Design of A Wireless Lawn Mower Robot Based On ESP32-cam Using Intranet Network

Sang Wijaya Nyng Setiawan[1], Wiwid Suryono [2] Fiqqih Faizah[3], Lady Silk Moonlight[4], Yesy Diah Rosita[5]
[1]Study Program Of Diploma 3 Airport Electrical Engineering, Aviation Polytechnic Of Surabaya,
Jemur Andayani Street I/73, Surabaya, Indonesia

Article Info

Article history:

Received: Maret,10, 2024
Revised: Maret, 17, 2024
Accepted: Maret: 30, 2024

Keywords:

Lawn Mower Robot
ESP32-CAM
OV2640 camera module
L9110 Motor Fan
Intranet
Arduino IDE

ABSTRACT

The advancement of robotics technology significantly contributes to facilitating human tasks, including the often overlooked task of grass cutting. This research introduces a robot design to assist many, particularly in situations like grass cutting at airports. The implementation system employs the ESP32-CAM wireless controller module within an intranet network, enabling control of the grass cutter through a web browser. It utilizes the OV2640 camera module for visualizing the grass area, ESP32 Wi-Fi module for communication, and the L9110 fan motor for the grass cutter blade. Robot control can be accessed via the IP address provided by the ESP32 module, accessible through a web browser on a laptop or smartphone. This prototype can handle grass with a height of 3-5 cm, provided that the robot and controller are on the same network. Despite testing with a limited operational range using a mobile hotspot, the wireless lawn mower robot can operate for 10 minutes on a full battery charge. However, it's crucial to note that this robot is only suitable for smooth and flat terrain, and cannot overcome obstacles larger or taller than itself. This research aims to promote broader adoption of robotics technology, streamlining various human activities.

Corresponding Author:

Wiwid Suryono
Study Program Of Diploma 3 Airport Electrical Engineering, Aviation Polytechnic of Surabaya,Surabaya, Indonesia
Email: widsuryono@gmail.com

1. INTRODUCTION (10 PT)

Nowadays it is very diverse, especially in helping human activities. Human activities that are very simple and simple but if left unchecked can disrupt other activities, especially in vital objects at airports such as when the plane will taxiing, taking off, or landing that is mowing the grass. If airfield lighting system lights (PAPI, Taxiway Edge Light, Runway Edge Light) obstructed by lush grass that growing around the lights, especially during the rainy season then it will interfere with the the view of the pilot to see the visibility lights.

In addition, limited technicians are also an constraints, so the need for a mower that can be controlled remotely so that technicians can do several jobs at once. Wireless networking is a technology that technology that allows two or more connected devices to communicate with each other without each other without using cables in terms of data transmission. Wireless network uses electromagnetic waves such as microwaves, radio, and infrared to handle data transmission between devices. There are various types of such as WLAN, WMAN, WPAN.Prototype robot with remote control via Wi-Fi using embedded web system and this system can be developed with control via the internet using IC ENC28J60 connected to ATMEGA 32L.[1]

Automatic lawn mower with AT89C51 microcontroller using zigzag motion system with 1800 tilt angle. In the design of this system has two DC motors, namely for grass cutter and for movement the mobility of the design itself. Results the results of the mileage, rotation, and distance settings will be displayed on a seven-segment display and seven-segment BCD decoder. Test results test results in the form of a comparison of distance traveled per keyboard setting keyboard setting, the number of revolutions made per keyboard setting, and the steering angle of the mower.[2]

Based on some of these studies therefore here using the prototype research method because it describes system that has a clear picture that will be developed from previous research previous research. Therefore, in this research This research will build a tool that will be a solution and direction of robot development with the title "DESIGN OF A ROBOT LAWN MOWER ROBOT BASED ESP32-CAM NETWORK USING INTRANET".

2. METHOD

Robot prototype design automatic lawn mower robot is designed with hope that it can be implemented according to its main function, namely in helping human activities in terms of cutting grass. In addition, it is also expected to become a learning module on campus Aviation Polytechnic Surabaya for participants students, in this case cadets, so that they can better understand more about the world of robotics. So that later thisdesign can be developed to be more complex. The research method used is prototype method because the system has concept and a clear picture of the robot that will be developed using esp32-cam.

2.1 Hardware components

1. Battery
   In this design the battery used is a battery with Lithium Polymer (Li-po) with a capacity of 500 mAH which is voltage 7.4 VDC
2. ESP32-CAM
   ESP32-CAM functions as a microcontroller that gives command to Arduino Uno to move the robot and cutting motor and as a means of connecting between the robot and the access point[3].
3. MOTOR FAN MODULE L9110
   For the cutter drive, this tool uses the L9110 module fan motor with a 5V voltage source as the cutter drive. The cutting motor itself is progammed with the Arduino IDE which is connected to the Arduino UNO.[4]
4. DC Motor
   It is a type of electric motor that operates by utilizing a direct current (DC) power supply. The motor is a crucial component in robot parts. Robot drive mower in this research is designed using a 12V DC motor that is connected to a L293d motor driver as a connected to a motor driver L293d as controlling the direction of rotation of the motor[5].
5. DT HiO Battery Shield
   Used as a DC Motor power supply which is used to move the wheels robot which has the main components, namely Lippo battery
6. Arduino Uno
   Used as a microcontroller driving the DC motor of the robot wheel and rotating the Fan motor Program module from the ESP32-Cam as the robot's cutting motor[6].
7. MP1584EN
   Used to lower the voltage battery before supplying the Fan Module motor.

2.2 Software components

1. Arduino IDE
   This design uses an Arduino as the microcontroller. The Arduino must be given a program so that it can run. So in this tool using software arduino IDE software which is used to program arduino from laptop to microcontroller[7].

2.3 Tool Design

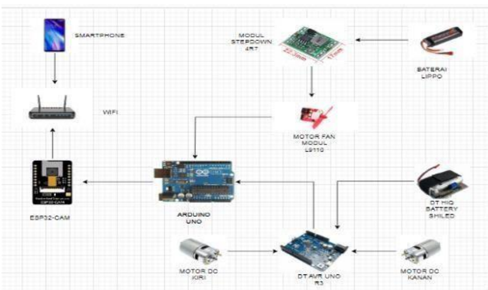

Figure 1. Block Diagram

It can be seen that the tool design is assembled in such a way. For the left and poles are connected to DT AVR Uno R3 as a driver to control the direction of rotation of the DC motor. For the DT HiQ Battery Shield, it is connected to the DT AVR Uno R3 as the power supply. For Fan Motor L9110 module is connected to Arduino Uno as a microcontroller and obtains power supply from the Lippo battery. From the Arduino Uno will send the camera module program to ESP32-Cam. And from ESP32-Cam will be connected to WiFi as well as also with a smartphone that will be used as robot control must also be connected to the the same WiFi server that is connected to the ESP32-Cam.

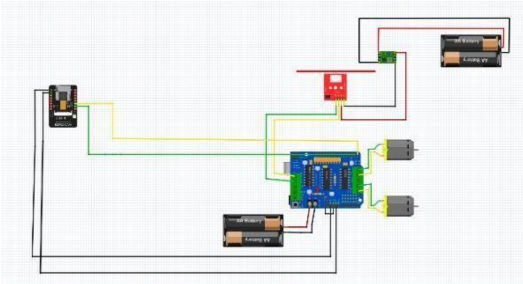

Figure 2. Wiring Diagram

In This figure, you can observe the wiring arrangement depicted using the Fritzing application. This entails the connection of two DC motors to the m3 and m4 pins on the motor shield. Additionally, a 7.4 VDC battery is linked to the VCC and GND pins on the motor shield. The L9110 motor's output is directed towards the m1 pin of the motor shield, while its input is sourced from the output pin of the stepdown module, which receives a voltage from a 7.4 VDC source. Moreover, the rx and tx pins on the ESP32-Cam are affixed to pin 1 and pin 2 on the motor shield. Its power supply is linked to the VCC output pin and GND on the motor shield.

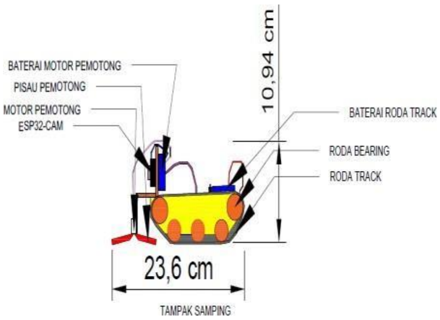

Figure 3. Tool Design Plan

As shown in the figure, the robot's design incorporates a length of approximately 23.6 cm and a height of around 10.94 cm, utilizing a continuous track as its wheel.

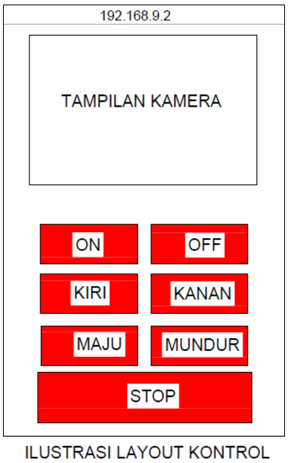

Figure 4. Controll Layout Illustration

As depicted in the above figure, the controller interface comprises an upper screen displaying camera visuals transmitted from the ESP32-Cam, while the lower screen features buttons for operating the robot.

2.4 How the tool works

Begin by preparing the tools required for grass cutting. Next, activate the lawn mower robot, along with the wifi module and camera module. Then, switch on the access point which serves as the link between the robot and the controller. The ESP32 wifi module will connect to this access point, which is linked to the mower robot controller. Once the robot is connected to the access point and both the access point and the control device are connected to the same network, the device can be used to control the robot. If the robot fails to connect to the access point, the controller and camera images will not display on the phone or laptop. The robot will continuously attempt to connect to the hotspot until a successful connection is established. After the device is successfully linked to the robot and ready for control, if the intention is to directly mow the grass, activate the fan motor of the L9110. This motor serves as the mower, allowing the robot to cut the surrounding grass. Without the brushless mower activated, the robot can move but will not be able to cut the grass around it.

3. RESULTS AND DISCUSSION

The instrumental design of this research is a prototype of a lawn mower based wireless robot ESP32 Camusing intranet.

Figure 5. Photo of the whole device

3.1. Overall Test Result Device

1. Results of testing the forward and backward movement of the robot

This test is conducted to determine the performance of the controller as well as to know the distance traveled forward and backward robot and the direction of movement when it is operated for some time. Here's test data:

Table 1. Test Result data of forward and backward robot

Direction intructions	Operating time (second)	Direction	Distance (cm)	Speed (cm/s)
Forward	3	forward	80	26,7
	5	forward	136	27,2
	7	forward	186	26,5
	10	forward	266	26,6
	15	forward	392	26,1
Average Robot Forward Speed				26,62
Backward	3	backward	82	27,3
	5	backward	134	26,8
	7	backward	187	26,7
	10	backward	271	27,1
	15	backward	403	26,8
Average Robot Backward Speed				26,94

Table 1 illustrates that there is not a substantial distinction in the average results of the robot's forward and backward motion tests. Specifically, the average forward speed measures at 26.62 cm/s, while the average backward speed is 29.94 cm/s. This indicates a marginal difference of approximately 0.32 cm between the forward and backward speeds of the robot.

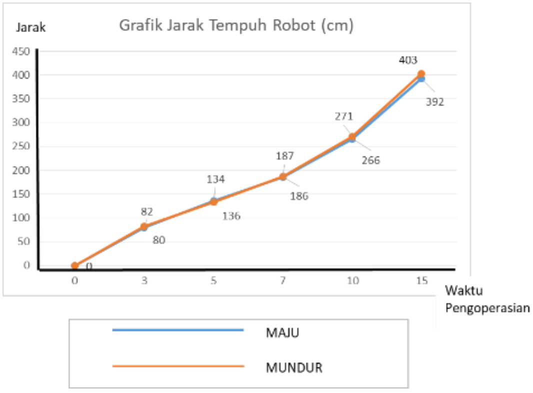

Figure 5. Robot Distance Testing Graph

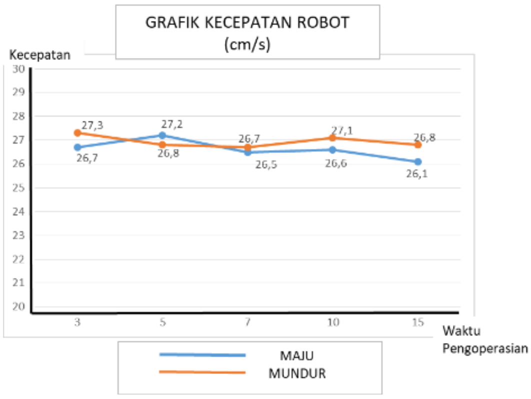

Figure 6. Robot Speed Testing Graph

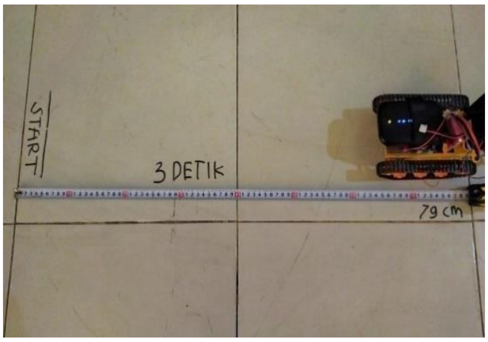

Figure 7. Photos of Testing the Forward and Backward Movement of the Robot

This Figures show graphs illustrating the distance covered and the speed of the robot. Observing the plotted lines, it is evident that there is not a substantial difference between the forward and backward tests. The close alignment of the graph lines serves as evidence of this similarity. This affirms that the robot's speed remains equally stable in both forward and backward movements, accounting for consistent motor specifications and identical PWM input settings. Additionally, both the left and right DC motors share the same specifications. Figure 10 displays a photograph captured during the testing of the equipment.

2. Left and Right movement Testing Results Right

This test is conducted to determine the performance of the controller as well as to know the distance traveled forward and backward robot and the direction of movement when it is operated for some time. Here's test data:

Table 2. Test Result data of left and right Movement Testing
Result Right

Direction intructions	Button Presses	Robot rotation direction angle	Average
Left	1x	31^0	31^0
	3x	93^0	31^0
	5x	155^0	31^0
	7x	217^0	31^0
	10x	310^0	31^0
Backward	1x	35^0	35^0
	3x	105^0	35^0
	5x	175^0	35^0
	7x	245^0	35^0
	10x	350^0	35^0

Based on the data provided, it's evident that the robot's turning radius is consistent, regardless of whether it's turning left or right, with a consistent difference for each button press. The average rotation when turning left is approximately 310 degrees, while when turning right, it's around 350 degrees. This uniformity is due to the identical PWM settings for both the right and left motors, ensuring that the degree of turning when the robot moves in either direction doesn't vary significantly.

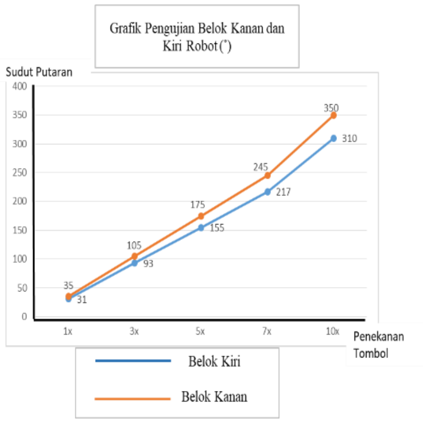

Figure 8. Right and Left Turn Test Graphs Robot

Figure 9. Photos of Tool Testing

The figure 8 shows the graph Testing the right and left turns of the robot. Based on the graph, it can be seen that the line scheme between left and right turns not too much difference. This proves that the motor rotation when robot turns right and left is quite synchronized. synchronized. And in Figure 9 is photo when testing the tool.

3. Operating Distance Test Results Robot

The table labeled 3 illustrates the effective range of the robot, revealing that its ideal maximum operating distance is merely 30 centimeters. This limitation arises from the utilization of a mobile hotspot from a cell phone for testing the robot's WiFi connection, which inherently restricts its operational range. Beyond this 30-centimeter threshold, the robot is prone to experiencing delays in response or may even become entirely inoperable once it ventures outside the WiFi signal's reach. Figure 10 also depicts the layout for controlling the robot, specifically designed for operation within this optimal distance.

Table 3. Test Result data of Operating distance test results of robot

Distance	Status	Description
1-15 cm	Connected	The robot can be controlled well
16-30 cm	Connected	The robot can be controlled well
31-60 cm	Connected	The robot can be controlled poorly, the control is delayed, the cutter cannot be turned on
61-100 cm	Connected	The robot cannot be controlled

Figure 10. Photos of Tool Testing

4. Cutting Motor Testing Results

Table 4. Cutting Motor Test Result data

Grass length		Description
Before	After	
3 cm	3 cm	Grass cut to 1 cm
3 cm	3 cm	Grass cut to 1 cm
3 cm	3 cm	Grass not cut

The cutter test shows that even with a depth of only about 1-2 cm, the cutter can trim the grass. This is due to the relatively weak motor rotation and the blade being too small. Additionally, the instability of the WiFi signal can also lead to the cutter frequently shutting down.

Figure 11. Photos Of Cutting Motor Testing

Table 5. Motor Duration Test Result Data Cutter

Remaining battery capacity (V)	Cutting motor duration (Minutes)	RPM of Cutting Motor
7,4 V	2.33	12000
5,2 V	1.47	12000
3,9 V	1.13	12000

Based on the above information, the capacity of the mower significantly impacts the duration of the motor rotation. The smaller the battery capacity, the shorter the motor rotation time. Under full conditions, the mower motor can rotate for approximately 2 minutes and 33 seconds, while for the lowest battery capacity, it can only rotate for 1 minute and 13 seconds. The rotational speed of the mower motor remains constant at 12000 RPM due to the settings in the Arduino IDE, achieved by setting a high input signal in the code.

5. Test Results for The Duration The Robot is on

Table 6. Motor Duration Test Result Data Cutter

3S LiPo Battery (VDC)	Description (Bad/Good)	Duration Robot is on (minutes)
7,25	Good Condition	10.33
7,08	Good Condition	10.30
7,14	Good Condition	10.32

This test is conducted to determine the duration the robot can turn on. From Table 3.6. It can be seen that for duration of robot operation in full battery state the robot can be operated until approximately 10 minutes

4. CONCLUSION

Based on the results of testing and analyzing data of the research entitled "Design Build a Wireless Lawn Mower Robot Based on ESP32-cam Using Intranet Network Intranet Network" the following conclusions were obtained the following:

1. Design of a wireless lawn mower robot that has been done in this final project, as long as the robot and controller are in the same network, the robot can be controlled by the controller. It's just that in this test the network used ismobile hotspot cell phone so that the maximum maximum operating distance is about 30 cm.
2. The cordless lawn mower designed in this research can cut grass with a height of 3-5cm.
3. This wireless lawn mower robot can operate with the battery capacity full for 10 minutes and the cutting motor can operate with full battery capacity for 2 minutes. This wireless lawn mower robot can only can pass through smooth terrain and contoured flat ground. The robot cannot pass through obstacles or obstacles that larger and taller than the dimensions of the dimensions of the robot.

Advice

In making this final project of course, there are shortcomings so that further development is needed further. Constructive suggestions ar needed to perfect this final project among others as follows:

1. Dimensions of the robot and cutting blade must be enlarged again so that the grass that can be cut can be longer and varied
2. The robot must be given its own access point that is connected to a sufficient battery or battery attached to the robot. In order to the Wifi signal emitted is stable and strong enough strong enough for control

REFERENCES

[1] Nugroho Erdhi Widyarto, "Desain Robot Kendali Jarak Jauh Berbasis WiFi," 2013.

[2] A. Yusup, M. Arkanuddin, and T. Sutikno, "Perancangan Model Alat Pemotong Rumput Otomatis Berbasis Mikrokontroler AT89C51," 2015.

[3] R. Bangun Sistem Keamanan Kendaraan Bermotor Roda Dua Berbasis, A. Rio Maldini, E. Nasrullah, and A. Sadnowo Repelianto, "Internet of Things dengan Modul NodeMCU ESP8266 V3 dan ESP32 -CAM," 2022.

[4] Suciati Ika, "SISTEM OTOMATISASI SENSOR FLAME PADA PROTOTIPE ROBOT LINE PROXIMITY PEMADAM API BERBASIS ARDUINO TUGAS AKHIR," 2021.

[5] D. Setiawan, J. Yos Sudarso Km, K. Kunci, and A. Uno, "SISTEM KONTROL MOTOR DC MENGGUNAKAN PWM ARDUINO BERBASIS ANDROID SYSTEM," *Jurnal Sains, Teknologi dan Industri*, vol. 15, no. 1, pp. 7–14, 2017.

[6] A. S. Pambudi, S. Andryana, and A. Gunaryati, "Rancang Bangun Penyiraman Tanaman Pintar Menggunakan Smartphone dan Mikrokontroler Arduino Berbasis Internet of Thing," *JURNAL MEDIA INFORMATIKA BUDIDARMA*, vol. 4, no. 2, p. 250, Apr. 2020, doi: 10.30865/mib.v4i2.1913.

[7] S. Samsugi, Z. Mardiyansyah, and A. Nurkholis, "SISTEM PENGONTROL IRIGASI OTOMATIS MENGGUNAKAN MIKROKONTROLER ARDUINO UNO," 2020.