

Design of Bluetooth Wireless Transporter Mecanum Wheeled Robot with Android Smartphone Controller for Moving Item

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Abstract – Technology development are going so fast. One of technology development on purposed reasearch is moving item technology. Moving item can be dangerous works for human. There are some dangerous case of moving item, heavy weight items, hazardous chemical compounds, etc. The purpose of this research is to minimize risk from previous problem. It can reduce work load energy and minimize an accident in terms of moving items for operator, which are often encountered in the industry sector. Proposed research made bluetooth wireless transporter mecanum wheeled robot with android smartphone controller for moving item. Robot was made in prototype scale. Robot size is 28x13x15 cm(s). Robot made based on arduino uno and L293D driver motor shield with android smartphone controller. Using android controller made user easier to use. This robot design equipped with 4 mecanum wheel (4 DC motors), two 1850 batteries, Arduino Uno, L293D driver motor, HC-06 bluetooth module, LCD and two M90s Servos for gripper. Gripper has two motions, shift and lift motions. After several tests, it can conclude that proposed transporter robot can be controlled wireless with bluetooth from 0 to 20 meters. Gripper test result, proposed transporter robot can shift item up to 350 grams weight load and lift an item up to 200 grams. Robot can operate up to 128 minutes with full capacity batteries. From several tests, main purpose of this robot can be achieved. It is to moving an item to another place. Purposed robot can be implemented in industry sector with specification adjustment, but if weight load and dimensions match with this research, then proposed robot can be used properly.

Keywords: *Android, Bluetooth, L293D, Mecanum Wheel, Transporter Robot.*

I. INTRODUCTION

Technology development are going so fast. Society 5.0 era had began [1]. Indonesia needs technology improvement in any sectors. Nowadays, it is impossible not to use technology. There are many benefits that can be utilized by technology. It helps and facilitates human works [2]. Technology makes work so much easier. One of technology development on proposed research is moving item technology.

Moving item technology is implemented in many sectors, such as logistic [3], distributed in industrial area [4],[5], etc. Moving item with human, needs more power, especially for heavy weight item [5]. One of technology

that can move item is crane. Crane needs operator to operate, at least no human power is needed to move the item. Proposed research still needs operator, but operator can operate remotely. It eliminates risk, It is very dangerous when a lifted item falls down to crane and there are operators inside the crane. From previous problem, proposed research is using bluetooth wireless connection to operate the robot. Another case, it can be more dangerous when human have to distribute hazardous chemical compounds [6]. Many employees are not careful in moving high-risk items, it might cause work accidents such as poisoned hands cause from chemical compounds [6]. Something can replace human to do dangerous work is robot [7][8][9]. From previous statement, proposed research was made. This research was conducted in order to reduce work load energy and minimize an accident in terms of moving items which are often encountered in the industry. Proposed research made a robot that can be controlled using bluetooth wireless by smartphone. Proposed research's scale is prototype, but it can be implemented to real scale with few components adjustment.

On previous research [10], it made bluetooth wireless transporter robot with joystick controller. It was made based on arduino and L298N driver motor. It has 4 wheels, gripper, force sensitive resistor (FSR) sensor, cause it can be controlled by joystick, it has RX joystick to communicate with the robot. In [10], robot gripper grab items received input from FSR sensor. FSR sensor is used for strength or pressure analysis and these sensors have a value that varies according to the applied pressure. The FSR sensor is used to capture the incoming pressure [11],[10]. Transporter robot can be controlled remotely using a wireless joystick, the speed of moving the robot forward, backward, turn left and turn right can be controlled with five variations of speed set on the joystick, the gripper on the transporter robot will stop clamping if the resistance value on the existing FSR sensor on the jaw gripper reaches the pressure value set by the program. The farthest control distance on [10] is 17 meters.

From previous research [10], proposed research made bluetooth wireless transporter mecanum wheeled robot with android smartphone controller. Robot was made based on arduino uno and L293D driver motor with android smartphone controller. Using android controller

makes user easier to use. From statistic, android has most active users in the world [12][13]. This robot can easily be paired to another android device because it works with bluetooth connection. This robot design is equipped with 4 mecanum wheels (4 DC motors), two 1850 batteries, Arduino Uno, L293D driver motor, HC-06 bluetooth module, LCD and two M90s Servos for gripper. Gripper has two motions. Mecanum wheel is chosen because it has very adaptive movement [14].

II. METHODOLOGY

A. Block Diagram

How Bluetooth Wireless Transporter Mecanum Wheeled Robot with Android Smartphone Controller, is explained in Figure 1.

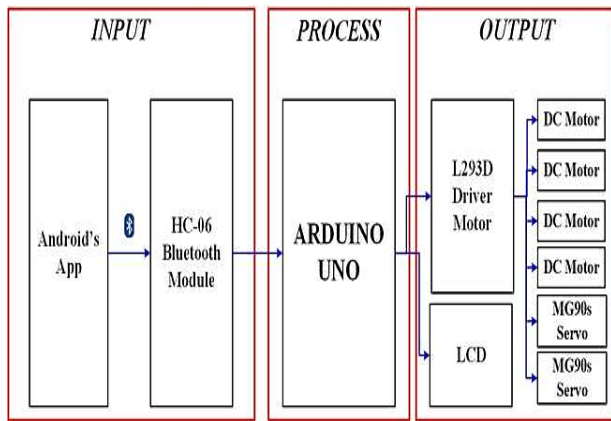


Figure 1. Block diagram of robot

Figure 2 used to describe the work system of robot: input unit, processing unit, and output unit. Input unit uses an Android smartphone connected to HC-06 bluetooth module through bluetooth connection. "Bluetooth RC Car" app can be downloaded via Google Playstore. The process unit uses Arduino Uno as the processing unit. Output unit contains LCD and L293D driver motor for 4 DC motors used as 4 mecanum wheels and 2 M90S servo motors used for gripper with grabbing items and moving up motions.

B. Flowchart system

Flowchart is visual diagrams that outline the separate steps of a process in sequential order. Figure 2 is flowchart system for purposed research.

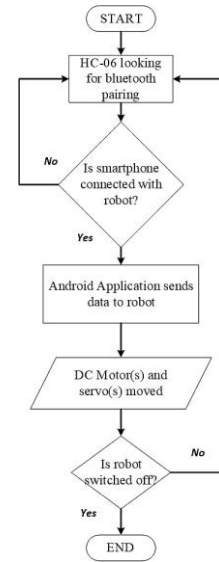
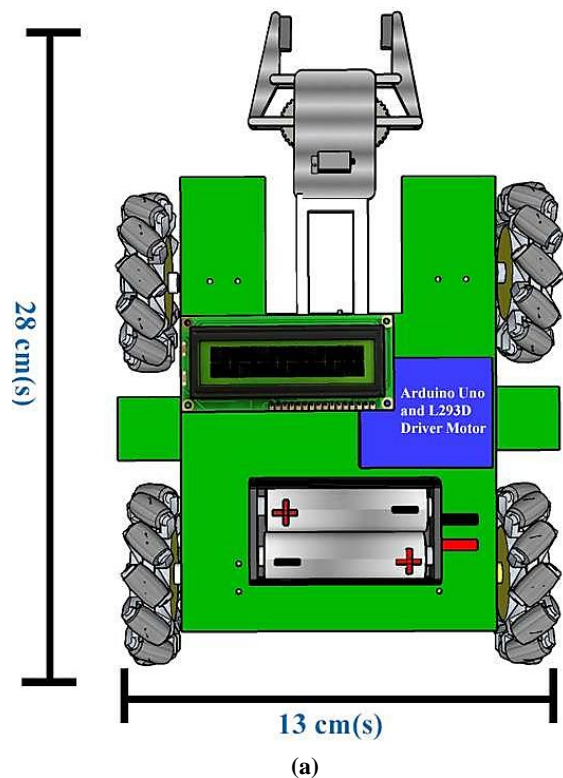


Figure 2. Flowchart of robot system

Flowchart system starts with robot being turned on using a switch, when the robot is turned on, the HC-06 bluetooth module sends out bluetooth signal. Next, the android smartphone is connected to the HC-06 bluetooth module, after bluetooth signal is connected, when application button is pressed, it will send commands to the DC motor(s) and servo (s), so that the robot can be moved. Next step when the robot is turned off, the robot system stops, and when the robot is not turned off then the system will repeat continuously.

C. Robot Design

Design of purposed research shown in Figure 3.



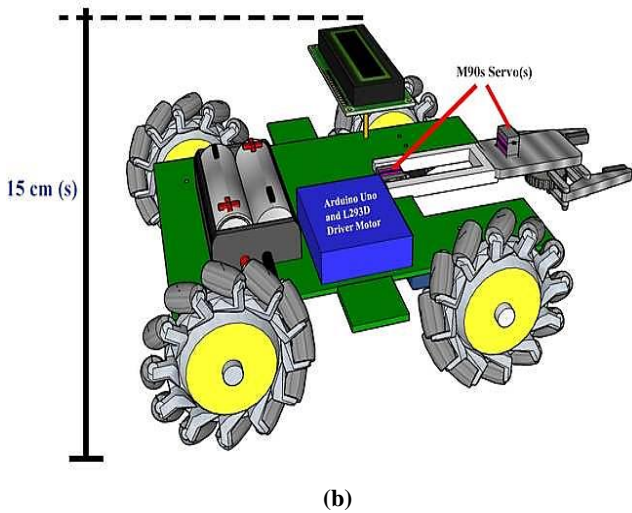


Figure 3. Robot design (a) Above Angle (b) Side Angle.

Figure 3(a) shows robot design from above angle, and 3(b) shows robot design from side angle. Robot design size is 28 x 13 x 15 cm(s) (length x width x height). Robot base is made from 3mm acrylic. Robot moves with 4 motor DC paired with 4 mecanum wheels. Mecanum wheel has specific set up to move smoothly, it is set up for purposed robot bas eon [15]. One of benefits of mecanum wheel is when robot make a turn, it is no needs to make a forward then make a turn. Mecanum wheel can move right or left directly [14]. Gripper is using 2 M90s Servo(s) for two motions (shift and lift motion). Lift motion is for moving item to higher place. Robot powered with two 18650 battery (around 7.2-9 Volts). Blue box in Figure 3 is Arduino and L293D driver motor position. Arduino and L293D driver motor are paired, L293D driver motor is connected directly into arduino uno. LCD is for showing bluetooth status connected or not.

D. Android Application

Android apps for purposed research is using “Bluetooth RC Car” app, developed by Andi.co. It can downloaded via Google Playstore. It works based on bluetooth connection. Android apps is shown in Figure 4.

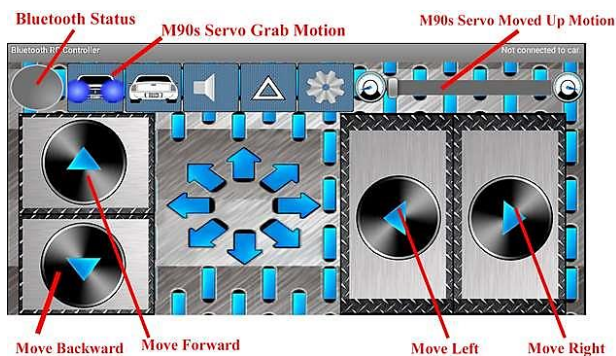


Figure 4. “Bluetooth RC Car” android app based on bluetooth (source: Andi.Co app, downloaded via google playstore and captured in 2023)

Figure 4 shows android app layout and distribution button function for robot. This app send data to HC-06 bluetooth module. Data sent are in alphabetical form (example F for forward, B for Backward, etc.). Beside arrow button, this apps—also contain upper button and slider. Gripper grab motion uses left-upper button and gripper moves up motion using slider.

E. L293D Driver Motor Shield

Purposed robot uses L293D driver motor shield, because it is very compact, because L293 driver motor shield is connected above arduino uno. L293D driver motor shield has provided port for 4 DC motors and 2 servo motors. L293D driver motor shield and arduino are powered by two 18650 batteries. L293D driver motor shield and arduino uno connection is shown in Figure 5.



Figure 5. L293D Driver Motor Shield [16]

F. HC-06 Bluetooth Module

HC-06 Bluetooth module can operate in two modes, there is master or slave. Master is the first device to provide synchronization, and the others are considered recipients only (slave). There are two types of Bluetooth modules, odd and even versions.

The Bluetooth module with odd series (HC-05 or HC-03) is an improved version of the even series (HC-06 or HC-04). The HC-05 module can be set as a master or slave, while the HC-06 can only be used as a slave [17]. Purposed robot uses HC-06 because its only receives data from android. HC-06 and its architectures are shown in Figure 6.

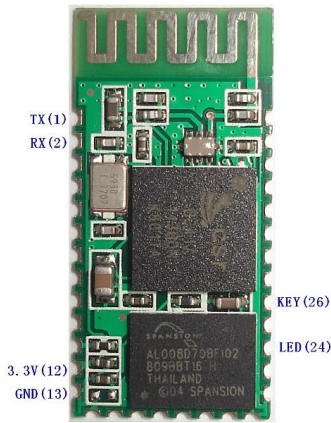


Figure 6. HC-06 Bluetooth Module [18]

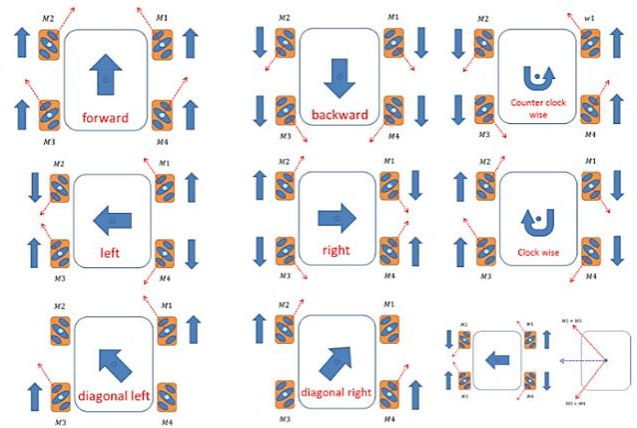


Figure 8. Four Mecanum Wheel Configuration [20] Results and Discussion

G. Mecanum Wheel

Mecanum Wheels were chosen because the movement of the robot is freer than using regular wheels [19] which are often called Differential Wheeled motion. The movement of the robot utilizes the speed of each wheel to be able to move in all directions without having to change its facing direction first. Mecanum wheel has lot of directional operation. Based on [19] Mecanum wheel has very fast dynamic motion for every direction. It can move rapidly and efficiently transfer forward wheel spin into sideways motion. It is suitable for both indoor and outdoor designs. It has long lifespan.

III. RESULTS AND DISCUSSION

Mecanum wheel has specifics configuration to do robot drive. Purposed robot has four mecanum wheels. Every wheel has configuration. The configuration is shown in Figure 7.



Figure 7. Mecanum Wheel [20]

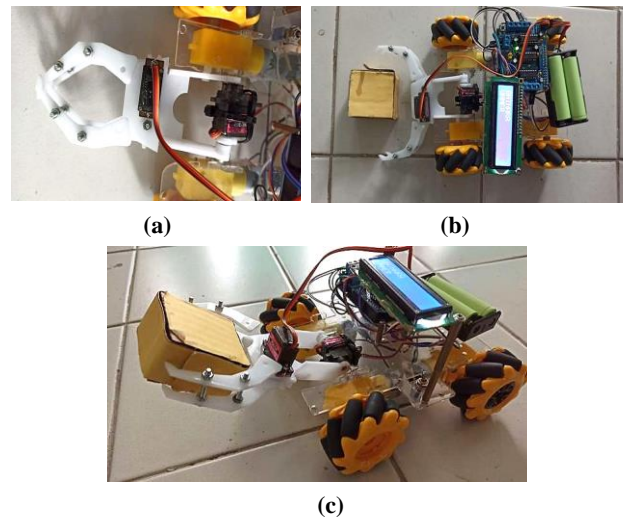


Figure 9. Purposed Robot (a) Gripper (b) Ready to grab (c) Lift motion

Figure 9 shows purposed robot. Fig 9(a) is the gripper, 9(b) robot is ready to grab items and 9(c) robot grabs item and moves up (lift motion). Robot performance depends on bluetooth wireless distance. Robot performance depends on how far the distance between robot and controller which is android smartphone. Table 1 shows robot performance based on bluetooth distance.

Table 1. Robot performance based on Bluetooth Wireless Distance

Distance (meters)	Bluetooth Status	Robot Performance
0-15	Connected	Works Fine
15-17	Connected	1 sec delay
17-19	Connected	2-3 secs delay
19-20	Connected	3-4 secs delay
>20	Disconnected	Not working

Bluetooth have various versions, test scenario is using android 5.0 bluetooth version and HC-06 bluetooth

module in robot. Table 1 shows bluetooth distance test with five various distances from 0 to >20 meters. Robot has no problem at 0 to 15 meters, robot was responsive. Within 15 to 20 meters bluetooth status was still connected, but power signal with farther bluetooth object gave lower signal. Robot delayed at 15-17 meters for 1 second. Bluetooth tests within 17-19 meters show delay around 2-3 secs. At 19-20 meters tests, bluetooth status is still connected but there were around 3 to 4 secs delay. At more than 20 meters test, bluetooth status is disconnected and robot doesnot work anymore, to make robot move again, robot has to be connected with android smartphone again. Robot cannot connect anymore is because bluetooth range are limited, when robot and controller farther pass through bluetooth range, bluetooth will disconnect. Table 1 robot test performance based distance happens at all app button. Figure 10 shows robot test based on distance in accordance with table 1.



Figure 11. Items for robot test

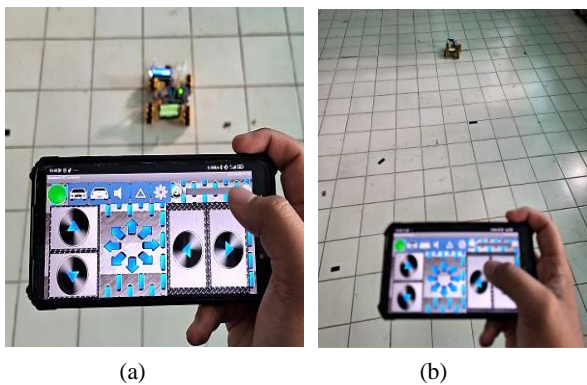


Figure 10. Robot test based on distance (a) 0.5 m Distance (b) 4m Distance

Robot powered with two 18650 batteries, each battery have 3000 mAh (miliampere hour). So, there are 6000 mAh to power robot. Second test is longevity test. Test shown how long robot can operate with one and two 18650 batteries. Test scenario is robot programmed with looping motion and using timer to detect the longevity. longevity test is using two 18650 batteries with full capacity batteries. It can operate smoothly until 114 minutes. In 115th to 127th minutes robot performance shown starts decreased. 115th until 128th minutes robot performance shown starts decreased. Robot movements begin to slow down and finally robot shut down at 128th minutes.

Main purpose of this robot is to move items to another place / position. Gripper is the most important part to moving an item. Gripper has 2 motions. There are grab item then move forward (shift) and move up (lift) motions. In this research, gripper test is using paper shaped into box and filled with some weight loads. It will give gripper performance of this research. Table 2 shows a gripper performance based on item's weight. Gripper test is only uses one type of box dimension (50x50x30 mm) with different weight as shown in Figure 11.

Table 2. Gripper Performance based item's Weight's

Item's Weight (grams)	Grab and Forward (Shift) Motion	Move Up (lift) Motion
20	✓	✓
50	✓	✓
100	✓	✓
200	✓	✓
350	✓	✗
500	✗	✗

Notes: ✓ : Test successful ✗ : Test Failed

Table 2 shows gripper performance based on item's weight. There are 6 weights for gripper test. Around 20 to 200 grams there are no problem for gripper doing the two motions. Around 350 grams, there are problem for lift motion. Gripper is not strong enough to lift the item, but for shift motion there are no problem. Around 500 grams gripper is not strong enough to do any motions. It cannot do any motion because of design of gripper and design of robot cannot provide it. If it made another servos, it can possibly move heavier items.

IV. CONCLUSION

The designed robot has already fulfilled its main purpose. It moves item to other place. After several tests, it can be concluded that purposed transporter robot can be controlled with wireless bluetooth connection. Bluetooth distance test works up to 20 meters, but within 15 to 20 meters there is 1 to 4 seconds delay. Robot can operate up to 128 minutes with full capacity batteries. Purposed robot gripper has two motions. Gripper test result, purposed transporter robot can shift item up to 350 grams weight load and lift an item up to 200 grams. Limitation of this purposed transporter robot is the M90s servos get heat up if robot is switched on for around 15 minutes, otherwise robot didnot do anything. So, purposed transporter robot needs to take a rest for a while after 15 minutes operation. For future work, purposed transporter robot can be upgraded to wifi connection for longer distance range. It can make bigger robot for bigger item to move. Purposed transporter robot is only prototype, for future works it can

be implemented to big scale of real moving items, It can be implemented for industrial sector, especially crane. Crane design is similar to robot. It only add bluetooth or Wi-Fi connection and microcontroller, it can refer to this research. If there are industrial sector using weight load and dimensions match with this research, then purposed robot can be used properly.

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