Internet of Things-Based Portable Smart Trash Bin Robot

Yuliarman Saragih, Ridwan S.Hadikusuma, Rahmat Hidayat, and Suroyo

***Abstract*—Nowadays, the development of technology has a very important role in the progress of human life. In addition, in the world of health, robots may be used as a therapeutic tool for healing diseases and even as a controller for hospital management monitoring system. The purpose of this study is to determine design of a smart robot for internet of things-based portable trash bin, to determine performance of a smart robot design tool of portable trash bin using android interface in its application in schools and hospitals, to determine the use of Internet of Things-Based Portable Smart Trash Bin Robot. The method used to achieve the program's objectives was: To produce a smart robot design tool for portable trash bin using android interface which is carried out with technical steps for making hardware, software and testing. The expected output in this study is the creation of Internet of Things-Based automatic portable smart trash bin robot as a means of convenience in disposing of trash in schools and hospitals and being able to know the performance of tools to help school and hospital cleaner, visitor and patient in disposing of trash**

***Index Terms*— About Technology, Trash Box Portable, Smart Robot, Internet**

I. INTRODUCTION

IN the nature of human life, trash has become a source of problems. The problems caused are disease, flooding, and bad odors around the landfill. There are many types of trash, one of the types of trash that we often encounter is consumption trash, namely trash produced by human users of goods, in other words, waste that is thrown into the trash bin. This is common trash and needs to be thought about by humans, in this case there must be a solution. Until now, some people have not fully complied with the awareness to dispose of trash in its place, even though trash bins have been provided. Plus, trash is sometimes thrown everywhere. It could be that the lack of cleaners is also the cause of the trash bin being sometimes found full so that visitors simply place leftover food and so on in the hospital. Problems also arise in the world of education and health, both schools and hospital, which in this case are caused by littering students, patients, and visitors.

This cannot be separated from the activities of schools and hospitals that never stop making trash so that it becomes a concern that cannot be ignored. During operations, especially in schools and inpatient rooms and emergency rooms filled with visitors who come and go and most students, patients who are hospitalized are generally reluctant to throw trash in the trash bins that have been provided. This certainly contributes to the volume of waste or hospital and school waste. In addition to the indiscipline of students and visitors as well as inpatient staff causing the problem of trash in schools and hospitals to pile up inappropriately. This is one of the things that makes the world of education and health both in schools and hospitals, look shabby and dirty in plain view.

Therefore, there is a need for a solution for cleaner to avoid sources of disease caused by trash. It is ironic that schools and hospitals are sources of disease, while schools and hospitals are places for education and healing of disease or education and care for sick patients. So, one way that can be done to overcome this problem is to use an automatic trash bin that uses an application system to design a smart robot for a portable trash bin based on the internet of things as a mover for the trash bin. Basically, the internet of things is a concept to maximize internet connectivity function [8]. IoT can also be used as Automatic Water Control, Monitoring Water Tanks, and monitoring BTS room control so that this trash robot can also use IoT to monitor the motion and contents of the trash bin. IoT is very suitable for use when it requires real-time and low-cost data transmission [15-17].

In this case, the automatic trash bin can move to the student study room and patient room with the mover, namely the design of a smart robot for portable trash bins using an android interface given a path. While this study roadmap is in accordance with the roadmap of the Electrical Engineering study program and Faculty of Engineering, Universitas Singaperbangsa Karawang, namely developing Information and Communication Technology (ICT) Device Technology, in this case, the study that we focus on is smart robots, Internet-

Manuscript received on May 10, 2020. This work was supported in part by the LPPM (Lembaga Penelitian Dan Pengabdian Kepada Masyarakat) Universitas Singaperbangsa Karawang. This grant for lecturer academic year 2020/2021 Under Grant Nomor :261.97/SP2H/UN64.10/LL/2021 (sponsor and financial support acknowledgment goes here).

Y. Saragih is with the Fakultas Teknik, Program Studi Teknik Elektro, Universitas Singaperbangsa Karawang, West Java, PO Box 14361 Indonesia (corresponding author to provide phone: +62 87897476162; fax: +62 276 641177; e-mail: yuliarman@staff.unsika.ac.id).

R. S. Hadikusuma is with the Department of Electrical, Engineering Faculty, Universitas Singaperbangsa Karawang, West Jawa, PO Box 14361 Indonesia (e-mail: ridwansatrio2@gmail.com).

R. Hidayat is with the Department of Electrical, Engineering Faculty, Universitas Singaperbangsa Karawang, West Jawa, PO Box 14361 Indonesia (e-mail: rarhmat.hidayat@staff.unsika.ac.id).

Suroyo is with with the Department of Management, Economic Faculty, STIE Tribuana Tambun, Bekasi, West Java PO Box 17113 Indonesia, (e-mail:suroyo@stietribuana.ac.id).

based portable trash bin for all trash.

II. LITERATURE

A. Robot

A robot is a form of intelligent control that moves independently and is widely designed for study, industrial and human work uses. As the name implies, the task that the robot must carry out is to follow instructions from the user or guide which are made with a certain level of accuracy. There are many problems encountered in the design and implementation of autonomous car robots. These problems are operations on the reduced natural language used by robots to be able to receive commands, transformation of information from sensors to robot knowledge bases, computer architecture and software organization to deal with the previous two problems, description of the environment for the reality of motion situations, robot vision systems and the decision-making process by the robot independently based on the view of the environment [2].

From a systems perspective, autonomous mobile robots are situational automatons, or modules consisting of part of a closed-loop system together with environment (Nourbakhsh, 2000). The current study on Line-Following Robots generally concentrates on software algorithms to obtain a good robot response. One of the studies is using cerebellar controls inspired by cerebellar biology to control line-following robots. Cerebellar control simulation can improve accuracy in following the line through the learning process [3].

B. Smart Robot

One of the existing robots is a line follower robot. There are several methods to make a Line Follower Robot follow the line. The first way is to draw a line between the rows of sensors. Second, by making the sensor above the line. Third, by always detecting the edge of the line. The fourth way is to always cross the line back and forth. Line follower robots are included in the category of autonomous robots that move by following lines on surface. The working principle of Line Follower Robot can be described as follows: [3].

First, get the line position via a sensor placed on the bottom front of the robot. The sensor is usually a photo reflector, installed two or more at the bottom of the front of the Line Follower Robot. Some use a camera (or image sensor) for a higher resolution of line reading, thus making the robot's movement more accurate.

Second, after getting the line position against the robot body (represented by the sensor), move (or rotate) the motor in the direction of the line. This process only adjusts each motor's rotation speed, so it can perform the desired movement. However, for line follower robots that have high enough speed, several control algorithms need to be applied to run smoothly. The control can be continuous control, PID, fuzzy logic, or others [7][9].

After that, adjust the speed, especially when facing a change of track, from straight to corner or vice versa from corner to straight. There are 2 track/road mechanisms used, first a white line on a black surface, or vice versa, a black line on a white surface. However, what is more widely used is track type 2 (black line on a white surface). To get a super-fast line follower robot, it is necessary to pay attention to the form and control used. Should strive for a compact form with as precise control as possible. Mini Line Follower is quite interesting to try.

C. Sensor of Internet of Things-Based Portable Smart Trash Bin Robot

The sensor used by the smart robot in the portable trash bin using an android interface is ultrasonic. An ultrasonic sensor is a proximity sensor that is used to detect distances and objects in front of them. This sensor is widely used for intelligent robot control systems.

By transmitting object position, distance between working positions of the intelligent robot can be known. HC-SR04 Ultrasonic Range Finder, is an ultrasonic distance measuring module with a fairly low price which is specially designed for robotics technology. With a fairly small size (2.1cm x 4.5cm), this 59-thousand-rupiah sensor can measure distances between 2cm to 500 cm with a resolution of 0.3 cm.

The ultrasonic sensor HC-SR04 consists of a 40KHz signal generator chip, ultrasonic speaker, and microphone. The ultrasonic speaker converts the 40 KHz signal into sound while the ultrasonic microphone detects the sound reflection. On the ultrasonic sensor module HC-SR04 four pins are used for power supply line (+5V), ground, Trigger, and Echo. The trigger pin is used to transmit ultrasonic signals, while the echo pin is used to receive ultrasonic signals when there is an obstacle in front of the sensor.

D. Trash

Trash is unwanted residual material after the end of a process. Trash is a man-made concept, in natural processes there is no waste, only immovable products. Trash can be in any phase of matter: solid, liquid, or gas. When released in the last two phases, especially gases, wastes can be said to be emissions. Emissions are usually associated with pollution. In human life, large amounts of waste come from industrial activities, such as mining, manufacturing, and consumption. Almost all industrial products shall become waste at some point, with the amount of waste more or less equal to the amount of consumption [1]. Consumption waste is waste generated by (humans). However, the amount of waste in this category is still much smaller than the waste generated from mining and industrial processes. In other words, user goods are trash that is thrown in the trash. This is trash that people are used to seeing [5]. The process of collecting waste, which is carried out by checking trash collection sites one by one, causes ineffective and efficient work because it takes a lot of time, effort and money [10].

III. LITERATURE

A. Object of Study

The object of this study is to design a smart robot for a portable trash bin using android interface that shall be

developed which is a combination of hardware and software, so as to produce a working tool that is in accordance with the design idea. It is hoped that the results of this intelligent robot portable trash bin can be functionally useful and add to the repertoire of electronics science. The program design determines data processing so the robot can execute incoming data as a variable. While this study roadmap is in accordance with the roadmap of the Electrical Engineering study program and Faculty of Engineering, Universitas Singaperbangsa Karawang, namely developing Information and Communication Technology (ICT) Device Technology, in this case, the study that we focus on is a smart robot, internet-based portable trash bin.

B. Study Models and Schemes

This study uses an experimental quantitative study model. This is based on data that shall be presented empirically with the aim of testing the truth of the theory that is realized in the realization of a real electronic system, namely the application of a microcontroller, a robot circuit, an Android interface system, and magnitude of the electric voltage that can be measured, assessed or expressed in one form. The study scheme to create a portable trash can smart robot using an android interface refers to a deductive study scheme. This is based on the development of a study that starts from theoretical level then to the conceptual level and continues to the operational level.

The mechanical implementation of a portable smart trash bin robot using an android interface is shown in the figure above. The material used for the robot chassis is 5 mm thick acrylic material. In the mechanics design, a worm gear transmission is used for the front steering part of the robot to provide a large reduction in speed and the ability to lock the steering movement. For the rear propulsion of the robot, tilt gears are used to accelerate the rotation of a DC motor whose rotational speed is very slow. This software is implemented with the Timed Event method to save the use of the Timer. In this method, the timer interrupts the CPU of the microcontroller every certain time duration, which is 200µs.

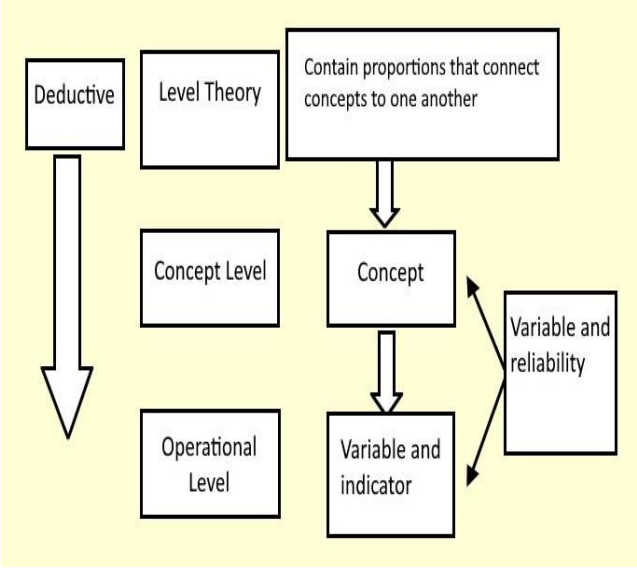

Fig. 1. Framework

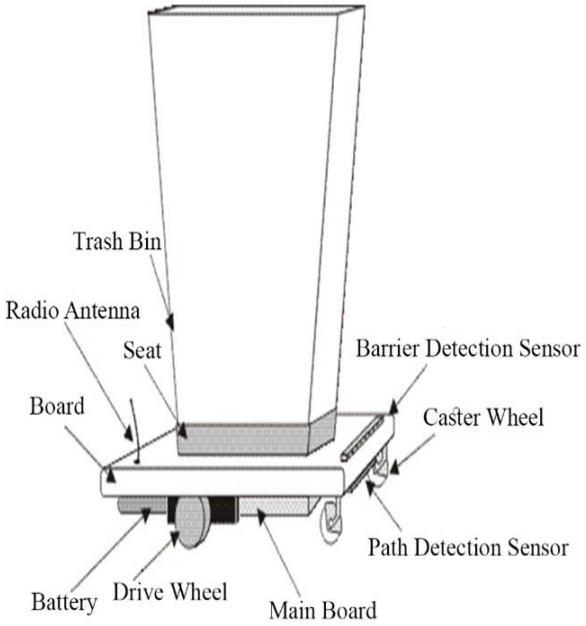

Fig. 2. Design of Internet of Things-Based Portable Smart Trash Bin Robot

So the main of program only contains the initialization subroutine, while subroutine core program is inside the Timer interrupt service subroutine. Overall program flow chart is shown in Fig 3.

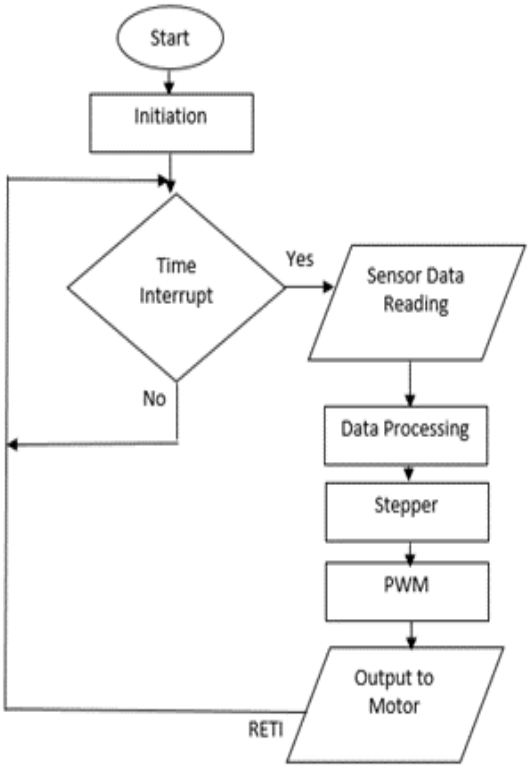

Fig. 3. Flow chart of overall program for designed robot

The core program performs the tasks of reading sensor, processing sensor data, and controlling both motors. The robot's knowledge base is based on the method used by robot

to follow a line, namely positioning a line between a row of 4 sensors. The instrument test of each test requires an instrument (measuring instrument) to determine the value of a system according to its magnitude so that it can be analyzed. In a study on making smart robots, portable trash bin using the Android interface several instruments are needed, including a Solder, PCB, PCB Drill, Cathode Ray Oscilloscope (CRO) and AVOmeter, and Android interface system [4].

C. *Assembly Process*

In designing a tool, the most important is assembling, it should be emphasized that the installation of the motor on the robot must be appropriate to carry the load so that there is no abnormality in motor performance. In general, assembling guidelines refer to the technical construction system starting from the process of translating drawings, cutting, drilling, and assembling processes as well as wiring. The battery or power needed to operate this trash robot is a 12 VDC battery with remote control using an esp32 cam which is controlled via Blynk software.

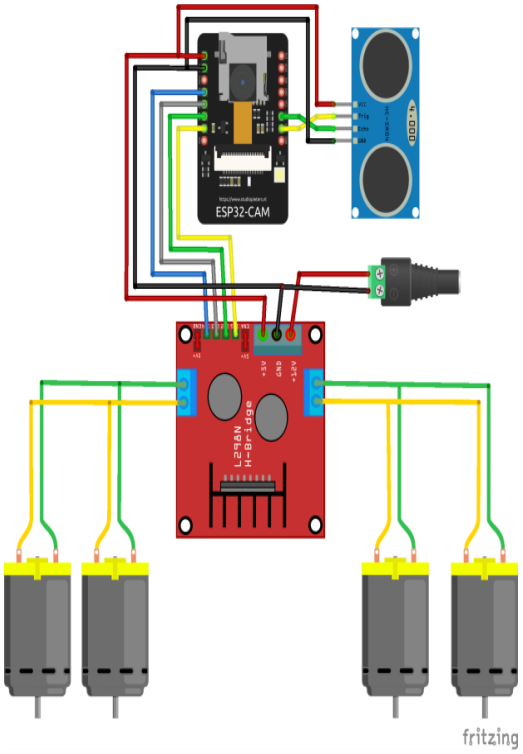

Fig. 4. Electronic Design

Data retrieval is done by measuring using a measuring instrument. Measurement or data retrieval in study on making smart robots in portable trash bins using Android interface is focused on measuring software, measuring hardware and performance results. Data obtained shall be used as material for product development analysis. Data analysis in this study was carried out quantitatively. This is done by calculating measurement results and then comparing them with theoretical analysis results. The results of this analysis are a combination of the results of measurements and theoretical calculations. From this data analysis, conclusion shall be drawn from what has been formulated.

IV. Discussion and Results

The system testing stage is the stage where after all components are assembled and the system is ready to operate. System testing is carried out to know whether the system is working as desired or not. In testing, this system can also identify the advantages and disadvantages of the system created. Before testing, it is necessary to check the installation of jumper cables that connect all components on the microcontroller. Testing is done by experimenting with filling the trash box from empty to full. Checking position of ultrasonic sensor must also be considered in order to produce accurate output and ensure the sensor is properly connected.

Fig. 5. IoT-based portable smart trash bin

Fig 5 shows the trash bin in an empty condition, and the ultrasonic sensor has been installed properly and correctly on the front of the trash box. This section works when the user wants to move the trash bin from one point to another using a smartphone. After making sure the trash box is empty, then run the program code to see the height generated by the ultrasonic sensor. In ultrasonic sensors, ultrasonic waves are generated through a device called a piezoelectric with a certain frequency.

This piezoelectric shall generate ultrasonic waves (usually 40kHz) when an oscillator is applied to the object. In general, this tool shall shoot ultrasonic waves towards an area or target. After the wave hits the target surface, the target shall reflect the wave back. The sensor shall capture the reflected wave from the target, and then the sensor calculates the difference between the time the wave is sent and the time the reflected wave is received (Fig 6) [11-13]. Using ultrasonic sensors, this smart trash bin avoids collisions or collisions with objects in front of it.

Configuration is needed to perform distance calculations on the ultrasonic sensor used [14]. Configuration can be used by

using distance formula written in the program on microcontroller used which in this case uses the ESP 32 Cam with the speed of sound (v) of 340 m/s or 0.034 cm/us emitted by the trigger pin on ultrasonic sensor and with time = t/2, distance can be calculated using formula:

$$S = Vt \tag{1}$$

$$S = t \times \frac{0.0034}{2}$$

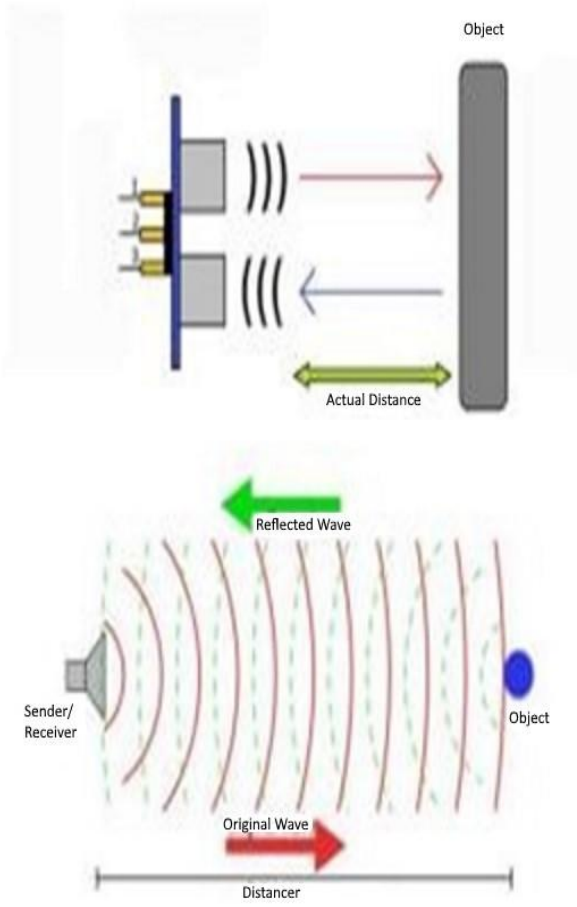

Fig. 6. How ultrasonics sensor works

Fig. 7. Filled trash bin

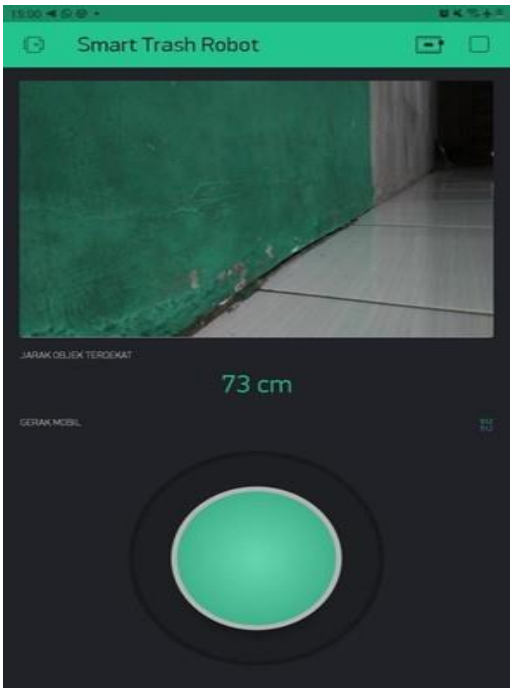

Fig. 8. Blynk display in smart trash bin

Fig 7 shows the trash bin has been filled, and the system shows the height of the trash bin has reached 26 cm, and trash bin may be controlled using the Blynk application via a smartphone so that it can be moved from one place to another (as shown in figure 9). The capacity of a trash bin can accommodate trash up to a height of 40cm. If it has reached 40cm, Blynk shall send a notification via email as shown in Figure 10, which has tried 9 times, and all of them have successfully sent the notification via email. This shall make it easier for users, in this case, the community, when the trash bin is full, they shall be notified via notification and can control the trash bin remotely. Test also found that this trash bin does not require a lot of power, just 12 VDC is enough to turn on this trash robot and move optimally.

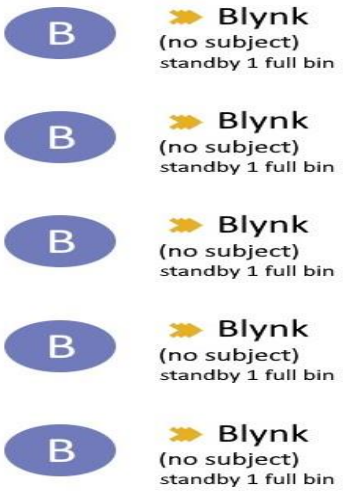

Fig. 9. Notification when the trash bin is full

From the previous testing stages, several stages have been carried out to find out how the system runs. By looking at how the system runs, the advantages and disadvantages of this system can be analyzed.

System Advantages:

1. Notification via email is more efficient because it does not require manual waste control.
2. ESP 32 Cam microcontroller is used to make it easier to monitor when moving trash bins from one place to another.
3. The system can be used in various places. Trash bins is classified as portable.
4. The use of a hotspot can cover several trash bins.

System Disadvantages:

1. The tool is still a prototype, so it still needs a lot of improvement because there are still errors in detecting the volume of waste
2. Delivery of notifications is late if the signal is weak or experiencing interference
3. The size of the trash is still in cm.

V. CONCLUSION

Based on process analysis to system testing, the following conclusion can be drawn:

1. Smart trash bin with IoT-based and portable notifications
2. It works well because it can be controlled using a smartphone and cannot hit objects in front of it because it is equipped with an ultrasonic sensor. The notification has been received successfully.

Suggestions for system development and further study are as follows: From design of this tool there are still many shortcomings that can be added to the next design. For future designs, this height measurement tool already uses the % number, and can automatically deactivate the system if needed.

REFERENCES

[1] A.Saputra, "Bank Sampah Karya Baru Terbukka Sebagai Alternatif Lingkungan Untuk Memperpanjang Umur Bumi Di Sumatra Selatan," 2021.

[2] B. Widodo, *Panduan lengkap belajar mikrokontroler : Perancangan sistem dan aplikasi mikrokontroler*. Jakarta Elex Media, 2005.

[3] D. Collins and G. Wyeth, "Cerebellar control of a line following robot," Proc. Aust. Conf. Robot. Autom., pp. 74–79, 1999.

[4] P. Sudira, Modul Bahan Ajar: Mikrokontroller. 2005.

[5] A. Supriyanto, "Nyamuk Demam Berdarah Lebih Pintar," 2005. www.tempo.co.id (accessed Apr. 23, 2021).

[6] T. L. M. E. (LAMEL), Pemrograman Mikrokontroler AT89S51 dengan C/C++ dan Assembler. Yogyakarta: Andi, 2007.

[7] W. K. Tim Litbang, Tutorial membuat program dengan Visual Basic. Jakarta: Salemba Infotek, 2004.

[8] B. Widodo, Robotika Modern: teori dan implementasi. Yogyakarta: Andi Offset, 2014.

[9] N. L. Husni, S. Sitangsu, S. Rasyad, F. Damsi, and A. Silvia, "Real Time Garbage Bin Capacity Monitoring," *Comput. Eng. Appl. J.*, vol. 9, no. 2, pp. 127–133, 2020.

[10] N. L. Husni, Robi, E. Prihatini, Nurhaida, A. Silvia, and Firdaus, "Garbage Monitoring and Warning System," *ICECOS 2019 - 3rd Int. Conf. Electr. Eng. Comput. Sci. Proceeding*, pp. 171–175, 2019, doi: 10.1109/ICECOS47637.2019.8984545.

[11] T. Anagnostopoulos, A. Zaslavsky, and A. Medvedev, "Robust waste collection exploiting cost efficiency of IoT potentiality in Smart Cities," 2015 *Int. Conf. Recent Adv. Internet Things*, RIoT 2015, no. April, pp. 7–9, 2015, doi: 10.1109/RIOT.2015.7104901.

[12] M. Sanjaya WS, Membuat Robot Arduino bersama Profesor Bolabot Menggunakan Interface Python. Yogyakarta: Gava Media, 2016.

[13] A. Fakhrana, "Pembuatan prototype robot kapal pemungut sampah menggunakan mikrokontroler arduino uno dengan aplikasi pengendali berbasis android. Jurnal Ilmiah Teknologi Dan Rekayasa, 21(3), 185–195.gut sampah m," *J. Ilm. Teknol. dan Rekayasa*, vol. 21, no. 3, pp. 185–195, 2016, https://ejournal.gunadarma.ac.id/index.php/tekno/article/view/1597/1356

[14] G. Sivasankar, B. Durgalakshmi, and K. Seyatha, "Autonomous Trash Collecting Robot," *Int. J. Eng*. Res., vol. V6, no. 04, pp. 162–165, 2017, doi: 10.17577/ijertv6is040231.

[15] Y. Saragih, J. H. Prima Silaban, H. Aliya Roostiani, and A. S. Elisabet, "Design of Automatic Water Flood Control and Monitoring Systems in Reservoirs Based on Internet of Things (IoT)," Mecn. 2020 - *Int. Conf. Mech. Electron. Comput. Ind. Technol*., pp. 30–35, 2020, doi: 10.1109/MECnIT48290.2020.9166593.

[16] Y. Saragih, G. R. Hakim, S. A. Elisabet, and H. A. Roostiani, "Monitoring Design of Methods and Contents Methods in Semi Real Water Tandon by Using Arduino -based on Internet of Things," *ICRAIE 2019 - 4th Int. Conf. Work. Recent Adv. Innov. Eng. Thriving Technol*., vol. 2019, no. November, pp. 27–29, 2019, doi: 10.1109/ICRAIE47735.2019.9037783.

[17] Y. Saragih et al., "Prototype of Radio Frequency Identification Technology Utilization for Monitoring of BTS Room Using of IoT (Internet of Things) System," 2019 *Int. Conf. Comput. Sci. Inf. Technol. ICoSNIKOM* 2019, doi:10.1109/ICoSNIKOM48755.2019.9111585.

Rahmat Hidayat received the bachelor's degree in electronics engineering from Universitas Negeri Yogyakarta, Yogyakarta, Indonesia. He received a master's degree in Electrical Engineering from Universitas Negeri Yogyakarta, Yogyakarta, Indonesia. His research interest includes robotics, engineering technology, and industrial automation.

Suroyo was born in Purworejo, Indonesia. He received the bachelor's degree in education from STIE Pelita Bangsa, Jakarta, Indonesia. He received a master's degree in management from IPWI, Jakarta, Indonesia. He received a doctor degree in management from Universitas Brawijaya (UB), Malang, Indonesia. Currently, he is the lecturer at Management Department, Faculty of Economic, STIE Tribuana Tambun, Bekasi,Indonesia. His research interest includes education and management.