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Control of Wheeled Robots with Bluetooth-Based Smartphones

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Abstract: ***Wheeled robot is a robot that can run on a flat surface with the help of wheels as a driving medium. The robot is made using Arduino as a programming brain, where the robot can move forward, backward, turn right, and turn left with a smartphone via Bluetooth module. It is controlled via a smartphone as a remote control and Bluetooth HC-05 as a connecting medium between smartphone and robot. In addition to using the Arduino robot, it uses the L298N motor driver as an output regulator for DC motors. Based on the results of testing on this design, in experiment 1, the speed of robot experiment I is 0.58 m/s for a distance of 3 meters completed in 5.1 seconds, in experiment II, the speed is 0.56 m/s with the same distance and completed in 5.3 seconds, and in experiment III, the speed is speed of 5.4 m/s in 5.5 seconds. The difference in speed and duration between experiments is influenced by factors such as reduced battery voltage, and the process of sending data and pairing can be done as far as 13 meters.***

Index Terms**: Arduino, DC motor, bluetooth, l298n.**

I. INTRODUCTION

The current development is much improved, especially the increase in the field of technology such as communication which has become a daily necessity. Technology that is currently developing, and many users in Indonesia are users of the Android and IOS operating systems which are available on smartphones. Most of the Android operating system users only use for communication tools and play social media and do not maximize the use of the smartphone itself in terms of hardware (software) or software (software). Of the many functions of an Android smartphone, there is one function which can control the robot using a Bluetooth connection found on a smartphone. In this case, the robot used is shaped like a car robot or wheeled robot. Along with the development of the industry, the robots, especially wheeled robots, have been used in several fields, such as industry, health, and research. In the industrial sector, many wheeled robots help moving goods. The use of wheeled robots has dramatically increased industrial profits, both in terms of operations and material. Moreover, also in the world of education, there are many developments to improve the performance of wheeled robots in all areas of life. Remote control has been extensively investigated by previous researchers. Litta conducted research on flexible platforms with wireless interface for remote control of DC motors using Bluetooth [1]. Ebrahim Abidi conducted research on the development of voice control and home security for smart home automation received by android and transmitted using Wi Fi and Bluetooth to control household appliances [2]. Cui designed and implemented a new type of smart automatic parking lock using a STC12C5A60S2 type microcontroller connected to android via Bluetooth [3]. Goyal designed home automation and intelligent light control system using microcontroller. The system used an application installed on an Android to control lights by using Bluetooth communication [4]. Dongmei designed smart home system based on ZigBee and CPS using ZigBee modules and Cyber-physical systems (CPS) [5]. Grace designed wireless sensor-based control system in agriculture. The system was controlled and monitored using a GSM module [6]. Ahmed examined design and implementation of vehicle tracking and theft control systems using a GPS sensor to determine the position of the motor and use GSM to turn on and turn off the motor [7]. Al-Ali examined ZigBee-based irrigation system for home gardens managed by a microcontroller associated with ZigBee [8]. Sunehra examined remote monitoring and control of cellular robot system with capabilities to avoid obstacles controlled remotely using Dual-Tone Multi-Frequency (DTMF) signals [9]. Design of temperature and humidity control system using the Fuzzy Logic based on microcontrollers was examined by Purwanto. The system was completed with temperature and humidity control system using server logic based on Wemos D1 microcontroller as an infrared transmitter to remotely control temperature and mode settings of AC to manage the temperature and humidity of the server room. It was also designed to monitor temperature, humidity and voltage online on a website and provided early warning messages via social media twitter [10]. Khera conducted a research on the development of microcontroller-based digital AC dimmers for light intensity control.

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The system consisted of AC dimmer, Bluetooth, microcontroller, TRIAC, and zero crossing detector. The system was remotely controlled by an Android using Bluetooth communication [11].

Zaman studied a user-friendly and low-cost circuit breaker for home equipments using an Android application to help users save electricity. The system used a Mega Arduino microcontroller, a Bluetooth module, a 4x4 matrix keyboard, methane gas sensors, and an Android cellular application [12]. Choudhury investigated design and implementation of an SMS-based home security system. The system used a microcontroller for system control, GSM technology for communication and SMS for sending emergency messages and GPS locations. This tool consisted of an 8-bit ATmega 16 microcontroller, a GSM SIM900A module and two Android applications. [13].

Bluetooth technology has become an easy and efficient technology for humans by which the technology sends or receives data to be further processed by the device. Currently, the Bluetooth technology has become a useful and widely used data communication technology. Based on the explanation, the researchers designed a wheeled robot controlled by a smartphone using Bluetooth connection. The robot has a wheel drive system on both wheels. Each robot wheel is connected using a DC motor.

II. RESEARCH METHOD

The design of the wheeled robot shown in figure 1 diagram block aims to facilitate the device construction. The design of the robot is divided into two parts, namely hardware design and software design. The application had been made previously. The commands in the application are forward, backward, turn right, turn left and stop. First, the user must connect the Bluetooth on the smartphone using a Bluetooth module. When it is connected, the user uses the GUI (Graphic User Interface) to select the device to be controlled. The data sent from the Bluetooth will be received by the Bluetooth module and processed in the microcontroller. The controlled tool is the DC motors on the robot wheels.

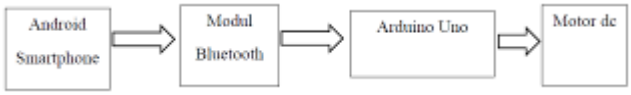

Figure 1. Overall System Modeling

Hardware design

In the robot design, the Arduino Uno microcontroller was used as the robot controller. The L298N Motor Driver was used as the current and voltage amplifier, so the motor gets the appropriate current supply. The HC 05 Bluetooth was used for connections between the robot and the smartphone. A switch was used as the ON/OFF button. Wheels were used to help robots move. Chassis was used to place the components contained in a robot.

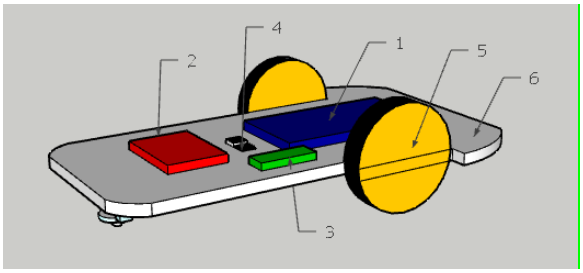

Figure 2. Upper robot design

Figure 3 shows the overall design that aims to determine the position of the robot components using a schematic image to make easier in assembling the robot. The robotic system consists of an Arduino microcontroller [14]–[17], a Bluetooth module, a motor driver, and a DC output.

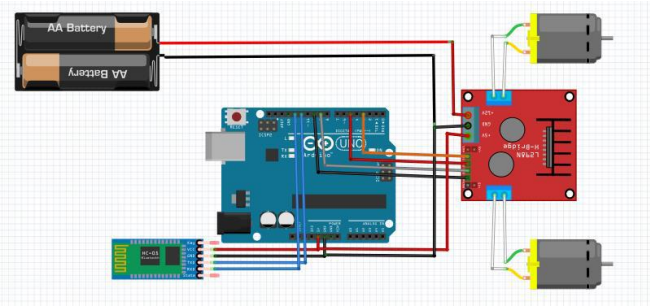

Figure 3. Overall Series

Software design

Figure 4 illustrates the flow chart for sending data on smartphones. After the user presses the desired command, the data is transmitted to the Bluetooth module. After sending the data to the Bluetooth module, the system will see if the data sent to the DC motor is entered. If there is no movement on the DC motor installed on the robot wheel, the program only runs up to the data transmission.

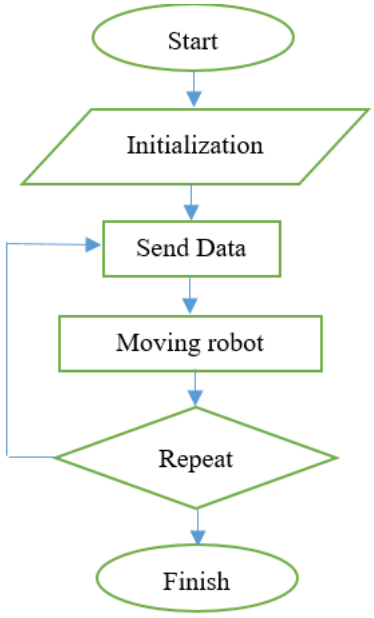

Figure 4. Flow chart for sending data on a smartphone

Flowchart of data reception on Arduino controller is shown in figure 5. First, the Bluetooth module receives the data sent by the smartphone. The microcontroller, as the control, processed the data, and then connected the data directly to the DC motors.

The data received for the first time were checked to see whether the motion control was satisfactory. If there are no data, the microcontroller will examine the Bluetooth module condition. The commands of forward, backward, turn right, turn left, and stop had been integrated with the application in the smartphone. The button 1 moves the robot forward, button 2 moves the robot backward. After the program starts, the Arduino microcontroller checks the device. If it works according to the data sent, the robot works appropriately.

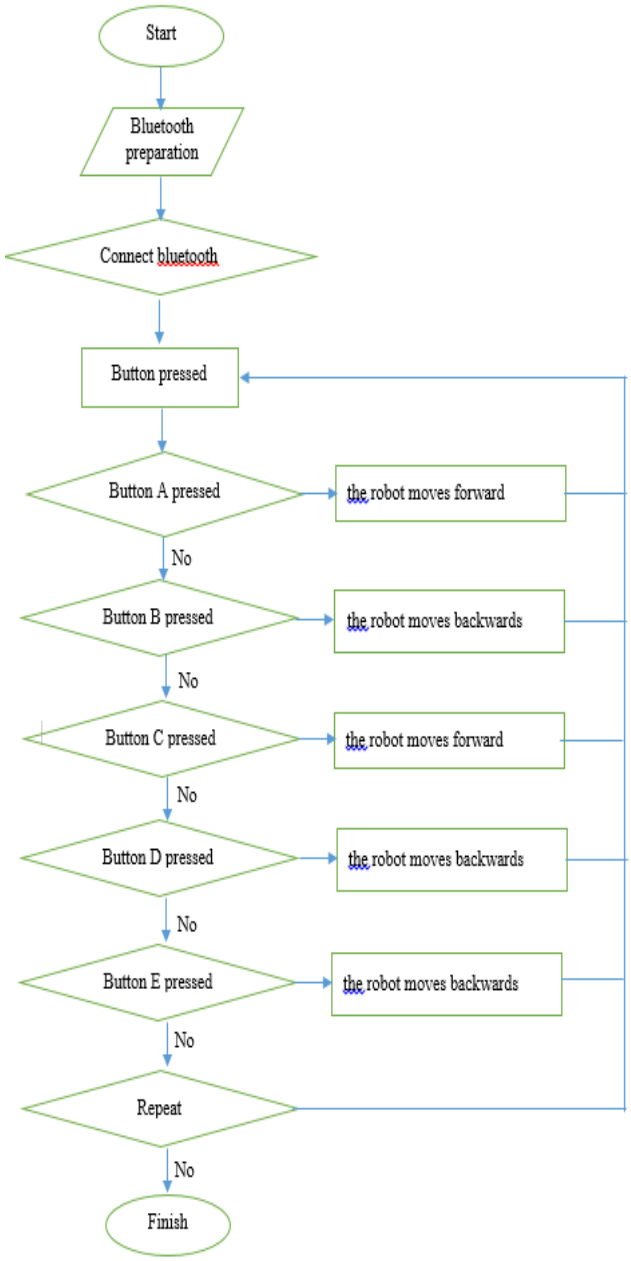

Figure 5. Microcontroller flow chart

Smartphone application interface design

Figure 6 this robot controller application was made with mit-inverter 2, in which the command was made according to the program made previously. The figure shows that seven buttons are used to control the robot using Bluetooth. Five buttons are used to control wheeled robots; forward, backward, left, right, and stop, and two buttons to connect to and disconnect the Android system.

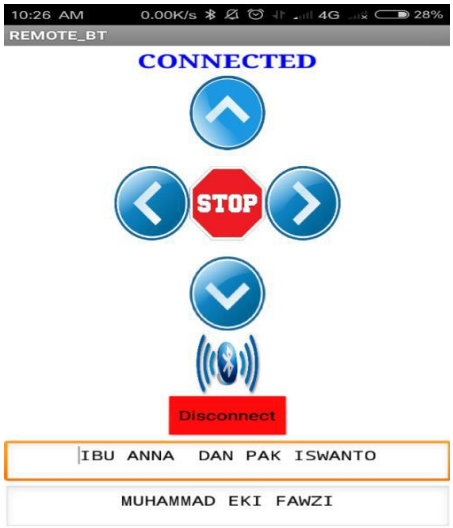

Figure 6. Program interface

III. DISCUSSION

The purpose of testing the circuit is to obtain the data according to the theory stated earlier. It also aimed to see whether the circuit is satisfactory or not. Repeated experiments were carried out to get accurate and complete results.

Input Measurement

Table 1 presents input measurement in the motor driver circuit. It was carried out on pins connected to the DC motor using the l298n motor driver. The measurements were made on the output on the DC motor located on the pin in 1, in 2, in 3, and 4. Based on the measurement results of the L298D inputs conducted using a digital voltmeter. The value of the left motor is 3.1V and the right motor is 3.3V. The different voltage on a different DC motor makes the robot run straight not perfectly.

Table 1. Measurement chart of sensor output.

Pin Arduino	Pin L298n	^	v	<	>	O
3	IN1	3.1V	0	3.3V	0	0
5	IN2	0	3.1V	0	0	0
9	IN3	3.3V	0	0	0	0
10	IN4	0	3.3V	0	3.1V	0

Speed Testing

This test aimed to find the speed of a wheeled robot and see the ability of the DC motor. The result of the test showed that it took 5.1 seconds for the robot to run three meters. The speed of the robot on the first experiment was 0.58 m/s, and the speed of the robot was 0.54 m/s at the 2nd experiment. The reduction of the speed could be affected by the battery voltage. On the 3rd experiment, the battery started to weaken.

Testing of Connection and Delivery Range

This test aimed to determine the distance range of the HC-05 Bluetooth module to a smartphone. First test was to determine the range of the pairing to find out how far the Bluetooth connection can do pairing, and the second test was to find out the extent of the process of sending data. Based on the test results, the pairing process could be carried out as far as 13 meters. If the pairing process is successful, the data will be sent.

If the pairing process fails, the data transmission will not work. The test to get the maximum distance so that the data could be sent successfully was performed by sending the data in the smartphone by pressing the buttons such as forward or backward. The maximum distance obtained was13 meters. Overall Working Principle Start the application and pair with the Bluetooth, when they are connected each other, the smartphone controls the robot's movement. The five movement directions are forward, backward, turn left, turn right, and stop. After the application is active and has been connected to the robot, the communication between the smartphone and the robot starts. It is because the program on the Arduino microcontroller give commands that have been synchronized with the commands in the application. The Bluetooth on the robot functions to capture the signal emitted by the Bluetooth smartphone. When it is connected, the signal is received by the Arduino microcontroller through the ports connected to the motor driver. The right DC motor stops and the left motor moves to turn left, and vice versa.

IV. CONCLUSION

The research process has succeeded in creating a system as a tool for sending and receiving data to control the motion of the robot wheels using Bluetooth. The tests were carried out to see the robot's speed. The test result showed that the speed of the robot is average 0.56 m/s in 3 meters, depending on the battery voltage conditions. The pairing can reach 13 meters and the process of sending the data is thriving.

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Iswanto was born in Sleman, Yogyakarta, Indonesia, in 1981. He received the B.S degree and M.Eng degree from Universitas Gadjah Mada, Yogyakarta, Indonesia in 2007 and 2009. Now, he is on Phd Program at Universitas Gadjah Mada. He has been a Lecturer and Researcher in the Electrical Engineering Department at Universitas Muhammadiyah Yogyakarta since 2010. His current research is focused on formation control, path planning and Control UAV.