544–551. https://doi.org/10.29207/resti.v3i3.1334

Suastika, K. G., Nawir, M., & Yunus, P. (2014). Sensor Ultrasonik Sebagai Alat Pengukur Ultrasonic Sensor As a Measurement Device of Air Flow Velocity in the Pipe. *Jurnal Pendidikan Fisika Indonesia (Indonesian Journal of Physics Education)*, *10*(1), 163–172. http://journal.unnes.ac.id/nju/index.php/JPFI

Thornton, D. A., Redmill, K., & Coifman, B. (2014). Automated parking surveys from a LIDAR equipped vehicle. *Transportation Research Part C: Emerging Technologies*, *39*(2014), 23–35. https://doi.org/10.1016/j.trc.2013.11.014

Wang, B., Zhu, C. ping, Gong, R. hang, Zhu, J., Huang, B., Xu, F., Ren, Q. gong, Han, Q. bang, & He, Z. bing. (2015). Degradation of acephate using combined ultrasonic and ozonation method. *Water Science and Engineering*, *8*(3), 233–238. https://doi.org/10.1016/j.wse.2015.03.002

Zováthi, Ö., Nagy, B., & Benedek, C. (2022). Point cloud registration and change detection in urban environment using an onboard Lidar sensor and MLS reference data. *International Journal of Applied Earth Observation and Geoinformation*, *110*(October 2021), 102767. https://doi.org/10.1016/j.jag.2022.102767

*name of corresponding author