Cargo Simulation Robot Prototype with Bluetooth Based Motor Driver Shield Using Arduino Uno Microcontroller

Yudi Irawan Chandra[1*], Irfan[2], Anargya Satya Rifisyah Putro[3]
[1,2,3]STMIK Jakarta STI&K, Jl. BRI No.17 Radio Dalam Kebayoran Baru, Jakarta Selatan, Indonesia
[1]yirawanc@gmail.com*; irfansasa357@gmail.com; anargya@jak-stik.ac.id
*Corresponding Author

ABSTRACT

From the android developer website, it can be seen that the number of android users in the world is increasing. Almost 70% of the world's people use Android as their gadget. Nevertheless, today's average person uses android gadgets only to send messages, social media, and telephone. Furthermore, they do not realize they can increase the ease and sophistication of other things in the world and are very useful for everyday things and certain things in life. In today's modern era, many communication types of equipment have an intelligent system or what is commonly referred to as a smartphone. Modern society uses branded gadgets as a lifestyle. Today, the average person uses android gadgets only to send messages, social media, and telephone. When using Bluetooth, applications are generally used to exchange data. However, now Bluetooth is not only used to communicate with telephones or computers but can also be used to command an electronic device according to the needs of its users. The purpose of this research is to create a robot simulation that can be controlled using Bluetooth to move an item to facilitate human work, relieve heavy tasks that have a high risk, for example carrying goods in the factory and reduce accidents in terms of carrying goods, and able to be controlled things remotely as desired by utilizing Bluetooth media using the Arduino Uno-based L293D Motor Shield Driver.

Keywords: Cargo Simulation Robot, Bluetooth, Motor Driver, Arduino Uno

Article History

Received : May, 10th 2022	Revised : May, 22nd 2022	Accepted : May, 25th 2022

I. INTRODUCTION

When using Bluetooth applications, people only use them to exchange data. However, now Bluetooth is not only used to communicate with phones or computers but can also command a device according to the needs of its users. In particular, robots that can be controlled using Bluetooth to move an item aim to facilitate human work, relieve heavy tasks that have a high risk, for example carrying goods in the factory and reduce accidents in terms of carrying goods and can be controlled remotely using Bluetooth media. Therefore, it is necessary to develop technological innovations, especially by using a telephone or smartphone already owned. Therefore, the author is interested in making a device using Bluetooth technology.

In previous study, an autonomous forklift robot prototype used an Android tablet to stack items. This forklift robot prototype follows a predefined trajectory line to stack shelves. This forklift robot moves cargo. Robot's line follower employs a photodiode. It detects products on tiny stacking objects with proximity sensors. This determines if a product can go in a given shelf cell. Three-cell rows divide the tiny shelves. Two input controllers operate the robot. Robot first. The other device was Android and Bluetooth-controlled [1]. Robotic arms are used to pick up and transport things to the operator. Robotic arms do several tasks. During the inquiry, a prototype was constructed to transfer objects to random locations or containers. Robot has object's coordinates. The arm robot prototype contains a camera. Camera mounted above robot's workstation. The camera finds an object's coordinates using image processing. The object's coordinates are fed into inverse kinematics to generate an angle at each servo arm position. The robot arm's end effector can be moved [2]. Automatic umbrella garden cover. An Arduino Uno microcontroller processes input data, while an L298N motor driver controls DC motor speed and direction. Arduino Uno controls light and rain sensors. Right turns the motor open, left closes the umbrella. [3]

Based on the background described above, it was identifying the problem above is how to design a device to carry goods with Bluetooth connectivity control. Some limitations of the problem in this study can be formulated, namely: Devices made using the Arduino Uno Microcontroller, Devices using Bluetooth HC-05 to be connected to android devices, Android Bluetooth distance that can be connected to the HC-05 Bluetooth module, number of devices that can be connected to the Bluetooth module. HC-05.

While the purpose of this research is to design a device that can remotely control a Bluetooth-based robot using an Arduino Uno-based motor driver shield.

II. METHOD

The design and fabrication of Robotics tools are separated into numerous parts. Circuit block diagrams describe input, process, and output blocks in general. The design of circuits and components outlines the steps of tool building design, the components needed, their functions, and the final circuit. The working principle of the circuit offers a full description of the work process. The program flow diagram describes the tool's functioning steps in the form of a diagram. Making a microcontroller program contains the stages of software programming [3][4]. Before compiling a program on the Arduino Uno microcontroller, the first step that must be done is producing a flowchart that will be used as a reference for writing program sketches on the Arduino Uno Microcontroller [5]-[7]. The flow diagram of the goods transporting robot simulation may be shown in Fig. 1.

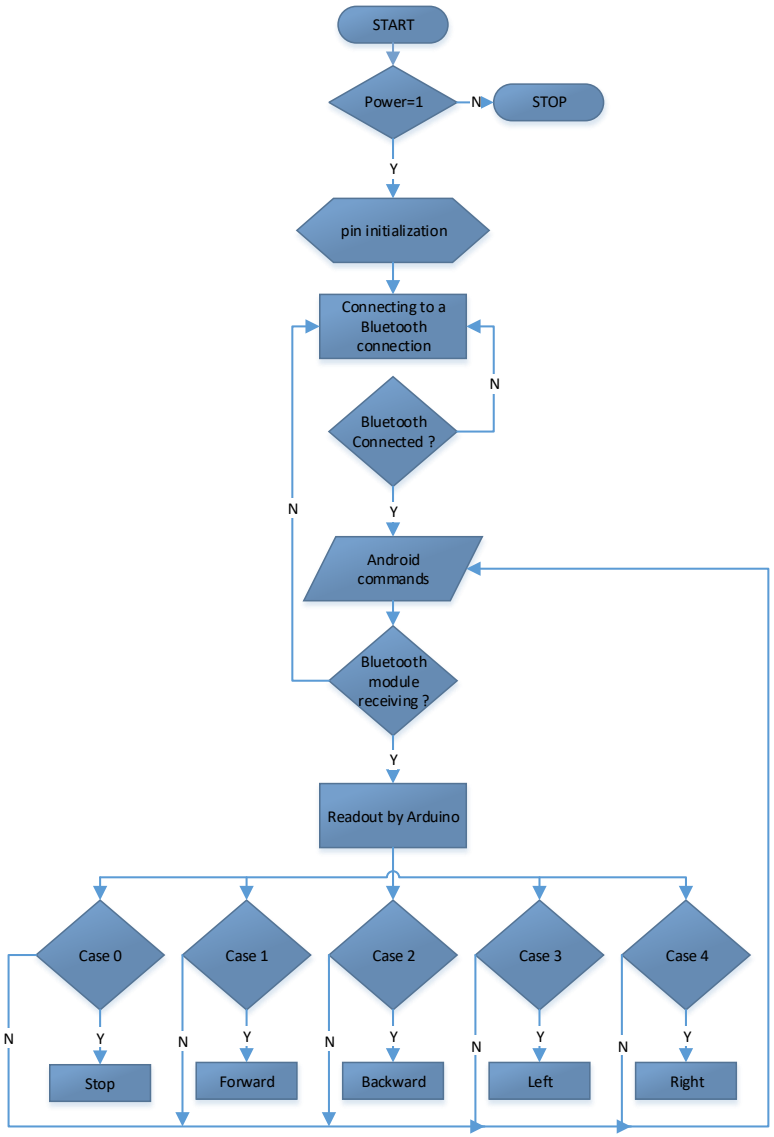

Fig. 1. Program Flowchart

The robot can move after accepting voltage input, initializing pins, and variable declarations, as shown in Fig. 1. The Bluetooth module then accepts the Android command. Arduino for processing will be transmitted to dc motor, and Arduino Uno will be used for reading. 0 robots will stop, case 1 will go ahead, case 2 will retreat, case 3 will move to the left, and case 4 will move to the right [8][9].

This tool gets input from the Android application and the HC-05 Bluetooth module, which the Arduino Uno then processes to produce a revolving dc motor as output. The Arduino Uno is powered by a 5V voltage supplied by a battery connected to the shield

DOI: http://dx.doi.org/10.25139/ijair.v4i1.4326

motor driver and then sent to the Arduino Uno, as depicted in Fig. 2.

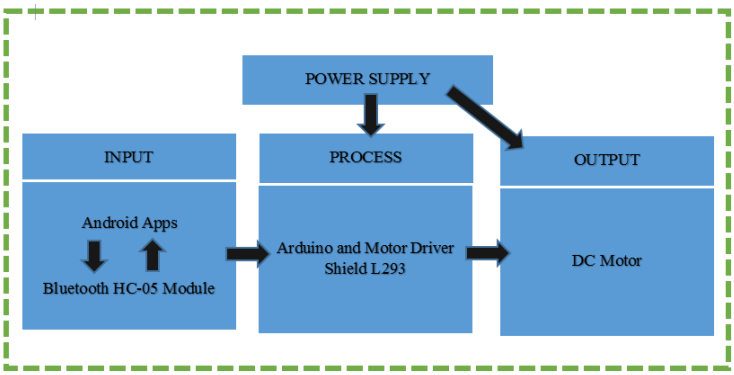

Fig. 2. Tool Block Diagram

Fig. 2 shows how each block of the series works. Here is a description of how it works:

- Android application as an input device to drive a dc motor
- Bluetooth HC-05 as an input device to receive input from android applications and forward it to Arduino Uno
- Arduino Uno as the processing of input blocks
- Motor Driver shield L293d as processing from Arduino and determines the direction of the DC motor, which is then forwarded to the output control
- DC motor as output/driver.

III. RESULT AND DISCUSSION

In the research of the cargo carrier simulation robot using Bluetooth based Motor driver shield L293d by utilizing the Arduino Uno Microcontroller, which is used to process data received from the android application and the HC-05 Bluetooth Module, the microcontroller also functions to control resources and components connected to the microcontroller so that it can perform digital data processing and processing. The microcontroller can work by connecting it via the battery from the shield motor driver so that it gets the voltage needed to work at 7.4-9V; then, the dc motor will move according to the input given from the android application and the Bluetooth Module HC-05 [10][11].

The HC-05 Bluetooth module is a 2.4GHz Bluetooth wireless communication module with two connectivity modes. Mode 1 only acts as a slave or data receiver, but mode two can act as either a master or a transmitter. Fig. 3 depicts the shape of the HC-05 Bluetooth module.

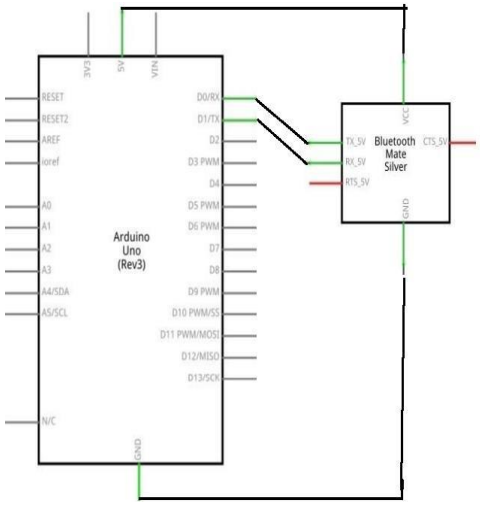

Fig. 3. Bluetooth HC-05 Circuit

The HC-05 Bluetooth module's pins are connected to the Arduino Uno's pins in this cargo carrier simulation robot. The VCC pin is a positive voltage pin; on Bluetooth, it is connected to the 5V pin on the Arduino Uno. In the form of an electric current, the GND pin requires a return connection to the ground. Bluetooth's TX pin is connected to the RX pin on the Arduino because

DOI: http://dx.doi.org/10.25139/ijair.v4i1.4326

Bluetooth is the master module. Table I displays the pin arrangement of the HC-05 Bluetooth module.

TABLE I
HC-05 BLUETOOTH MODULE PIN CONFIGURATION

MODULE BLUETOOTH HC-05	ARDUINO UNO
Vcc	5V
RX	D1/TX
TX	D0/RX
GND	GND

The overall circuit is a collection of components utilized by the simulated robot that transports cargo. This robot operates depending on the Bluetooth module and Android application input [12] [13]. Then, the Arduino Uno microcontroller processes the input to provide the process outcomes. The outcome of the Arduino Uno process will be delivered to the output, a DC motor, which will turn the wheels based on the outcome of the process. Fig. 4 depicts the total circuitry of the cargo-carrying simulation robot.

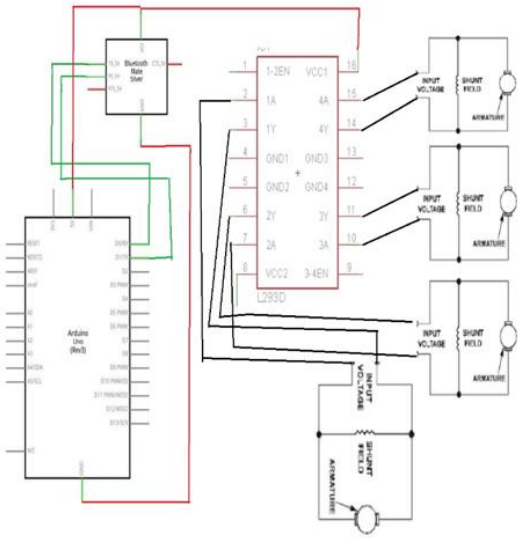

Fig. 4. Overall Schematic of the Tool

For this simulation robot to transport cargo, the microcontroller must be programmed according to the robot's operating principle. The first step is to launch the Arduino IDE application; Fig. 5 depicts the initial look of the Arduino IDE.

Fig. 5. IDE Arduino Editor View

where:

- The sketch program has been created, and the next step is to compile the program to check whether or not there are errors in writing program coding.

- The program is decompiled. The program can be uploaded to the Arduino Uno if there are no errors. Before uploading the program, first set the type of board on the Arduino by selecting tools– board- Arduino Uno, then do the port settings by selecting tools- port- COM4 (Arduino Uno) [14]. After the setup is complete, the program is ready to be uploaded.
- After uploading the code to the Arduino-Uno microcontroller, the next step is to download the application on Android via Playstore, typing "Bluetooth controller for Arduino," then select as shown in Fig. 6.

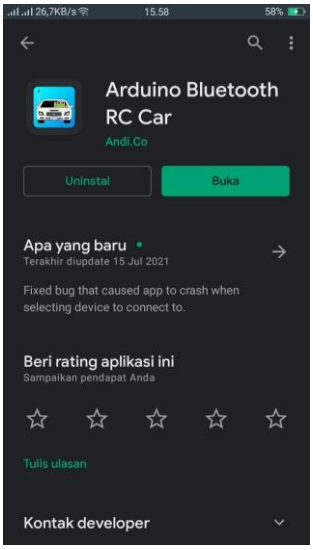

Fig. 6. Arduino Bluetooth App

The following are the application configuration steps [16]-[18]:
1. Open the application, then press the settings button next to the triangle icon
2. After entering settings, press "connect to the car" to connect it with Bluetooth HC-05.
3. After that, press HC-05 to connect the application with Bluetooth Hc-05
4. Wait until the application is connected with Bluetooth HC-05 marked with the upper left circle green, as shown in Fig. 7.

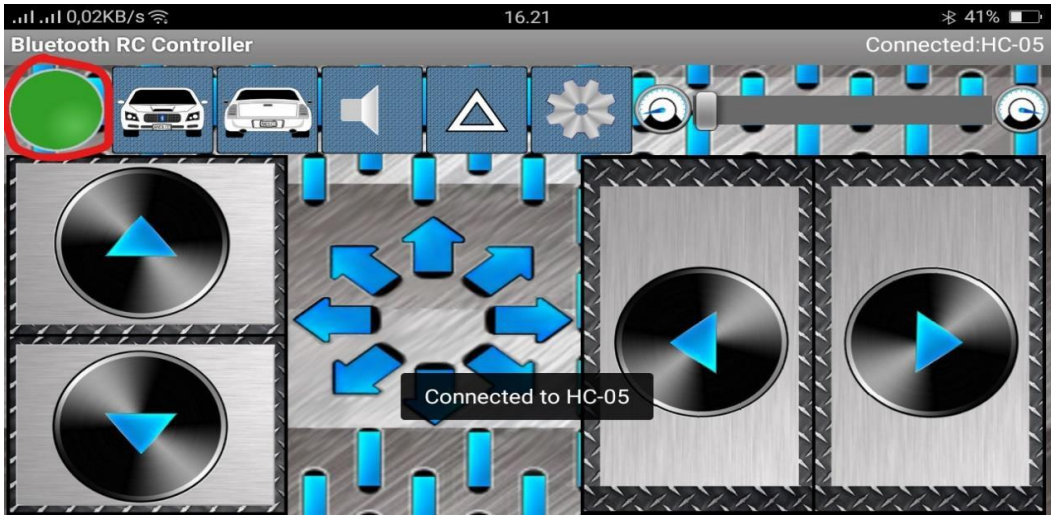

Fig. 7. Bluetooth RC Controller

The prototype produced is then implemented for a cargo carrier simulation tool. The following image is a prototype of a cargo carrier robot. The placement of the Bluetooth component on the robot looks like in Fig. 8, namely the placement of the Bluetooth on the front of the robot at number 1, the motor driver shield at number 2, Arduino Uno at number 3, DC motor at number 4, where the items to be carried at number 5.

DOI: http://dx.doi.org/10.25139/ijair.v4i1.4326

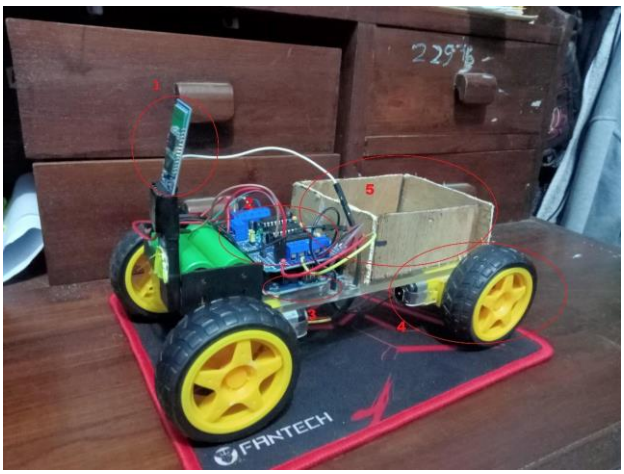

Fig. 8. The Final Result Of Making A Robot

The tool's approach is to download the program onto the Arduino Uno microcontroller to test each connected component. Tests are separated into three categories: technical testing, functional testing, and experimental evaluation. The technical test entails measuring the electrical quantity of the component in question. Functional testing includes Bluetooth functioning and responsiveness within a given distance and the ability of a dc motor to carry items, including their weight and quantity. Experimental analysis is a review of previously conducted experiments.

A. Technical Test

During technical testing, the specifications for the quantity of electricity that works on the component are determined using a multimeter that measures voltage or voltage. A connected circuit on a robot that transports cargo [15]. This circuit comprises a sequence of Bluetooth Module HC-05 and DC Motors by obtaining measurements at a particular position. This cargo-carrying robot simulation will transport the largest quantity of products.

1) Bluetooth Circuit Testing HC-05. Tests on this Bluetooth circuit are carried out at two points: the positive (+) and the negative (-). The positive point on the TX pin is connected to the Arduino microcontroller, while the negative pin is on the ground pin. Table II notes that the test is carried out to enter data on the HC-05 Bluetooth module when receiving input from Android devices.

TABLE II
TEST RESULTS BLUETOOTH MODULE DATA DELIVERY DISTANCE

NO.	BLUETOOTH DISTANCE	INFORMATION	
		NO BARRIERS	WITH BARRIERS
1	1 m	Connected	Connected
2	2 m	Connected	Connected
3	3 m	Connected	Connected
4	4 m	Connected	Connected
5	5 m	Connected	Connected
6	6 m	Connected	Not Connected
7	7 m	Connected	Not Connected
8	8 m	Connected	Not Connected
9	9 m	Connected	Not Connected
10	10 m	Connected	Not Connected
11	11 m	Connected	Not Connected
12	12 m	Connected	Not Connected
13	13 m	Connected	Not Connected
14	14 m	Connected	Not Connected

2) DC Motor Circuit Testing. Utilizing a digital multimeter, tests are conducted on a dc motor. This test is performed to detect the voltage or voltage level. Table III shows this is accomplished by connecting Terminal (+) as a positive voltage and Terminal (-) as a negative voltage.

TABLE III
DC MOTOR TEST RESULTS

NO	DC MOTOR	VOLTAGE (V)	RESULTS
1	ON	1.540	Moving
2	OFF	0	Not Moving

B. Functional Testing

Functional testing is performed to determine the initialization of each circuit and whether or not it has worked and is operating properly and as required. This simulation cargo-carrying robot's functional tests include the Bluetooth connection range, the load capacity, and the time required to transport the load. A number of tests are conducted to determine whether or not the complete fleet of Simulation Robots transporting items will operate as required. Connecting the Arduino Uno microcontroller to a 5V power supply to activate the circuit is the first step of the test. Connect the Android Bluetooth to the HC-05 Bluetooth module after the robot is active. Once connected, the Android Rc Bluetooth program will initially test whether the dc motor moves when the controller button is pressed. Due to the availability of the products, the author attempts to place two things weighing a total of 540g in Fig. 9.

Fig. 9. The Condition of The Robot Carrying Goods

The following is a table of the overall test results of the simulation robot goods carrier using a Bluetooth-based motor driver shield, as seen in Table IV.

TABLE IV
TRAVEL TIME TRIAL RESULTS

TESTING OF THE GOODS	DISTANCE (meters)	WEIGHT (grams)	TIME THAT TAKEN (seconds)
1	1	320	1,9
	2	320	2,5
	3	320	3,4
	4	320	4,5
	5	320	5,7
2	1	220	1,4
	2	220	2,1
	3	220	3,0
	4	220	3,9
	5	220	4,5

C. Analysis of Test Results

Overall, the circuit is divided into input, processor, and output. The input consists of an android application and the HC-05 Bluetooth module in this robot. This section sends input via the Bluetooth Android Rc application to the processing section, namely Arduino Uno and motor driver shield. In this processing section, Arduino is tasked with processing the input received from the Bluetooth HC-05 and the android application, then forwarded to the motor driver shield to be forwarded to the output, namely the

DC Motor. Overall, it is known that all the circuits in this system are connected or related to each other, such as the HC-05 Bluetooth module with the Rc Bluetooth android application. The Bluetooth application is input then the Bluetooth module accepts and inputs it into the Arduino Uno microcontroller. Arduino and the motor driver shield will process input from the Rc android application and the HC-05 Bluetooth module. Then, it will be forwarded to the output, namely the DC motor as a robot driver.

IV. CONCLUSION

The following conclusions can be drawn from designing a cargo-carrying robot using Bluetooth based on a motor driver shield. The application can communicate with the cargo-carrying robot via a Bluetooth network as a medium for sending control commands to the cargo-carrying robot. The connection distance reached by the HC-05 Bluetooth module is up to 14 meters but is interrupted for distances exceeding 6 meters with obstructions. The obstructions such as walls can affect the connection distance between the smartphone and the Bluetooth module. The heavier the item being carried, the more time it will take to reach the destination, and the larger the item being carried will also affect the rotational speed of the DC motor. The further research for the development of this research, a WIFI module can be added so that the distance that can be reached is wider; the load carried can be heavier if the place to put things is enlarged, and you can add an ultrasonic sensor so that the robot can avoid automatically if there are obstacles.

REFERENCES

[1] Suryowinoto A, Wijayanto M, "The Prototype of A Forklift Robot Based on AGV System and Android Wireless Controlled for Stacked Shelves", International Journal of Artificial Intelligence & Robotics (IJAIR), 2(1), 2020, 1-7.
[2] Fahruzi A., Agomo B. S., & Prabowo Y. A. "Design Of 4DOF 3D Robotic Arm to Separate the Objects Using a Camera", International Journal of Artificial Intelligence & Robotics (IJAIR), 3(1), 2021, 27-35.
[3] Chandra, Yudi Irawan, et al. "Automatic Garden Umbrella Prototype with Light and Rain Sensor Based on Arduino Uno Microcontroller." International Journal of Artificial Intelligence & Robotics (IJAIR), 2(2), 2020, 42-51.
[4] A. N. Raghavan, H. Ananthapadmanaban, M. S. Sivamurugan and B. Ravindran, "Accurate mobile robot localization in indoor environments using bluetooth," 2010 IEEE International Conference on Robotics and Automation, 2010, pp. 4391-4396
[5] Nasereddin, Hebah HO, and Amjad Abdullah Abdelkarim. "Smartphone control robots through Bluetooth." International Journal of Research and Reviews in Applied Sciences 4.4 (2010): 399-404.
[6] Singh, Akash, Tanisha Gupta, and Manish Korde. "Bluetooth controlled spy robot." 2017 International Conference on Information, Communication, Instrumentation and Control (ICICIC). IEEE, 2017.
[7] van Delden, Sebastian, and Andrew Whigham. "A bluetooth-based architecture for android communication with an articulated robot." 2012 International Conference on Collaboration Technologies and Systems (CTS). IEEE, 2012.
[8] Purbowaskito, W. and Hsu, C. "Sistem Kendali PID untuk Pengendalian Kecepatan Motor Penggerak Unmanned Ground Vehicle untuk Aplikasi Industri Pertanian", Infotel, 9(4), 2017, pp. 376– 381.
[9] Yuliza, U. N. K. "Robot Pembersih Lantai Berbasis Arduino Uno Dengan Sensor Ultrasonik"', Jurnal Teknologi Elektro, Universitas Mercu Buana, 6(3), 2015, pp. 136–143.
[10] KristyawanY., & YikwaA., Automation System for the Disposal of Feces and Urine in Rabbit Cages Using Arduino. International Journal of Artificial Intelligence & Robotics (IJAIR), 3(2), 2021, pp. 67-74.
[11] WibisonoV., & KristyawanY., An Efficient Technique for Automation of The NFT (Nutrient Film Technique) Hydroponic System Using Arduino. International Journal of Artificial Intelligence & Robotics (IJAIR), 3(1), 2021, pp. 44-49.
[12] Bauer, Waldemar, and Aleksandra Kawala-Janik. "Implementation of bi-fractional filtering on the arduino uno hardware platform." Theory and Applications of Non-Integer Order Systems. Springer, Cham, 2017. 419-428.
[13] Sugathan, Akshay, et al. "Application of Arduino based platform for wearable health monitoring system." 2013 IEEE 1st International Conference on Condition Assessment Techniques in Electrical Systems (CATCON). IEEE, 2013.
[14] J. Sankari and R. Imtiaz, "Automated guided vehicle (AGV) for industrial sector," 10th International Conference on Intelligent Systems and Control (ISCO), Coimbatore, India, 2016, pp. 1-5
[15] K. C. T. Vivaldini et al., "Robotic forklifts for intelligent warehouses: Routing, path planning, and auto-localization," IEEE International Conference on Industrial Technology, Vina del Mar, 2010, pp. 1463-1468.
[16] Kadir, Abdul.. Arduino dan Sensor (Tuntunan Praktis Mempelajari Penggunaan Sensor Untuk Aneka Proyek Elektronika Berbasis Arduino). Edisi I. Yogyakarta: Andi, 2018
[17] Tukadi, T. Pembelajaran Embedded System Berbasis Arduino Mega 2560 dan MIT App Inventor. Inform: Jurnal Ilmiah Bidang Teknologi Informasi Dan Komunikasi, 2(2), 2017. pp. 2–6.
[18] Firmansyah Safitri, *Proyek Robotika Kontrol Dengan Arduino*, Jakarta : PT. Elios Media Komputindo. 2015