

Development of Rechargeable Lawn Mower

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Abstract—Lawn mower is device to mow grass. The lawn mower will be having a problem such as the lawn mower widely used around by handle manually with hand. Next, the power source for lawn mowers is from petrol energy. That energy is nonrenewable energy and has bad impacts on the environment and people. In this paper, a prototype of lawn mower is designed and fabricated with its operation movement system through the Smartphone via Wi-Fi connection. The lawn mower is powered using the sealed acid battery that it can charging by using the photovoltaic cell or AC voltage source. The development of rechargeable lawn mower using ESP32 to keep and process data before sending to the webpage IP Address 192.168.4.1 to show the control movement of lawn mower via Smartphone. Based on experimental test results, the lawn mower was able to control its movement via a smartphone through a Wi-Fi connection. Next, the results were revealing the ability of solar panels for 2 hours and AC voltage for 1 hour to fully charged the sealed lead-acid batteries. Finally, a grass trim performance test was carried out on a lawn mower in the yard of the house and the result was that the grass could be cut. After that, the battery consumption of lawn mower operation for 1 hour was obtained the result around 50% of the capacity which is fully discharge because occurs the maximum depth of discharge of sealed lead acid batteries.

Keywords—Batteries, ESP32, Lawn Mower, Lead-Acid Smartphone, Photovoltaic Cell

I. INTRODUCTION

In current years, the renewable energy such as photovoltaic system and fuel cell system becomes a progressively important source of energies. With increasing environmental concerns, rising operating costs and rising labor costs, renewable energy technologies are becoming increasingly important. Renewable energy technologies are sometimes often viewed as direct substitutes for current technologies, so their benefits and costs are considered in light of assessment methods developed for current technologies. Renewable energy technologies can serve as cost-effective and environmentally friendly alternatives to conventional energy production [1].

The typical lawn mower widely used around by handle manually with hand and power source from gasoline or petrol energy. The petrol come from crude oil or petroleum, which comes from deep underground. The lawn mower working principle is to convert the chemical energy of the fuel (petrol) into kinetic energy. Following that working principle which is that contribute to air pollution for the people because it produces the carbon monoxide. Indeed, the petrol is from petroleum which is non-renewable energy comes from sources that will run out and to pay such the high cost for the sources which is non-renewable energy quite wasteful and bad for the environment. There are has the other option to substitute the energy for replace the usage of petrol and convenient way to use lawn mower. [2,3]. The Solar energy is widely used in significant sources. This is because solar energy is unlimited, available worldwide, and clean [4]. Therefore, the innovations from the typical gasoline or petrol lawn mower were introduced which is the Development of Rechargeable Lawn Mower. The innovation was dual option power source either using the photovoltaic cell (Solar energy) or also AC voltage as power source. Next, the lawn mower able to control the movement through Smartphone [5,6,7]. This is the new innovation for the lawn mower from aspect the power sources and the control movement system to able trimming the grass at house garden.

II. METHODOLOGY

A. Circuit Development of Rechargeable Lawn Mower

The circuit diagram for the development of a rechargeable lawn mower is formed from several components, including the ESP32 module which is a microcontroller that needs to be connected to two L298N motor driver modules. The two DC motor of wheels was connected to each L298N motor driver motor while a DC motor for blade is connected directly to sealed lead acid batteries. The power supply from Solar power panel or AC Voltage source which means that it can select the Input power source to turn on lawn mower. Each power supply has control regulator as protection overcharging to charge the sealed lead acid batteries which is solar charge

controller for Solar power panel and battery charger for AC voltage source. Its circuit diagram is shown as in Figure 1 below:

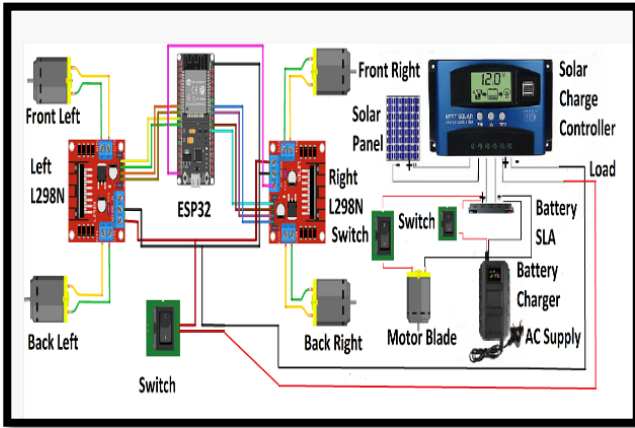


Fig. 1. Circuit Diagram of Rechargeable Lawn Mower

B. Hardware of Rechargeable Lawn Mower

The hardware components in Figure 2 below are consisted of two power sources that can be select either Solar panel [9] or AC Voltage as power source to charge the sealed lead acid batteries of lawn mower. The type of wheel of lawn mower used is meconium wheel that has omnidirectional movement. Each wheel is connected with DC motor by its coupling. The two L298N motor driver module which is to control the DC motor wheels of lawn mower are connected with ESP32 microcontroller which is built in Wi-Fi module in it that has been programmed with coding by using Arduino IDE software. Thus, it can be connected to the device which is Smartphone to control the movement of lawn mower by using the webpage IP address 192.168.4.1. For the DC motor of blade is connected directly with the batteries, so whenever the power of lawn mower is turned on, the DC motor of blade also turned on, its use the cable ties as blade.

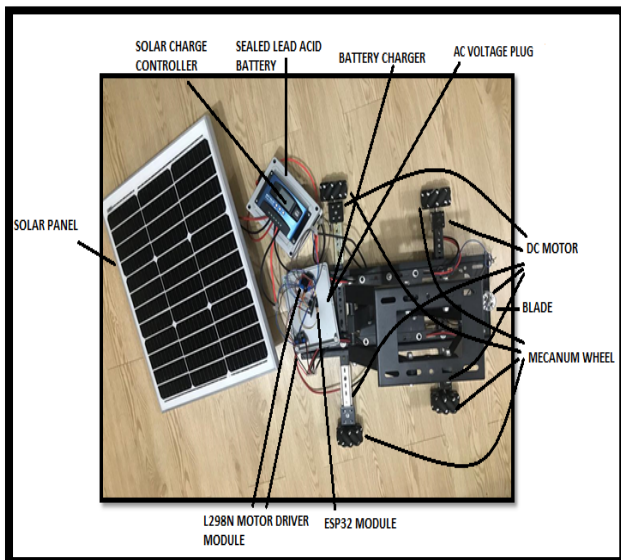


Fig. 2. Prototype for Development of Rechargeable Lawn Mower

C. 12V Sealed Lead Battery Voltage Charts

Table I shows the 12V Sealed Lead Acid Battery Voltage Charts. Assuming 50 % maximum depth of discharge, Table I shows that the batteries are fully charged at around 12.89V and fully discharged at around 12.23V [8].

TABLE I. 12V SEALED LEAD ACID BATTERY VOLTAGE CHARTS

Voltage	Capacity
12.89 V	100%
12.78 V	90%
12.65 V	80%
12.51 V	70%
12.41 V	60%
12.23 V	50%
12.11 V	40%
11.96 V	30%
11.81 V	20%
11.70 V	10%
11.63 V	0%

III. RESULT AND DISCUSSION

The result obtained through the testing on hardware had shown in this part and also had the analysed from the result testing.

A. Program ESP32 module by Arduino IDE software

Figure 3 and 4 show the test results obtained for availability of a Wi-Fi network and the webpage IP address 192.168.4.1 as remote to control lawn mower. Then, the results are shown by Figure 5 and 6.



Fig. 3. The availability of a Wi-Fi network

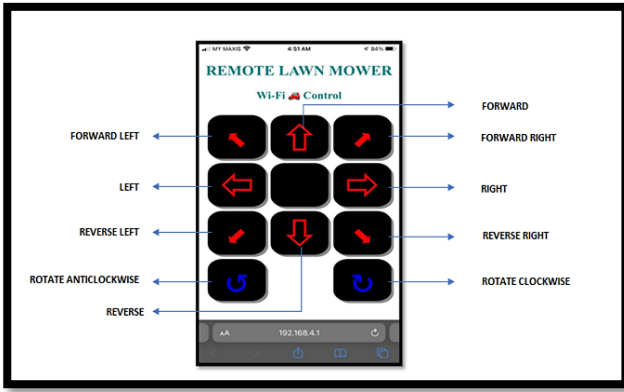


Fig. 4. The webpage IP address 192.168.4.1 of smartphone



Fig. 5. Static movement Development of Rechargeable Lawn Mower



Fig. 6. Reverse movement Development of Rechargeable Lawn Mower

Figure 3 shows the visual of availability of Wi-Fi network that means the successfully program installed in ESP32 module and also ready to connect by the smartphone. After that, the next step is to test the connectivity of Wi-Fi connection by surfing the webpage of 192.168.4.1. Figure 4 shows the successfully interface webpage of smartphone as remote to control the lawn mower. Next, test the movement for the Development of Rechargeable Lawn Mower according to the smartphone remote control as follows. The successful results have been recorded. Figure 5 and 6 show the movement for the Development of Rechargeable Lawn Mower from static to reverse movement respectively.

B. Charging Time

The following tests are conducted to look at the performance of solar panel and battery charger for charging the battery 12V 14Ah sealed lead acid battery.

Solar Charging Time

Figure 7 and 8 show the test performance of solar panel for charging the 12V 14Ah sealed lead acid battery.

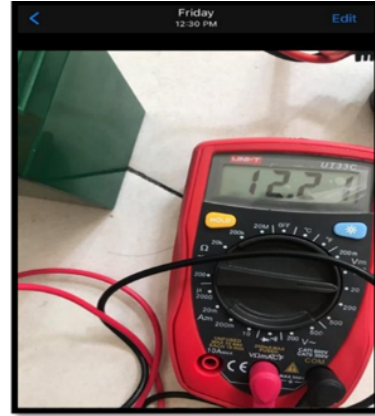


Fig. 7. Before charging from Solar Panel



Fig. 8. After charging from Solar Panel

The conducted test performance of solar panel for charging the 12V 14Ah sealed lead acid battery was taking place for 2 hours from 12:30 PM to 2:30 PM. In Figure 7 shows 12.21V before charging the sealed lead-acid battery, and Figure 8 shows 13.3V after charging the battery solar panel for 2 hours. See Table I, the state value or capacity of the sealed lead-acid battery before charging is 50%, and the capacity increases to 100% after charging for 2 hours. The results reveal the ability of solar panels to charge sealed lead- acid batteries.

Battery Charger Charging Time from AC Voltage

Figure 9 and 10 shows the test performance for AC voltage source for charging the 12V 14Ah sealed lead acid battery respectively.



Fig. 9. Before charging from AC Supply



Fig. 10. After charging from AC Supply

The data taken was carried out for 1 hour from 7:00 AM to 8:00 AM with the initial voltage of 12V 14Ah sealed lead acid battery as 12.2V (see Figure 9) while the final value is 13.5V when fully charged (see Figure 10). During 1 hour charging the capacity of a 12V 14Ah sealed lead acid battery is 50 % to 100 % fully charged (see Table I). The results prove the charging of AC voltage to the charge sealed lead-acid batteries.

C. Performance of Lawn Mower to Trimming the Grass

Figure 11 below is done for analyzing the performance for Development of Rechargeable Lawn Mower to trimming the grass at garden. Figure 12 and 13 show the results of the test battery consumption of lawn mower operation for 12V 14Ah sealed lead acid battery respectively. The results obtained as shown in Figure 11 shows the performance of the Development of a Rechargeable Lawn Mower which can cut grass even if it is not perfect because it uses a cable tie as a cutting blade.



Fig. 11. Testing trim grass performance of lawn mower



Fig. 12. Value before operation



Fig. 13. Value after operation

The data testing carried out for 1 hour from 1:00 PM to 2:00 PM with the initial voltage value as 12.7V (see Figure 12) while the final voltage value is 12.2V (see Figure 13). As mentioned in Table I, the capacity of batteries is around 90% and after 1 hour capacity of batteries become around 50%

which is fully discharge because occurs the maximum depth of discharge.

IV. CONCLUSION

After showed the result of the program ESP32 integrated with Wi-Fi module by using the Arduino IDE software, the result of solar panel and AC voltage for charging the 12V 14Ah sealed lead acid battery, the battery consumption for the operation of the lawn mower and the performance of lawn mower to trimming the grass at the garden. The lawn mower operation movement system is successfully control through the smartphone application via Wi-Fi connection. The developed sealed lead acid battery charging system also works well. It can be charged using a photovoltaic cell and an AC voltage source. Subsequent tests carried out gave the following results: a) Solar Charging Time: 12.21 V which 50 % capacity of the sealed lead acid battery before charging increases to 13.3 V which is 100 % fully charged after 2 hours. b) AC Supply using Battery Charger Charging Time: 12.2 V which is 50 % capacity of sealed lead acid battery before charging increases to 13.5 V which is 100 % fully charged after 1 hour. Besides that, the lawn mower develops able to trim the grass. After that, the battery consumption of the lawn mower operation for 1 hour will reduce the voltage of the battery from 12.7 V to 12.2 V which is fully discharge because occurs the maximum depth of discharge.

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