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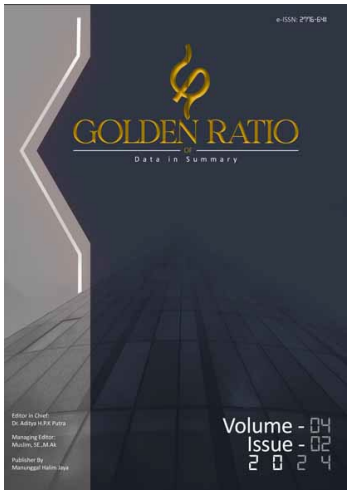

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DESCRIPTIVE OF QUANTITATIVE DATA | RESEARCH ARTICLE

Vacuum Cleaner Robot with Arduino R3 Android Based

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Abstract: The advancement of science and robotics technology has made human life faster and easier. The field of robotics now encompasses all sectors, including industry, mechanics, and household. Therefore, a floor vacuum robot is needed to facilitate home cleaning. This research discusses a vacuum robot that uses Arduino Uno, ultrasonic sensors, and Bluetooth serial to operate the robot. This vacuum robot moves automatically using ultrasonic sensors that move forward while avoiding obstacles such as walls, which act as distance detectors. This allows the robot to automatically turn and avoid obstacles, continuing the cleaning process. Meanwhile, the Bluetooth system can also be manually controlled via a smartphone, allowing it to move forward, backward, turn, and stop. With a DC motor, you can manually operate the vacuum cleaner by pressing the on/off button located on the body of the robot. This robot makes household chores easier to accomplish.

Keywords: Arduino Uno, Bluetooth, DC Motor, Ultrasonic Sensor, Smartphone.

1. INTRODUCTION

The rapid development of technology in this modern era, especially in the field of microcontrollers, has led us into the era of robotics. Robotic technology has become one of the most widely developed innovations because it provides solutions to various human needs, including household appliances (Harmo et al. 2005). Currently, various electronic devices have been designed to facilitate daily activities, one of which is the vacuum cleaner robot. By utilizing robotic technology, household tasks such as cleaning dust on the floor can be carried out more effectively and efficiently (Kim et al. 2019). The use of robotic technology in everyday life is becoming more widespread. There are various types of smart robots designed to make human tasks easier, such as legged robots and wheeled robots. These robots can move automatically using sensors as a control system or can be controlled by humans using remote control. One beneficial innovation is the vacuum cleaner robot, which is specifically designed to clean floors automatically without requiring continuous human interaction (Khanna and Srivastava 2022). Generally, people still use brooms or conventional vacuum cleaners to clean floors. The manual vacuum cleaners currently available usually use long cables to connect them to a power source. However, the use of long cables poses several challenges. Cables can get tangled or twisted, which can hinder cleaning activities. Additionally, using long cables can also risk causing electrical short circuits if not managed properly.

Based on these problems, a more practical and efficient solution is needed to clean dust and dirt on the floor. One interesting innovation is the vacuum cleaner robot equipped with Bluetooth technology and controllable via an Android-based smartphone. This technology allows users to operate the robot remotely without having to use cables. This robot not only works automatically but can also be controlled manually through an Android device. The vacuum cleaner robot designed in this study uses Arduino R3 as its microcontroller. Arduino R3 is one of the most accessible and widely

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used microcontroller platforms for various robotic projects. With support from ultrasonic sensors, this robot can detect and avoid obstacles in front of it. This allows the robot to move more intelligently and ensures that the entire floor area can be cleaned efficiently. The ultrasonic sensor technology applied to this vacuum cleaner robot is crucial because the sensor functions as the robot's "eyes" to detect the distance between the robot and obstacles. When the sensor detects an obstacle, the robot will automatically change direction to avoid it and continue its cleaning task. With this system, the robot can work independently without needing to be monitored by humans directly. In addition to moving automatically, this vacuum cleaner robot is also equipped with a manual control feature that can be accessed through an Android application. Through a Bluetooth connection, users can move the robot forward, backward, turn, or stop as needed. With this feature, users have full control over the robot and can ensure that the robot works according to their preferences, especially in certain areas that require more attention. Android, as a popular mobile operating system, has become the primary platform for developing control applications for this robot. Android provides convenience for users to control the robot through an intuitive and easy-to-use interface. By using an Android application, users can control the vacuum cleaner robot without needing to be connected to cables or additional hardware. This makes the robot a practical solution for modern household needs. The use of this vacuum cleaner robot not only facilitates household tasks but also helps save time and energy. With this robot, cleaning tasks can be done automatically, allowing users to focus on other, more productive activities. Additionally, the technology used in this robot also allows for more effective cleaning, as the robot can reach areas that are difficult to access with conventional vacuum cleaners. In an era of increasingly advanced technology, automation in households is becoming a necessity that cannot be avoided. This Arduino R3 and Android-based vacuum cleaner robot is a tangible example of the application of technology in everyday life. With this innovation, it is hoped that it can provide a better solution in maintaining home cleanliness and improving the quality of life for users. Thus, this study aims to design and implement an Arduino R3-based vacuum cleaner robot that can be controlled via an Android smartphone. This innovation is expected to make a positive contribution to the field of household robotics and provide a practical solution for maintaining home cleanliness efficiently and effectively. Through the use of ultrasonic sensor technology, Bluetooth, and an Android application, this vacuum cleaner robot can operate intelligently and provide an easier experience for its users. This research also proves that technological developments are not only beneficial in large industries but can also have a positive impact on everyday life, especially in household tasks that are often considered exhausting.

2. RESEARCH DESIGN AND METHOD

This research was conducted using an experimental method, with the main objective of designing and testing the performance of a vacuum cleaner robot based on Arduino R3, equipped with ultrasonic sensor technology, Bluetooth HC-06, and controllable via an Android application. This method was chosen because it allows for direct observation and measurement of the robot's performance in executing its functions, both automatically and manually. The robot is designed to assist with household tasks, particularly in cleaning dust on the floor, in a more practical and efficient way. The system designed in this study consists of several key components, namely the Arduino Uno R3 microcontroller, HC-SR04 ultrasonic sensor, Bluetooth HC-06 module, DC motors, and a vacuum fan. The Arduino Uno R3 microcontroller serves as the system's control center, where commands from the Android application are processed and sent to the DC motors to move the robot's wheels. The ultrasonic sensor is responsible for detecting obstacles in front of the robot, enabling it to avoid them automatically. The Bluetooth HC-06 allows the robot to connect to the Android application, enabling the user to control the robot's movements remotely. The research process began

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with the system design stage, which involved creating a hardware circuit diagram and developing software. The hardware consists of components connected according to the system's block diagram. At this stage, Arduino R3 was programmed to function as the primary controller. On the software side, an Android application was designed to provide an easy-to-use interface, allowing users to give commands such as move forward, backward, turn, and stop through a Bluetooth connection.

Once the design was completed, the system was implemented and tested. Testing was carried out to ensure that each component functioned as intended. The ultrasonic sensor was tested to determine the robot's ability to detect obstacles and how it reacts to those obstacles. Additionally, the Bluetooth connection was tested to ensure that commands from the Android application could be received and executed by the robot without any interference. Then, the vacuum fan was tested to evaluate its ability to clean dust from the floor surface. The tests not only focused on the robot's ability to move and avoid obstacles but also measured the efficiency of power usage and battery capacity. Battery usage duration became one of the important factors tested, as it relates to how long the robot can operate before needing to be recharged. In addition, the effectiveness of dust cleaning was also tested to assess how well the robot could vacuum dust, especially in areas that are difficult to reach with conventional vacuum cleaners.

3. RESULT AND DISCUSSION

3.1. Tools Overview

The design of this tool functions as a vacuum cleaner to clean the floor surface. In a system equipped with an L293D motor driver as a supporter of the DC motor motion system. Ultrasonic sensors in their use, the robot can walk and avoid obstacles in front of itself, and Bluetooth HC-06 is a feature that functions to be used as a robot motion controller so that the robot can be controlled with an Android-based smartphone via a Bluetooth module connection. The application is designed to be able to make a connection between the smartphone's Bluetooth and the HC-06 Bluetooth module on the Arduino Uno R3-based floor dust cleaning robot.

3.2. Block Diagram

The tool block below explains how the tool works as a whole from input, process, to output. In this tool block there is only a path relationship between the blocks, but each block has main components and supporting components.

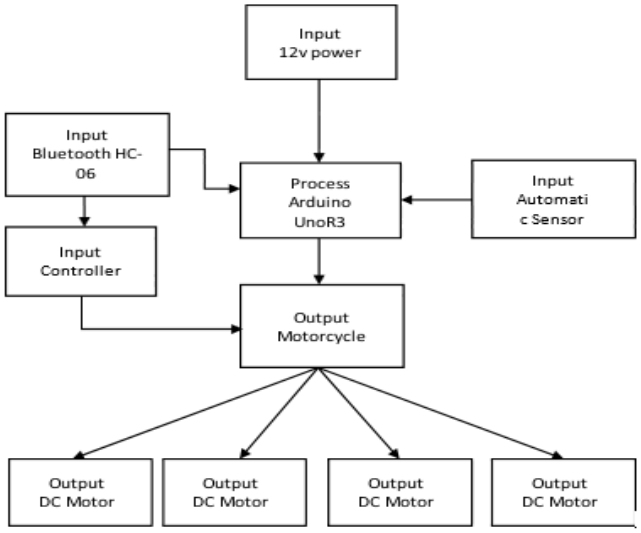

Figure 1. Tool Block Diagram

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The following is an explanation of the tool circuit block:

a. Input

This input component is the input component that will be processed. This component consists of:

1. A power supply is a tool or hardware that is capable of supplying power or electrical voltage directly from an electrical voltage source to another electrical voltage, (Destiarini and Kumara 2019).
2. Bluetooth HC-05 is a wireless communication technology that operates in the 2.4 GHz unlicensed ISM (Industrial, Scientific and Medical) frequency band using a frequency hopping transceiver that is capable of providing real-time data and voice communication services between Bluetooth hosts with limitedservice range. (Sentosa, Putra, and Wulandari 2017). Bluetoothas communication between the device and smartphone to make a controller connection.
3. Smartphones are a development of mobile phones that have been equipped with features like those on personal computers, features such as email, personal organizers, and also additional connectivity such as WiFi and Bluetooth that can be installed on the device. (Warangkiran et al. 2014). Smartphone Controllercontroller to control the speed of DC Motor movement.
4. Ultrasonic sensor to detect an object using sound reflection. Ultrasonic sensors consist of a transmitter and a receiver. The transmitter functions to transmit a sound wave forward. If an object is in front of the transmitter, the signal will bounce back to the receiver. The function of the ultrasonic sensor is to detect objects in front of the sensor. Its application is widely used in fire extinguishing robots and other obstacle robots. One of the most frequently used sensors is the HC-SR04 type ultrasonic sensor. This sensor can be used to measure the distance between obstacles and sensors. (Yulio, Aulisari, and Orisa 2021).
5. A switch is one of the electrical devices that has a function as a breaker or connecting the source of electrical voltage with the load. There are many types of switches used in electrical and light power installation circuits. (Teacher & Engineering, 2021).

b. Process

1. A microcontroller is a complete microprocessor system contained within a single chip. Microcontrollers differ from general-purpose microprocessors used in a PC, because a microcontroller generally contains the minimal system support components of a microprocessor, namely memory, I/O interfaces. (Dani, Adriansyah, and Hermawan 2016).
2. Arduino is a hardware and software that allows anyone to create a prototype of a microcontroller-based electronic circuit easily and quickly. (Kadir 2016).

The process is a data manager received from input which will then produce output. In this process the author uses the Arduino Uno R3 Microcontroller.

c. Output

Outputis the output of all processes that have been run. The output produced is:

1. A fan is a tool that functions to produce flow in gas fluids such as air. A fan has a different function from a compressor even though the working medium is the same, where the fan produces a fluid flow with a large flow rate at low pressure, while the compressor produces a low flow rate but high working pressure. Here I use a fan to suck dust on the floor.
2. DC motor is a motor that uses a DC voltage source and is used to convert electrical power into mechanical power. This component works on the principle of electromagnetism. When

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a voltage source is given, a magnetic field in the stationary part or called the stator will be formed. This magnetic field will make the rotor or moving part rotate and of course can be used to rotate other objects such as wheels. (Mahesa Ramadhan, Dedy Irawan, and Adi Wibowo 2023).

3. L293D Motor Driver

   The L293D IC is usually used to control DC motors. This IC is also often called a motor driver. The L293D is designed to control 2 DC motors. DC motors controlled by the L293D IC driver can be connected to ground or to a positive voltage source because the L293D driver system used is a totem pool. Basically, a DC motor must be able to regulate the speed and direction of rotation of the DC motor itself. Initially, to be able to regulate the speed of a DC motor, you can use the PWM (Pulse Width Modulation) method, while to regulate the direction of rotation, you can use an H-bridge circuit consisting of 4 transistors. (Complete, 2023).

d. Tool Circuit Schematic

In this section, the author creates a wiring diagram for the system design that will be created according to the Tools. Here is the wiring diagram

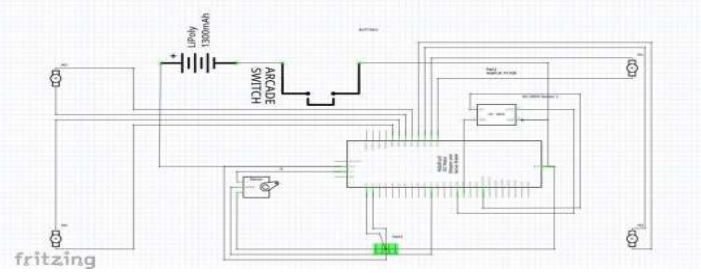

Figure 2. Tool Circuit Schematic

This design is a floor vacuum cleaner robot based on Arduino uno R3 with an android-based smartphone controller. This tool uses Arduino Uno R3 with an Atmega328 microcontroller as a data processing center. to control the robot's motion, the HC-06 Bluetooth module must be connected via a Bluetooth wireless connection on the smartphone, and is equipped with an L293D motor driver as a supporter of the DC motor motion system. To activate the system, connect the board to an external power supply of 6 to 20 Volts. If supplied with less than 6V, the board's performance will be affected. Arduino Uno becomes unstable. However, if the LED on the PCB circuit is dead, then check the voltage on the power supply. To simulate the tool, the initial condition of android sends a signal to Bluetooth processed by the microcontroller and will send to the motor driver to control the movement of the DC motor. To simulate ON/OFF can press the switch button.

3.3. How the Tool Works

a. Power Supply

In the power supply circuit, a 9Volt battery voltage is given with a DC power supply. For the battery adapter, it can be inserted into the Ground (GND) header or pin head and the pins of the power supply connector. The Arduino board can work by getting an external voltage supply of 6-20 volts. If the input voltage received by the Arduino is less than 5V, it can cause the input voltage to the Arduino Board to be unstable. VIN Input voltage to the Arduino when the board uses an external power supply source such as 5 Volts from a USB connection or other power supply sources. Can provide voltage through a pin or provide voltage through a power plug and access through this VIN

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pin. The 5 Volt output pin is a 5 Volt voltage that has been regulated by the regulator on the Arduino board. The board can be activated with a power supply from a DC power plug (7-12V), USB Connector (5V), or the VIN pin of the board (7-12).

b. Vacuum Fan

Vacuum Cleaneror better known as a vacuumcleaner functions as a dust cleaner on the floor and dusty carpets are always a major problem in the house. How the vacuum cleaner works is by utilizing air pressure, or where the air will flow at higher air pressure to lower air pressure. The air pressure in the vacuum is supported by a fan, so that the dust will be sucked by the vacuum cleaner through the pipe and into the filter or dust storage box.

c. Ultrasonic Sensor

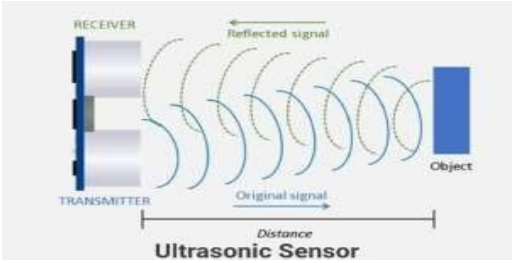

Figure 3 Ultrasonic Sensor

Ultrasonic Sensoris a sensor that functions to change physical quantities in the form of ultrasonic wave sounds into electrical quantities and vice versa. Ultrasonic sensors work based on the principle of ultrasonic wave reflection, where this sensor produces ultrasonic waves and then recaptures them with a time difference as the basis for sensing. The time difference emitted and received back is a direct comparison with the object's reflection distance.

d. Flowchart Diagram

This program flowchart explains the process of running the system using a robot car, a floor dust cleaning tool based on Arduino Uno R3, controlled using an Android smartphone as shown in the image below:

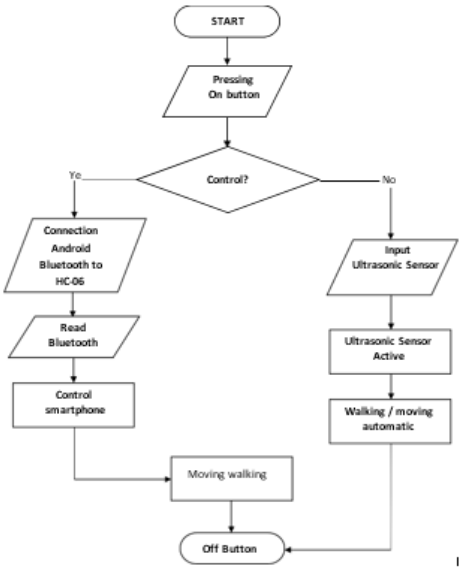

Figure 4. Flowchart Diagram

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e. Input Experiment Results

In the test results, the input from the Ultrasonic Sensor works well, the sensor system can detect avoiding objects in front. The Push Button or switch has no problem when turned on. And the Bluetooth module can be connected to the smartphone.

f. Output Experiment Results

The output test results on the tool were successful, the output system on the tool uses 4 DC motors controlled by the L293D Motor driver can move in the direction desired by the user. The fan works as a vacuum cleaner for the floor and works well. And the on/ off switch successfully provides a source of electricity.

g. Overall Experiment Results

After going through the stages of designing the tool which includes mechanical design and programming, the Arduino Uno R3-Based Floor Vacuum Cleaner Robot Car Design with Android-Based Smartphone Controller was formed. The following is a picture of the robot design below.

Figure 5. Robot Designer Results

This robot is a type of wheeled robot that has front and rear wheels with an L293D motor driver controller and an ultrasonic sensor on the top that functions to detect distance. Overall testing to find out the robot can do its job as expected. This floor vacuum cleaner robot can clean the floor with a vacuum fan located at the top towards the bottom. This robot can move using a smartphone controller or with automatic commands on the ultrasonic sensor.

Table 1. Testing Scenario for Using a Vacuum Cleaner Robot

No	Test Scenario	Expected results	Test Results
1	Press the On/Off Switch	If the robot is turned on press On, if press Off the robot is turned off	As Expected
2	Open the Bluetooth Car Controller Apk	Bluetooth Module On, HC-06 Bluetooth connection Apk is connected to each other	
3	HC-SR04 Sensor Program Input	Automatically runs, if there is an obstacle it will avoid it	

Table 2. Distance and Power Detection Testing on Vacuum Cleaner Robot

No	Component Testing	Test Result Description
1	Sensor	The distance between the sensor and the obstacle object is 12cm
2	9Volt Battery	Power usage limit -+ 1 hour
3	Battery Charger	Charging / power -+ 2 hours

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4. CONCLUSION

The built Robot Vacuum Cleaner Car can be controlled by the user with a Smartphone controller via a Bluetooth connection with a fairly good motion response. The Robot Vacuum Cleaner Car that was built can move / run automatically in suction using an Ultrasonic Sensor. Based on the results of the design test, it is known that when detecting obstacles, the robot will avoid obstacles that are about 12cm in front, then the robot will stop for a moment and turn right / left to find a wider path that is free of obstacles and will move straight. The vacuum / suction function can function properly but can only suck up fine dust. The weakness of this robot is in the level of cleaning which is less effective, because the suction power of the vacuum is not strong enough so that only fine dust can be produced.

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