Computer Engineering and Applications Vol. 10, No. 2, June 2021

# Wireless Controlling for Garbage Robot (G-Bot)

Nyayu Latifah Husni[1], Robi Robi[2], Ekawati Prihatini[3], Ade Silvia Handayani[4*], Sabilal Rasyad[5], Firdaus Firdaus[6]

[1-5]*Department of Electrical Engineering, State Polytechnic of Sriwijaya*
[6]*Department of Computer Engineering, Universitas Sriwijaya*
**ade_silvia@polsri.ac.id*

## ABSTRACT

This paper presents one of the solutions in overcoming the garbage problems. The people sometimes feel too lazy to throw the garbage into proper place due to their habit that has been grown since little kids. In this research, A G-Bot, a robot that has function as the garbage container is offered. By using an Internet of Things (IoT) application, the users can control the motion of the G-Bot wirelessly, so that it can move to the users' desired location. In addition, the covers of the G-Bot can also be opened using smart phones that connected to the G-Bot. A Blynk that acts as the IoT Application is used in order to set up the G-Bot communication. From the experimental result, it can be concluded that the proposed research has been successful to be implemented. The users can move the G-Bot to the targeted location wirelessly, and they can also open and close the G-Bot's lids wirelessly trough the mobile phones.

**Keywords**: IoT, G-Bot, Garbage, Controlling, Wireless.

## 1. INTRODUCTION

Disposing of trash not in its place is often considered as trivial problem by most people. However, when it is difficult for them to find the garbage box, they often lost their sense of responsibility in keeping their environment clean and healthy. The further distance of the garbage box is one of the reasons that force them to litter. They become too lazy to move to find the garbage box. Their mindset has less concerned about the garbage in the environment. On the other hand, if the environment is not specifically taken care, the environment will become so dirty. In this condition, many problems will occur easily.

The garbage problem becomes an important thing that must be considered [1], [2]. It is due to it has a strong impacts to the health [3]–[6]. The habit of throwing the garbage to the improper place poses a serious threat to human life [7]. This bad habit usually occurs due to many causes, namely: i) they are used to do littering since little kids; ii) they do not know the risks of bad environments caused by garbage; iii) they pretend not to know the rule that they should throw the garbage into its correct place; iv) and so on. In ideal cases, generating the tidy, clean and healthy environment becomes not only the responsibility of the government but also all of the community. Therefore, all of the people should participate in overcoming this problem.

Some of the research has discussed about the Garbage robot, such as in [8]–[11]. In [8], the author wanted to solve the problem of garbage by using a GABOT that functioned to substitute of garbage collector role. The author used camera as the sensor to detect the location of the garbage. When the camera detected the existence

of the garbage, the GABOT would move closer and picked it using its manipulator. However, the robot only focused on the mechatronic design. In addition, the robot was to small and only be able to pick small garbage. Another drawback of this robot is it cannot collect the garbage directly in its container (This GABOT was not accomplished with the container). It will need much time and energy due to the robots should move to pick the garbage and to bring the taken garbage to the garbage container, then it should move around again to find another garbage.

In [9] and [10], The author also used the robots to collect the garbage. In [9], the container of the garbage was implemented in the body of the robot. It had a big size. This robot was also an up-to-date robot. It is due to it has implemented the IoT in its technology. In [10], the research was quite the same with the research in [8]. They also used camera to detect the garbage. They used the YOLOv3 as their method in determining the garbage. These 2 research [9] and [10] were very valuable research in overcoming garbage problem, however, their garbage robot were implemented in the water. They were intended to make clean the river. In [11], the garbage robot was equipped with a robust algorithm which can manage the garbage robots to the correct place of the garbage. However, the author only focused in the algorithms not in the mechanical of the robots.

In this research, a G-Bot, a robot that has function as the garbage container is offered. The G-Bot is designed to attract the user. In addition, it is designed to be able to be washed. It is a clean robot; therefore, it is safe for the user. It consists of 3 parts that can be disassembled and set. All of the electronics components are installed at the base parts [12]. This research is also intended as the learning tool for the young children to manage the garbage. Using this G-Bot, it is hoped that they can grow their habit to throw the garbage in the proper place.

This research also supports the development of technology by applying wireless communication using Internet of Things (IoT). IoT has been applied in many areas, for instances in Health [13], [14], [15] smart homes [16], smart cities [17], [18], [19], smart government [20], sport [21], and agriculture [22], etc. The G-Bot movement in this research can be controlled wirelessly using the IoT. The users have only to connect to the internet. They can control the robot to come closer to them by pushing the motion control button in the mobile phones.

This research is the continuing of authors' previous research [12], [23], [24]. In this research, the mobile phones are not only able to control the motion of the G-Bot (in order to navigate to the desired location) but also to control the lids of the G-Bot (in order to control the opening and the closing of the G-Bot cover). By controlling the motion and the lids of the G-Bot, the users will be easier to throw the garbage.

## 2. G -BOT MOTION CONTROL DESIGN

G-Bot in this research was designed using 2 power supplies of 12 V batteries. It uses Arduino Mega RobotDyn that was equipped with a wifi module, i.e. ESP8266. It has function to connect the G-Bot with the controller module. By having that wifi module, G-Bot can be controlled and monitored remotely. The G-Bot was also equipped with 2 servomotors that have function to move the lids of G-Bot up and down so that the users can throw the garbage trough the opened lid of the G-Bot easily.


ISSN: 2252-4274 (Print)
ISSN: 2252-5459 (Online)

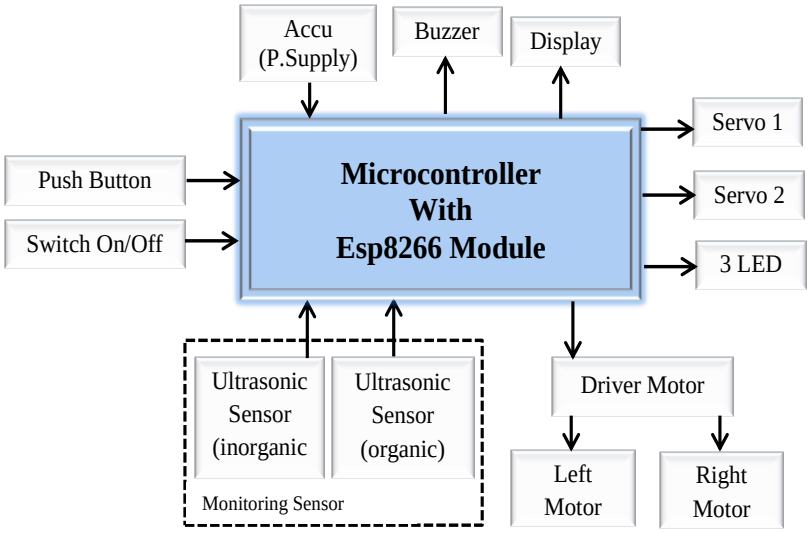
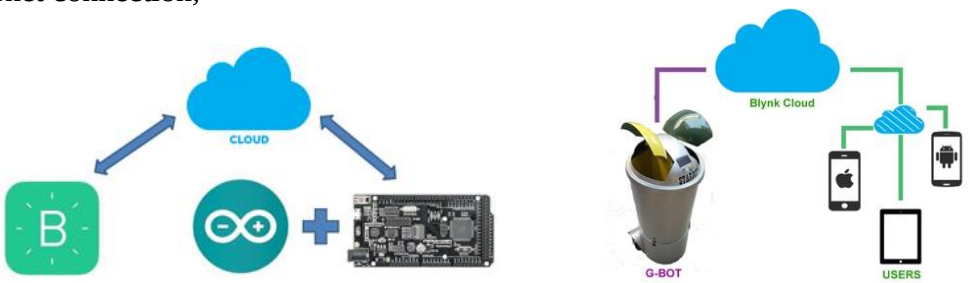



FIGURE 1. G-Bot Block Diagram

As the complementary of the G-Bot design, the G-Bot was also equipped with ultrasonic sensors that were installed in the garbage container. They were used to detect the waste capacity. Besides equipped with distance sensors, the G-Bot was also equipped with DHT22 and MQ7 sensors that were intended to measure the temperature and the humidity around the G-Bot and also to detect the toxic gas around the robot. Two driver motors that were installed in the G-Bot are useful for controlling the robot to move to the desired direction. When the garbage was full, the alarm or LED in the G-Bot will be active. All parameters, such as: capacity, temperature, humidity and air quality data were displayed on a 20x4 LCD. The block diagram of the G-Bot can be seen in Figure 1.

The communication in this research is based on the system presented in Figure 2 (a). The RobotDyn microcontroller in G-Bot is connected to the Blynk System trough the cloud. The data transmission is set up in the Blynk application trough the Blynk cloud. Before the Blynk application module and the RobotDyn microcontroller can communicate each other, they should be connected to the internet. It is not necessary for having the same internet connection for them. They are still able to communicate as long as they have internet connection,




(a) Communication (b) Controlling process

FIGURE 2. The System

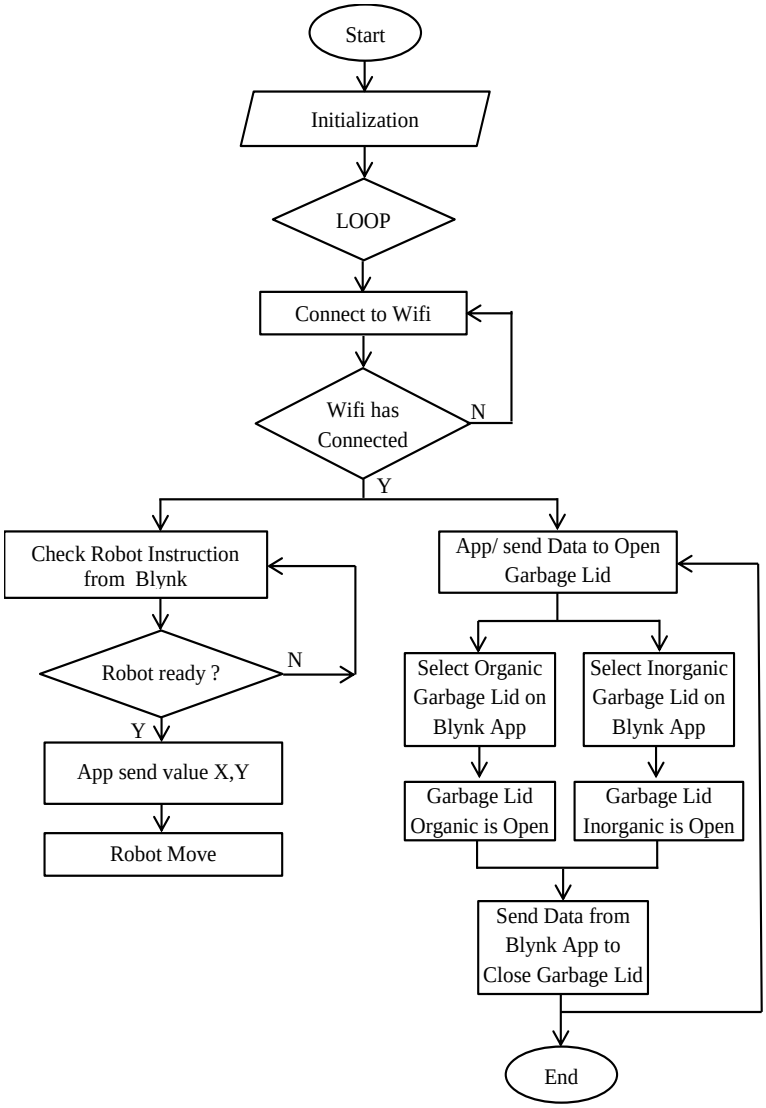



FIGURE 3. Flowchart of the G-Bot Moving

Figure 2 (b) describes the controlling process of G-Bot. By using the Blynk application, the controllers can be in the form of android or iOS. The users could control the G-Bot anytime, anywhere, and by anyone. The controlling process of the G-Bot can be seen in Figure 3. As mentioned above, the main condition to activate the G-Bot is that it should be connected to the internet. When the users and the G-Bot have internet connection, the users can control the G-Bot using the mobile phones (See the flowchart of the G-Bot in Figure 3). From Figure 3, it can be seen that two actions of controlling can be conducted, i.e. i) move the G-Bot to desired place; and ii) move the lids of G-Bot's to open or to close. The left side of the flowchart in Figure 3 is the G-Bot's movements controlling, i.e. by touching and moving the "G-Bot's motion control button" using the Blynk program in the mobile phone. This button has function to control the G-Bot wheels. When the robot is ready, the users can send the x, y


ISSN: 2252-4274 (Print)
ISSN: 2252-5459 (Online)

coordinate using the control button in order to activate the left and the right wheel of the G-Bot. By doing this, the users can move the G-Bot to the desired place. The right side of the flowchart in Figure 3 is the Lids of G-Bot's movement controlling, i.e. by clicking the button "open" and "close" either for organic or inorganic in the Blynk program in the mobile phone. When the "open" button is pushed, then the G-Bot's lids will open. It is the same when the "Close" button, is pushed, then the G-Bot's lids will close. The detailed information about the buttons in the mobile phone is presented in the next sub-section.

G-Bot in this research was designed using 2 power supplies of 12 V batteries. It uses Arduino Mega RobotDyn that was equipped with a wifi module, i.e. ESP8266. It has function to connect the G-Bot with the controller module. By having that wifi module, G-Bot can be controlled and monitored remotely. The G-Bot was also equipped with 2 servomotors that have function to move the lids of G-Bot up and down so that the users can throw the garbage trough the opened lid of the G-Bot easily.

## 3. MOVEMENT SETTING

The motion of the G-Bot is controlled using the joystick in the mobile phone that based on the coordinate presented in Table 1. The joystick regulates the direction of the robot wirelessly using Cartesian coordinates (x, y), i.e. using an internet connection with a range of 10 bits (0-1023). The G-Bot will move Forward when the x and y coordinate of the ADC are "312-712" and "≥712" respectively. It will move to the Right Oblique Forward when it has coordinate value "≥712" for x and "≥712" for y. When the coordinate of x and y are "≤ 312" and "≥712", it will move to the Left Oblique Forward. It will stop moving if x and y have value "512" and "512". The complete G-Bot's motion and its coordinate setting can be seen in Table 1.

The display of the controlled module (Mobile phone) can be seen in Figure 4. The controlled module display indicates the setting of the G-Bot's motion, i.e. i) right oblique forward; ii) forward; iii) left oblique forward; iv) right oblique backward; v) backward; vi) left oblique backward; vii) stop. The position of the control button in the Blynk application display in Figure 4 (a) – (g) shows how to control the motion of the G-Bot.

TABLE 1.
The Setting Of G-Bot Motion

| Coordinate (ADC Value) | | Motion of G-Bot |
|---|---|---|
| x | y | |
| ≥ 712 | ≥ 712 | Right Oblique Forward |
| 312-712 | ≥ 712 | Forward |
| ≤ 312 | ≥ 712 | Left Oblique Forward |
| ≤ 312 | ≤ 312 | Right Oblique Backward |
| 312-712 | ≤ 312 | Backward |
| ≥ 712 | ≤ 312 | Left Oblique Backward |
| 512 | 512 | Stop |

The Blynk application display in Figure 4 also shows how to control the lids of the G-Bot (See the "OPEN" button in each figure in Figure 4). Those open buttons are useful for the organic and inorganic garbage. When the lids are in the closed condition, the displays will show the "OPEN" button. However, when the lids are in the open condition, the displays will show the "CLOSE" button (these conditions are not shown in Figure 4 because all of the lids are in the closed conditions when the figures were taken).


FIGURE 4. The position of the G-Bot movement control button, (a) Left Oblique Forward, (b) Forward, (c) Right Oblique Forward, (d) Left Oblique Backward, (e) Backward, (f) Right Oblique Backward, (g) Stop

## 4. RESULT AND DISCUSSION

Figures 5 - 10 show the experimental result of the G-Bot motion in navigating to a certain place. The G-Bot was tested to move as commanded by the users. Figure 5 shows the G-Bot to move right oblique forward, while Figures 6 and 7 present the G-Bot moving forward and left oblique forward respectively. Figure 8 shows the movement of the G-Bot to right oblique backward, while Figures 9 and 10 present the G-bot navigation using backward and left oblique backward commands.

In Figure 5, the G-Bot moved right oblique forward starting in Figure 5 (a) at t =1 s as the initial point of the G-Bot until Figure 5 (e) as the final point. The G-Bot has moved to the right oblique about 60 degree with the left PWM 80 and right PWM 0. Figure 5 (f) shows the sketch of the G-Bot movement in right oblique


ISSN: 2252-4274 (Print)
ISSN: 2252-5459 (Online)

forward position. In Figure 6 (a) – (e), the G-Bot started to move forward with the right and left PWM 40. The G-Bot was controlled to move forward for 6s. The sketch of the G-Bot movement in this position can be seen in Figure 6 (f). Figure 7 (a) – (e) show the movement of the G-Bot to the left oblique forward.


(a) t = 1 s (b) t = 2 s (c) t = 4 s (d) t = 5 s (e) t = 7 s (f) the sketch

FIGURE 5. Right Oblique Forward


(a) t= 1 s (b) t = 2 s (c) t = 3 s (d) t = 4 s (e) t = 6 s (f) the sketch

FIGURE 6. Forward


(a) t= 1 s (b) t = 2 s (c) t = 5 s (d) t = 6 s (e) t = 7 s (f) the sketch

FIGURE 7. Left Oblique Forward

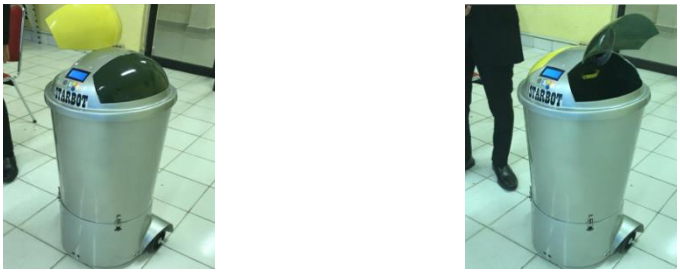

(a) t= 1 s (b) t = 2 s (c) t = 3 s (d) t = 5 s (e) t = 7 s (f) the sketch

FIGURE 8. Right Oblique Backward

The G- Bot moved to left oblique around 60 degree with the left PWM 0 and right PWM 80. The sketch of the G – Bot movement can be seen in Figure 7 (f). In

Figure 8, the G-Bot moved to right oblique forward about 60 degree with the left PWM 80 and the right PWM 0. This PWM amount is almost the same the right oblique forward. The different is only on the wheel rotating direction. It is also the same with Figure 9 and also Figure 10. For the backward, the PWM of left and the right wheel were 40, while for the left oblique backward, the left PWM was 0 and the right PWM was 80. These PWMs were the same with the forward and left oblique forward respectively. Figures 8 (f), 9 (f), and 10 (f) show the sketch of the G-Bot trajectory.

Figure 11 shows the position of the G-Bot lid when it was opened and closed. As the programs of G-Bot, the lid of the G-Bot can open for 5 second, and it will automatically close when it has passed 5 second. The G-Bot was also equipped with Push Button switch. When the users are lazy to use the mobile phones or there are some errors, the users can push the button and throw the garbage. In Figure 11 (a), when inorganic push button was pressed, the inorganic servo rotated 125 °. After 5 seconds, the servo rotated again 125 ° in the opposite direction and the lid of the inorganic G-Bot closed again. On the other hand, when the push button of the organic was pressed, the servo rotated 95 °, Then with the time delay of 5 seconds, the servo rotated again 95 ° in the opposite direction. In this condition, the lid of the G-Bot has closed again. In this case, the servo for opening organic and inorganic in G-Bot has different rotation angles. It was due to the mechanical part of the G-Bot, i.e., the lever that is connected from the servo to the lid of the G-Bot has a different length, namely the lever connected from the servo to open the lid of organic is longer than lever connected to the servo to open and close the inorganic of G-Bot. Figure 11 (b) shows the condition when the organic push button was pressed.

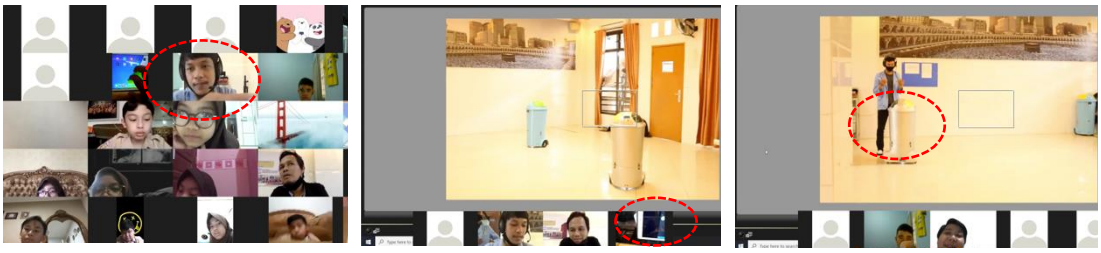


(a) Inorganic lid is opened (b) Organic lid is opened

FIGURE 11. The Open and Close position of the G-Bot lid

The G-Bot has been implemented at Harapan Mulia Islamic Junior High School in Palembang. All of the students were enthusiastic in controlling the G-Box trough their iPad. Due to the corona pandemic that also happens in Indonesia, all of the learning activity at Harapan Mulia Islamic Junior High School should be conducted using online application. The G-Bot has been successful to be controlled by the students from their home. The situation of G-Bot controlling implementation can be seen in Figure 12. Figure 12 (a) shows the students were listening to the instruction of the instructor. One of the students was trying to control the G-Bot trough his iPad is shown in Figure 12 (b). The G-Bot was moving to one of the instructors based on the order of the students who controlled it from his home is shown in Figure 12 (c).


ISSN: 2252-4274 (Print)
ISSN: 2252-5459 (Online)



(a) (b) (c)

FIGURE 12. Implementation of the G-Bot at Harapan Mulia Islamic Junior High School (a) The Instuctor was giving Instruction, (b) Controlling the G-Bot trough iPad, (c) The G-Bot was moving

## 5. CONCLUSION

The G-Bot in this research has been successfully implemented. The users can connect to G-Bot using Blynk application. G-Bot can navigate well using 7 different movements that have been embedded to it. In addition, G-Bot can also open and close its lid using wireless communication.

## ACKNOWLEDGEMENTS

Authors thank to the Indonesian Ministry of Research, Technology and Education (RISTEKBRIN) and State Polytechnic of Sriwijaya under Research Collaboration for their financial supports in Competitive Grants Project. Our earnest gratitude also goes to all researchers in Signal Processing and Control Laboratory, Electrical Engineering, State Polytechnic of Sriwijaya who provided companionship and sharing of their knowledge.

## REFERENCES

[1] A. Silva, M. Rosano, L. Stocker, and L. Gorissen, "From waste to sustainable materials management : Three case studies of the transition journey," *Waste Manag.*, pp. 1–11, 2016, doi: 10.1016/j.wasman.2016.11.038.

[2] K. Boonrod, S. Towprayoon, S. Bonnet, and S. Tripetchkul, "Enhancing organic waste separation at the source behavior : A case study of the application of motivation mechanisms in communities in Thailand," *"Resources, Conserv. Recycl.*, vol. 95, pp. 77–90, 2015, doi: 10.1016/j.resconrec.2014.12.002.

[3] P. I. Plaza and S. A. Lambertucci, "How are garbage dumps impacting vertebrate demography, heath, and conservation?," *Glob. Ecol. Conserv.*, vol. 12, pp. 9–20, 2017, doi: 10.1016/j.gecco.2017.08.002.

[4] T. Efferth and N. W. Paul, "Threats to human health by great ocean garbage patches," *Lancet Planet. Heal.*, vol. 1, no. 8, pp. e301–e303, 2017, doi: 10.1016/s2542-5196(17)30140-7.

[5] G. Li, H. Sun, Z. Zhang, T. An, and J. Hu, "Distribution profile, health risk and elimination of model atmospheric SVOCs associated with a typical municipal garbage compressing station in Guangzhou, South China," *Atmos. Environ.*, vol. 76, pp. 173–180, 2013, doi: 10.1016/j.atmosenv.2012.06.027.

[6] J. L. Domingo and M. Nadal, "Domestic waste composting facilities: A

review of human health risks," *Environ. Int.*, vol. 35, no. 2, pp. 382–389, 2009, doi: 10.1016/j.envint.2008.07.004.

[7] N. T. Xun, "Garbage Bin Monitoring for Smart Residence," Universiti Tunku Abdul Rahman, 2018.

[8] C. Mayorga *et al.*, "GABOT: Garbage autonomous collector for indoors at low cost," *Proc. - 2019 Int. Conf. Mechatronics, Electron. Automot. Eng. ICMEAE 2019*, pp. 56–61, 2019, doi: 10.1109/ICMEAE.2019.00018.

[9] M. N. Mohammed, S. Al-Zubaidi, S. H. Kamarul Bahrain, M. Zaenudin, and M. I. Abdullah, "Design and Development of River Cleaning Robot Using IoT Technology," *Proc. - 2020 16th IEEE Int. Colloq. Signal Process. its Appl. CSPA 2020*, no. Cspa, pp. 84–87, 2020, doi: 10.1109/CSPA48992.2020.9068718.

[10] X. Li, M. Tian, S. Kong, L. Wu, and J. Yu, "A modified YOLOv3 detection method for vision-based water surface garbage capture robot," *Int. J. Adv. Robot. Syst.*, vol. 17, no. 3, pp. 1–11, 2020, doi: 10.1177/1729881420932715.

[11] T. P. Tunggal, A. Supriyanto, R. Nur Mukhammad Zaidatur, I. Faishal, I. Pambudi, and T. Iswanto, "Pursuit algorithm for robot trash can based on fuzzy-cell decomposition," *Int. J. Electr. Comput. Eng.*, vol. 6, no. 6, pp. 2863–2869, 2016, doi: 10.11591/ijece.v6i6.10766.

[12] N. L. Husni, E. Prihatini, and A. Silvia, "Garbage Monitoring and Warning System," *3rd ICECOS*, 2019.

[13] M. R. B. and S. S. Zainab Alansari, Safeeullah Soomro, "The Rise of Internet of Things (IoT) in Big Healthcare Data: Review and Open Research Issues," *Prog. Adv. Intell. Syst. Comput.*, vol. 564, no. December 2017, 2017, doi: 10.1007/978-981-13-0224-4.

[14] K. B. M.N. and A.-S. N.M., "On the Internet of Things, smart cities and the WHO Healthy Cities," *Int. J. Health Geogr.*, vol. 13, no. 1, pp. 1–6, 2014, doi: 10.1186/1476-072X-13-10.

[15] N. Yusuf, A. Hamza, R. S. Muhammad, M. Aminu, and Z. A. Abubakar, "Smart Health Internet of Thing for Continuous Glucose Monitoring : A Survey," *Int. J. Integr. Eng.*, vol. 7, pp. 54–61, 2020.

[16] M. Al-Kuwari, A. Ramadan, Y. Ismael, L. Al-Sughair, A. Gastli, and M. Benammar, "Smart-home automation using IoT-based sensing and monitoring platform," *Proc. - 2018 IEEE 12th Int. Conf. Compat. Power Electron. Power Eng. CPE-POWERENG 2018*, pp. 1–6, 2018, doi: 10.1109/CPE.2018.8372548.

[17] O. Zedadra, A. Guerrieri, N. Jouandeau, H. Seridi, and G. Fortino, "The Internet of Things for Smart Urban Ecosystems," *Springer Int. Publ. AG, part Springer Nat. 2019*, 2019, doi: 10.1007/978-3-319-96550-5.

[18] K. Saravanan, E. G. Julie, and Y. H. Robinson, "Smart cities & IoT: Evolution of applications, architectures & technologies, present scenarios & future dream," *Intell. Syst. Ref. Libr.*, vol. 154, pp. 135–151, 2019, doi: 10.1007/978-3-030-04203-5_7.

[19] S. Rashinkar, S. Ghatole, S. Kadapatti, and V. Yadave, "IoT Based Smart Trash Bins – A Step Toward Smart City," pp. 768–771, 2017.

[20] A. T. Chatfield and C. G. Reddick, "A framework for Internet of Things-enabled smart government: A case of IoT cybersecurity policies and use cases in U.S. federal government," *Elsevier*, vol. 36, no. 2, pp. 346–357, 2019, doi: 10.1016/j.giq.2018.09.007.


ISSN: 2252-4274 (Print)
ISSN: 2252-5459 (Online)

[21] M. F. Roslan and A. Ahmad, "Internet of things (IoT)-based solution for real-time monitoring system in high jump sport," *Int. J. Integr. Eng.*, vol. 11, no. 8, pp. 197–205, 2019, doi: 10.30880/ijie.2019.11.08.020.

[22] N. Omar, H. Zen, N. N. Anak Aldrin, W. Waluyo, and F. Hadiatna, "Accuracy and Reliability of Data in IoT System for Smart Agriculture," *Int. J. Integr. Eng.*, vol. 12, no. 6, pp. 1–11, 2020, doi: 10.30880/ijie.2020.12.06.013.

[23] Nyayu Latifah Husni et al, "Garbage Box (G-Box) Designing and Monitoring," *ITC CSCC Conf.*, pp. 5–8, 2019.

[24] 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.