Vol. 5, No. 1, October 2024, page 177-186
JTTM: Jurnal Terapan Teknik Mesin
p ISSN 2721-5377| e ISSN 2721-7825
http://jurnal.sttmcileungsi.ac.id/index.php/jttm

# Design player robot badminton-based microcontroller

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Submitted: 03/01/2024 Revised: 28/01/2024 Accepted: 11/02/2024

**Abstract:** Robots are one of the technologies that is currently advancing quickly. Generally speaking, a robot's movement is similar to that of an automobile; it can only move forward, backward, left, and right. Because the movement is controlled by these movements, it is thought that the robot's movement is extremely restricted to the left and right directions. solely with the front wheels. As a result, a robot was developed in this study that can control sliding motions to the left and right utilizing omniwheels on its front and back wheels. Badminton is a sport involving rackets that is played by two people or two opposing pairs. Robotic badminton players are employed as a substitute for human trainers in the training process, particularly for service and drive motions. With the use of a wireless joystick, the robot's ATMega 8535 microprocessor controls both the robot's direction of motion and the movement of its racket. Using a double acting pneumatic cylinder that requires 7 bar of air pressure, the robot service arm uses the compressor's air pressure. The average time it takes for the racket to strike the ball at 7 bar of wind pressure is 00:5.2 seconds. The time it takes for the ball to fall onto the racket in the absence of wind pressure is 00:28 seconds on average. A difference value of 00:22.7 seconds is acquired, and this value will be utilized as the programming reference delay. The robot encounters a slope with an average angle change of 7º when moving forward, an average angle change of 10º when moving backward, an average angle change of 5.2º when moving right, and an average angle change of 3º when moving left. The uneven field surface causes the robot to move at a slope, which modifies the speed of the motor on the wheels.

**Keywords:** ATMega8535; joystick; pneumatic; DC motor; badminton robot

## 1. INTRODUCTION

Robots are one area of technology that is currently advancing quickly [1], which many groups are calling for more and more [2]. Generally speaking, whether a robot has four wheels or just two, its movement systems, like those of a car, can only go forward, backward, left, and right (not including free wheels) [3]. This kind of robot has very limited movement because it can only move in a left-to-right orientation using its front wheels. As a result, numerous researchers continue to develop robot movement [4]. This is done to enable the robot to move with greater accuracy and precision. In addition, robots should be able to rotate 360 degrees, perform diagonal motions, and other similar tasks [1].

Badminton is a racquet sport in which two players compete against one another in either singles or doubles competition [5]. The goal of badminton, like tennis, is to hit the shuttlecock (game ball) over the net and land it in the opponent's assigned playing field while trying to stop the other player from doing the same [6].

Playing badminton requires players to engage in a variety of physical and mental workouts [7]. A ball machine was used to build a tool since badminton players need to practice a lot [8]. The player only needs to execute a serve movement (throw the ball back to the opponent) after it is thrown. But since the machine ball can only do repetitive motions, someone came up with the brilliant idea of creating a badminton player robot that can coach players alongside human instructors, particularly when it comes to service and drive actions [6]. It is anticipated that this badminton player robot would be able to assist badminton players in their practice even in the absence of a dependable opponent [9].

A joystick will be used to control the movement of the robot badminton player [10]. There will be buttons for left, right, forward, and backward on the joystick. Other than that, the robot is equipped with omniwheel wheels. The robot will find it easier to walk on omniwheel wheels since they feature a mechanical mechanism that enables rotation without requiring the robot to adjust its body position [2].

## 2. METHOD

The design and manufacturing of a badminton-playing robot based on the ATMega 8535 microcontroller was done in stages for this study [8]. For the purpose of gathering the required data, this research started with a review of the literature on current, comparable robots. Next, move on to system design and the mechanical and electronic components of prototyping a robot. To assess the robot's performance and make sure it can operate as intended, test results are gathered from each test [11].

A block diagram and flowchart are made during the system design process to determine how the robot functions overall. Figure 1 shows the block diagram of a robot badminton player that uses the ATMega 8535 microcontroller.

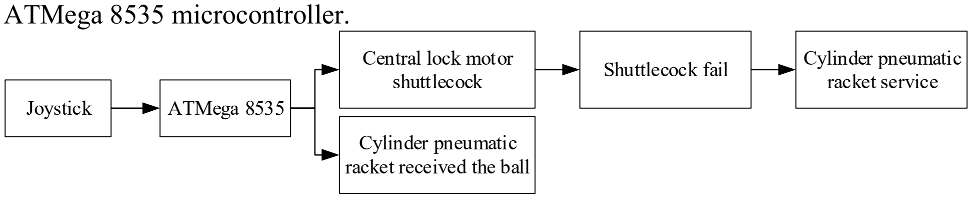



Figure 1. Block diagram

A block diagram of the robot's design is shown in Figure 1, which illustrates how commands controlled by the joystick work by sending a signal to the ATMega 8535 microcontroller, which then selects the required command [4]. The command to strike the service racket is the first of two regulated command selections. The shuttlecock ball will fall toward the racket and be struck by the service racket once the microcontroller receives a signal from the joystick. The microcontroller then activates the central lock motor, opening the shuttlecock lock. Hitting the racket to catch the ball is the second command. When the robot gets the ball from the adversary, it obeys this command. This command will be used to respond to the ball once the joystick and microcontroller have given an activation signal.

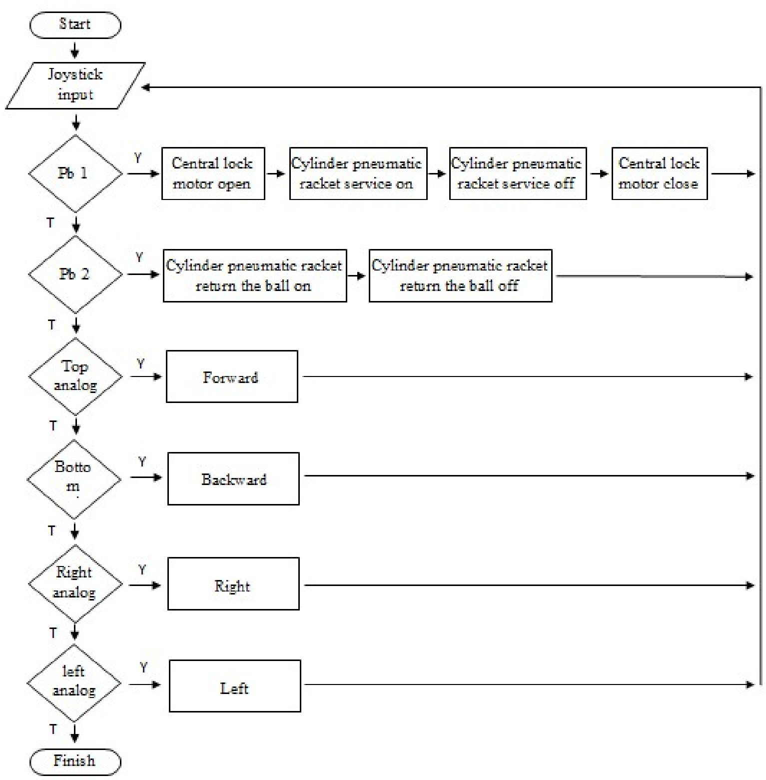



Figure 2. Flowchart

In order to provide an explanation of the software system for this robot badminton player, a flowchart was designed. In Figure 2, the intended flowchart is displayed.

This robot is equipped with an ATMega 8535 microcontroller, which is controlled by a joystick. There are many buttons on the joystick, including pushbuttons and analog buttons. Pushbuttons 1 and 2 work as a racket driver with the help of a pneumatic cylinder [12]. You can use the analog button to move the robot left, right, forward, and backward.

Mechanical design is done to ensure that the robot can function mechanically in 3D, 2D, and motion simulation, as well as to reduce errors in the usage of materials and tools [13]. Figure 3 shows the badminton player robot's mechanical layout.

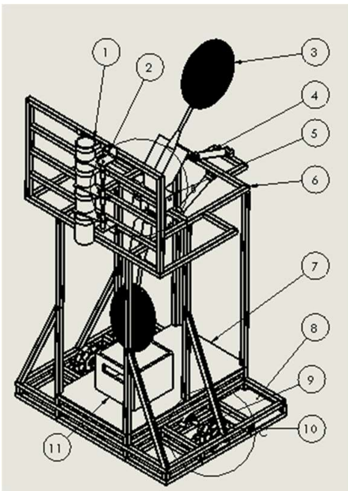



Figure 3. An ATMega 8535 microcontroller-based badminton player robot design

Information:

1. Shuttlecock housing/lock
2. Shuttlecock bracket
3. Racket
4. Cylinder
5. Racket position
6. Frame
7. Component box base
8. Base battery
9. DC motors
10. Omniwheel
11. Component box

This robot's frame is made of hollow type aluminum, which makes it lighter and reduces the amount of motor torque needed to move the robot [14]. The robot employs an omniwheel wheel that is powered by a DC motor to move. The pnuematic cylinder serves as the racket driver, while the central lock motor locks the shuttlecock.

A DC motor driver serves as the robot driver and a solenoid valve driver serves as the pneumatic cylinder driver in the ATMega 8535 microcontroller-based electronic design of the badminton player robot. The DC motor's rotation direction is controlled by the motor driver circuit [8]. The rotation can be changed by the driver in either a clockwise or counterclockwise direction. Figure 4 shows an illustration of the motor circuit.

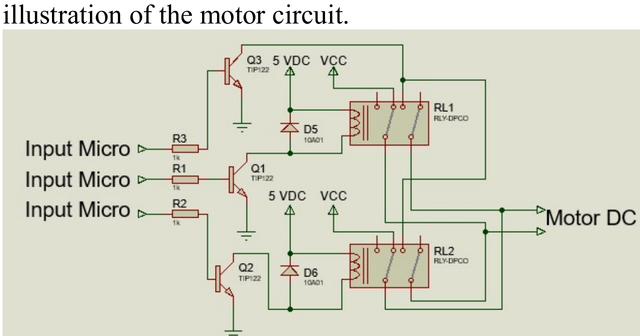



Figure 4. Motor driver circuit

Figure 4 illustrates that the motor driver consists of two signals: signal 1 and signal 2. Relay contact 1, which was originally in the NO (Normaly Open) state, changes to the NC (Normaly Close) state when signal 1 and signal 2 are sent from the microcontroller, and the motor rotates in a clockwise direction. Relay contact 2, which was originally in the NO state, changes to the NC state if signal 2 is high and signal 1 is low, at which point the motor will revolve counterclockwise [15].

The circuit known as the solenoid valve driver circuit serves as a conduit between the microcontroller port and the solenoid valve, which controls the cylinder's movement [16]. Figure 5 shows an illustration of the driving circuit.

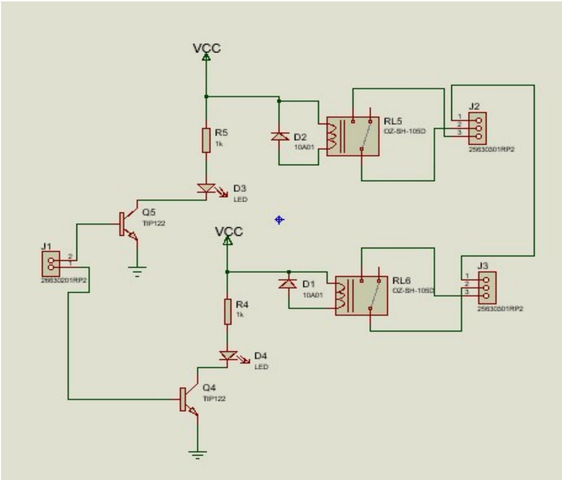



Figure 5. Solenoid valve driver circuit

Double acting cylinders, which may regulate forward and reverse movement depending on the procedure we desire, are the type of cylinder that is employed [14]. Two microcontroller input ports are present in the driver circuit; port 1 is used to activate the cylinder's forward motion, and port 2 is used to regulate its backward motion.

## 3. RESULTS AND DISCUSSION

Here is a finished prototype of a robot that can play badminton and is based on the ATMega 8535 microcontroller, after multiple design stages. The robot is shown in isometric view in Figure 6, in front view in Figure 7, and in side view in Figure 8.

Figure 6. Isometric view of the robot

Figure 7. Isometric view of the robot

Figure 8. Side view of the robot

A number of testing procedures were used to ascertain the degree of success of this robot in order to ascertain the outcomes of building a badminton playing robot that generates racket strokes and moves as intended. The robot tests included the following:

3.1 Service program delay testing

To ascertain whether the robot is successful in performing services, a number of tests are conducted prior to doing service testing. Data collection for the first test involved timing when the ball hit the racket, and the second involved timing the racket's movement when it struck the ball [6].

3.1.1 Testing the ball falls into the serving racket

The first test will calculate the ball's descent time onto the racket. To conduct this test, push the joystick button and use a timer to measure the passing of time. Figure 9 illustrates the testing procedure.

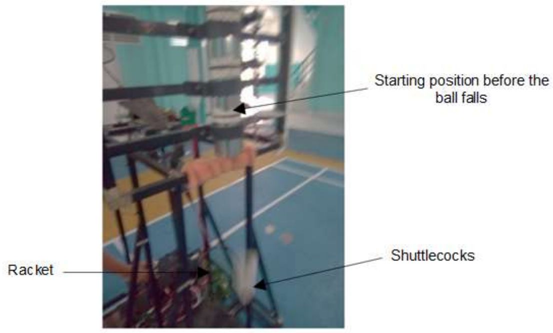



Figure 9. Testing the length of time for the shuttlecock falls onto the service racket

The purpose of this test is to determine how long the service program will last or how long it will be delayed. Following the ball's duration of fall test, the following data are acquired and are shown in Table 1.

Table 1. Measuring the duration of the shuttlecock's descent

| th test | Length of Time(s) |
|---|---|
| 1 | 00:27 |
| 2 | 00:31 |
| 3 | 00:23 |
| 4 | 00:35 |
| 5 | 00:25 |
| Average | 00:28 |

Table 1 shows that the average time for the ball to land on the serving racket during the five tests was 0.28 seconds. This average value will serve as a guide to determine the difference value for the program that will be implemented later on regarding service delays.

3.1.2 Test the length of time the racket takes when it hits the ball

Calculating the moment the racket strikes the ball is the next exam. This test is run by first activating the pneumatic cylinder with a joystick and then timing the duration with a timer. The exam is displayed in Figure 10.

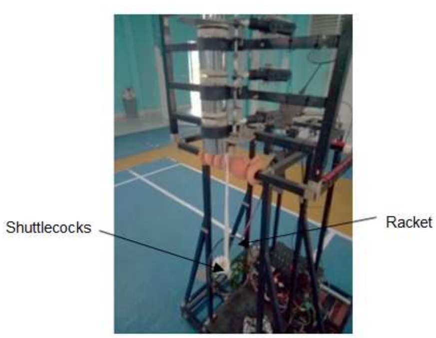



Figure 10. Testing the length of time for the racket hits the ball

Five separate wind pressures were used to conduct this test: seven, six, five, four, and three bars. Table 2 displays the test results.

Table 2. Testing the length of time the racket hits the ball

| Test | Wind pressure | | | | |
|---|---|---|---|---|---|
| | 7 bar | 6 bar | 5 bar | 4 bar | 3 bar |
| 1 | 00:05 s | 00:08 s | 00:09 s | 00:10 s | 00:15 s |
| 2 | 00:04 s | 00:06 s | 00:08 s | 00:13 s | 00:12 s |
| 3 | 00:05 s | 00:08 s | 00:10 s | 00:10 s | 00:13 s |
| 4 | 00:06 s | 00:09 s | 00:09 s | 00:12 s | 00:15 s |
| 5 | 00:06 s | 00:07 s | 00:10 s | 00:11 s | 00:11 s |
| Average | 00:5.2 s | 00:7.6 s | 00:9.2 s | 00:11.2 s | 00:13.2 s |

When the cylinder is activated by the joystick, data is gathered to determine how long the racket strikes the ball. Five trials at a pressure of seven bar were conducted, yielding an average time of 00:5.2 s. Five trials at a pressure of six bar were conducted, yielding an average time of 00:7.6 s. Five trials at a pressure of five bar were conducted, yielding an average time of 00:9.2 s. Five trials at a pressure of four bars were conducted, and an average time of 00:11.2 s was found. Five trials at a pressure of three bars were conducted, and an average time of 00:13.2s was found. The results show that the average time value obtained decreases with increasing wind pressure and increases with the consequent beating force.

Data is obtained from the average time the ball falls, which is 00:28 seconds, and the average time it takes the racket to hit the ball at a wind pressure of 7 bar, which is 00:5.2 seconds. The difference between these two values is 00:22.7 seconds. This is after data is obtained on the length of time the ball falls to the racket and the length of time the racket swings when it hits the ball. The service delay program for this robot will be updated using the known difference value as a reference value.

3.2 Service testing

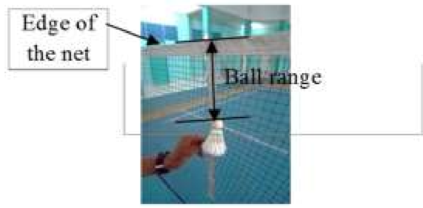
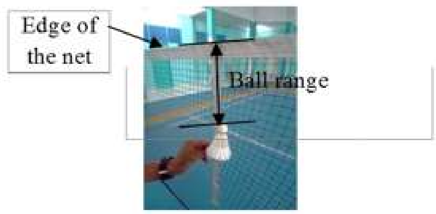
The robot is positioned in the front position of the court, 185 cm from the net, to perform robot service testing. The robot will use the compressor's 7 bar of air pressure to accomplish tasks when the joystick button is pressed. Figure 11 shows robot testing.

Figure 11. Robot position when performing service

Three runs of this test were conducted with varying programming delays but a constant 7 bar of wind pressure. Table 3 displays the results of the service tes.

The results of the robot service test are displayed in Table 3, where two out of the three samples that were tested were unable to cross the network. In the first effort, the ball could only reach a height of 45 cm from the net's edge. In the second attempt, it was only able to reach a height of 20 cm. Using a 180-meter delay program, the ball was able to pass through the net on the third attempt.

Table 3. Service test results

| Preasure | Testing | Program delay (ms) | Result | Information |
|---|---|---|---|---|
| 7 bar | 1 | 220 |   | 45 cm |
| | 2 | 270 |   | 20 cm |
| | 3 | 180 | √ | *Over The Net* |

3.3 Robot movement testing

The purpose of this test was to find out how much the robot tilted while it moved forward, backward, left, and right [17]. This is how the test image looks Figure 12, Figure 13, Figure 14, Figure 15:

Figure 12. Robot forward testing

Figure 13. Robot backward testing

Figure 14. Left shift test

Figure 15. Right shift testing

Robot forward testing was done by putting the robot in the rear position and measuring the robot's 4.6-meter forward travel distance. The robot was positioned at the front of the badminton court at a distance of 4.6 meters to test its ability to travel backward. Additionally, the controller's distance from the CPU was measured using this test [18]. Testing the robots' movements involved positioning the right sliding robot in the left position of the field at a distance of 5.18 meters, and testing the left sliding robot in the right position of the field at the same distance. Refer to Table 4 to test the robot's forward, backward, slide right, and slide left movements.

Table 4. Robot movement testing

| Test | Angle Change | | | |
|---|---|---|---|---|
| | Test forward motion | Test the reverse motion | Swipe right test | Left swipe test |
| 1 | 4º | 8º | 3º | 3º |
| 2 | 7º | 12º | 2º | 5º |
| 3 | 11º | 6º | 8º | 3º |
| 4 | 6º | 10º | 2º | 7º |
| 5 | 7º | 14º | 11º | 5º |
| Rata-rata | 7º | 10º | 5.2º | 3º |

Based on Table 4, each test was run five times for each movement. The robot tilted seven times on average during the forward movement, ten times on average during the backward movement, five times on average during the right sliding movement, five times on average during the left sliding movement, and five times on average during the right sliding movement. Due to an uneven field, the robot encountered a slant in motion, which made the omniwheel wheel's motor rotation unstable.

3.4 Testing the robot's diagonal movement

The robot is put through a series of tests including diagonal or oblique movement, where it must tilt forward, leftward, rightward, and backward. In order to assess whether the robot was successful in achieving the intended angle of 45 degrees, it was placed in the center of the front of the field. To obtain a forward right oblique movement for the forward right oblique test, combine forward movement with right shear. Combining forward motion with left slide is how the forward left tilt test is conducted. Combining backward motion with right sliding is how the backward right tilt test is conducted. Combining left sliding with backward movement is how the backward left sliding test is administered. Figure 16 displays the robot's starting location.

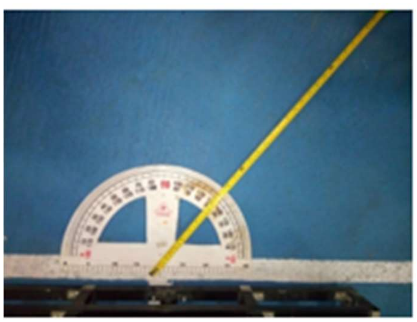


Figure 16. Initial position of robot movement

The test was carried out by experimenting 5 times for each oblique movement tested, the test results can be seen in Table 5.

Table 5. Oblique movement tests

| Test | Slant right forward | Lean left forward | Turn right backwards | Turn left backwards |
|---|---|---|---|---|
| 1 | 35º | 47º | 67º | 60º |
| 2 | 38º | 48º | 60º | 52º |

| Test | Slant right forward | Lean left forward | Turn right backwards | Turn left backwards |
|---|---|---|---|---|
| 3 | 38º | 37º | 57º | 63º |
| 4 | 41º | 42º | 52º | 58º |
| 5 | 36º | 40º | 56º | 52º |
| Average | 37.6º | 42.8º | 58.4º | 57º |

The outcomes of evaluating the robot's movement in forward left, forward right, backward right, and backward left tilts are displayed in Table 5. Because the robot moved farther forward when going at a straight angle in the experiment than when moving obliquely, an average angle of 37.6º was found. The robot's movement is also influenced by the field flatness factor. Because the robot moved erratically in the left-forward oblique movement experiment, an average angle of 42.8º was found. The robot slipped on all four wheels when it moved. The robot was more dominating in moving to the right than to the back, so the angle acquired was broader in the right and backward oblique movement experiment, where an average angle of 58.4º was obtained. An oblique movement to the left and back is the last test. An average angle of 57º is obtained in the backward left oblique movement. This is because the robot moves to the left more frequently than it does to the back, resulting in a larger angle

## 3 CONCLUSION

It is determined that the ball can only cross the net when the robot is in the front position and 185 cm away from the net, following a number of experiments and analyses related to the research on the Design of a Badminton Player Robot Based on the ATMega 8535 Microcontroller. Using a double acting pneumatic cylinder that requires 7 bar of air pressure, the robot service arm uses the compressor's air pressure. The average time it takes for the racket to strike the ball at 7 bar of wind pressure is 00:5.2 seconds. The time it takes for the ball to fall onto the racket in the absence of wind pressure is 00:28 seconds on average. A difference value of 00:22.7 seconds is acquired, and this value will be utilized as the programming reference delay. The robot encounters a slope with an average angle change of 7º when moving forward, an average angle change of 10º when moving backward, an average angle change of 5.2º when moving right, and an average slope when moving left. angle shift of 3º. The uneven field surface causes the robot to move at a slope, which modifies the speed of the motor on the wheels. When the robot was tested for right-sided oblique movement, it showed an average angle change of 37.6o, left-sided oblique movement showed an average angle change of 42.8o, right-sided oblique movement showed an average angle change of 58.4o, and left-sided oblique movement showed an average slope angle of 57º. The uneven surface of the field also affects the average value of the slope of the change in the angle of the oblique motion test, which makes the wheel slip or spin in place because the motor on the wheel is not rotating as optimally.

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