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SOLAR GRASS CUTTER: HARNESSING RENEWABLE ENERGY FOR SUSTAINABLE LAWN MAINTENANCE

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Abstract - In the realm of sustainable landscape management, the imperative to reduce environmental impact while enhancing efficiency is paramount. This paper presents a pioneering approach to address these challenges through the development of the Solar Grass Cutter. Grounded in the fusion of renewable energy technology and innovative design, our objective is to revolutionize traditional lawn maintenance practices by introducing a comprehensive system that harnesses solar power to trim grass effectively and sustainably.

At its core, the Solar Grass Cutter represents the convergence of modern engineering with environmental concern. This device provides a disruptive solution by combining solar panels with precision cutting mechanisms, reducing reliance on fossil fuels and the carbon emissions associated with traditional lawn care equipment.

Key features of the Solar Grass Cutter include:

1.Renewable energy utilization: Leveraging solar power, the system operates autonomously, reducing dependence on non-renewable energy sources and mitigating environmental impact.

2.Efficient grass cutting: Through innovative design and engineering, the Solar Grass Cutter ensures precise and efficient grass trimming, optimizing resource utilization and minimizing waste.

3.Environmental stewardship: By adopting sustainable practices, the Solar Grass Cutter promotes environmental stewardship, contributing to the preservation of ecosystems and biodiversity.

In essence, the Solar Grass Cutter represents an evolutionary leap in lawn maintenance, bringing technological innovation together with environmental responsibility. It represents a dedication to sustainable behaviours as well as a vision for a greener future in which human inventiveness and environmental consciousness combine to improve our planet's health.

Key Words: Solar Grass Cutter, Renewable Energy, Sustainable Lawn Maintenance, Precision Cutting, Environmental Stewardship, Technological Innovation.

1.INTRODUCTION

Due to the continuous increase in the cost of fuel and the effect of emission of gases from the burnt fuel into the atmosphere, this necessitated the use of the abundant solar energy from the sun as a source of power to drive a lawn Grass cutter. Based on the main idea of mowing, a solar powered lawn mower was created and built. The solar powered lawnmower is constructed with a D.C motor, a rechargeable battery, a solar panel, a stainless-steel blade, and a control switch. The D.C motor provides the necessary torque to operate the stainless-steel blade, which is directly linked to the shaft of the D.C motor. The solar lawnmower is controlled by a switch on the board that closes the circuit and permits electricity to pass to the motor, which drives the mowing blade. The solar charging controller recharges the battery. The created machine's performance was evaluated using several types of grasses. The sun provides sustainable energy for several functions on Earth, including the atmosphere. The only difference is the application of the energy source. It is assumed that Grass cutter using solar as the energy source will address several issues that the standard internal combustion engine and electric motors lawn grass cutter do not. A solar-powered lawnmower is easier to use since it avoids downtime caused by repeated trips to the gas station for refills and the dangers connected with fuel spillage. This eliminates harmful pollutants from gasoline spills and internal combustion engines. The solar powered lawnmower will help to reduce air pollution. Thus, solar grass cutter is used.

2. COMPONENTS USED

1.ARDUINO UNO

Figure 1: Arduino UNO

The Arduino UNO is a low-cost, adaptable, and user-friendly open-source microcontroller board that may be used in a wide range of electronics applications. This board is compatible with other Arduino boards, Arduino shields, and Raspberry Pi boards. It can control relays, LEDs, servos, and motors as output. The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc and initially released in 2010. Arduino Uno is a microcontroller board that controls the whole system. It has 14 digital input/output pins and all the sensors and motors are connected through these pins.

2. SOLAR PANEL

Figure 2: Solar Panel

Solar panels are devices that convert sunlight directly into electricity through the photovoltaic effect. They consist of multiple interconnected photovoltaic cells, typically made from silicon semiconductors, enclosed between protective glass and a backing material. When exposed to sunlight, the solar cells generate an electric current proportional to the intensity of the incident light.

3. 18650 RECHARGEABLE BATTERY

Figure 3: 18650 Rechargeable Battery

18650 rechargeable batteries are a popular type of lithium-ion cell, named after their cylindrical form factor of 18mm diameter and 65mm length. They employ a lithium-based cathode and a carbon-based anode, with a non-aqueous electrolyte in between. Key specifications include nominal voltage of 3.6-3.7V, typical capacities ranging from 2000-3500mAh, and energy densities around 200-300Wh/L. 18650 cells can be configured in series or parallel to meet desired voltage and capacity requirements.

4. SOLAR CHARGE CONTROLLER

Figure 4: Solar Charge Controller

A solar charge controller is an essential component in photovoltaic systems that regulates the charging of batteries from the variable output of solar panels. Its primary functions are to prevent overcharging of the batteries by limiting the voltage and current from the solar array once the batteries are fully charged, and to prevent reverse current flow from the batteries to the panels at night or during low light conditions.

5. L298N MOTOR DRIVER

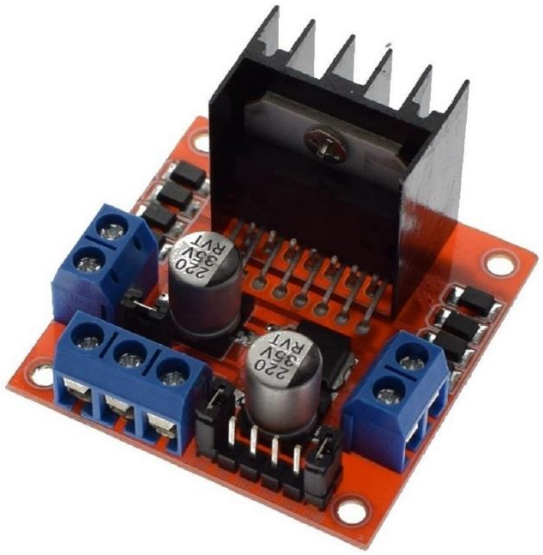


Figure 5: L298N Motor Driver

The L298N is a high-voltage, high-current dual full-bridge driver integrated circuit designed to control inductive loads such as DC motors, stepper motors, and other actuators. It features two H-bridge driver circuits with an output current rating of 2A per bridge and peak output current capability of 3A. The L298N operates from a wide supply voltage range of 5V to 35V, making it suitable for a variety of applications.

6. 2-CHANNEL RELAY MODULE

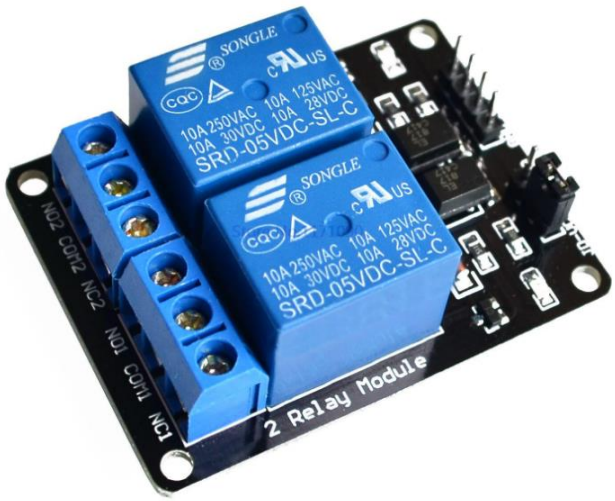


Figure 6: 2-Channel Relay Module

A 2-channel relay module is an electronic device that allows a low-power control signal, such as a microcontroller output, to switch higher-voltage or higher-current electrical circuits on and off. It consists of two independent electromechanical relays integrated onto a single board. Each relay acts as an electrically operated switch controlled by an input signal, typically at logic levels from 3.3V to 5V. When activated, the relay contacts change state to make or break a connection, enabling the module to control external circuits or loads up to the relay's rated voltage and current capacities.

7. BLUETOOTH MODULE HC-05

Figure 7: Bluetooth Module HC-05

The HC-05 is a widely used Bluetooth serial port module designed for transparent wireless serial communication. It is based on the BC417 Bluetooth-to-serial chip. The module operates in the unlicensed 2.4GHz ISM band with a range up to 10 meters. It supports master and slave modes, enabling it to connect to other Bluetooth devices or act as a wireless serial link to a microcontroller or computer.

8. 775 DC MOTOR (FOR GRASS CUTTING)

Figure 8: 775 DC Motor (For Grass Cutting)

The 775 DC motor is a small, affordable, and versatile permanent magnet direct current (DC) motor commonly used in hobby electronics, robotics, and low-power applications. It is a 12V motor typically found in sizes ranging from 25mm to 50mm diameter. The 775 motor contains a stator with permanently magnetized fields and a slotted rotor assembly with windings that generate an electromagnetic field when energized. When DC power is applied, the interaction between the two fields causes the rotor to spin continuously.
Key specifications include the rated voltage (typically 12V), no-load speed (around 3000-9000 RPM), stall torque, and power output (usually under 10W). Higher voltages lead to faster speeds, while the torque drops with increasing RPM.

9. DUAL SHAFT DC GEARED MOTOR (FOR WHEELS)

Figure 9: Dual Shaft DC Geared Motor (For Wheels)

A dual shaft geared DC motor is a type of electric motor that incorporates an integrated gearbox and has two parallel output shafts rotating in opposite directions. It combines the characteristics of a traditional geared DC motor with an additional coaxial shaft.
The motor consists of a small DC motor, typically brushed or brushless, coupled to a compact gearbox assembly. The gearbox contains a system of gears or planetary gear trains that reduce the high-speed rotation of the motor to a lower output speed while increasing the torque.

10. JUMPER WIRES

Figure 10: Jumper Wires

Jumper wires are simple electrical cables used to transfer signals or make temporary connections between components on a breadboard, circuit board, or other prototyping systems. They typically consist of a strand of flexible insulated wire with connector pins, often male-to-male or male-to-female, at each end.
The wires come in various colors to facilitate organization and tracing of connections. Common conductive materials used for the internal wire include solid or stranded copper, tinned copper, or copper alloy. The insulation is usually PVC, though silicone and other materials are also used.

11. CONNECTING WIRES

Figure 11: Connecting Wires

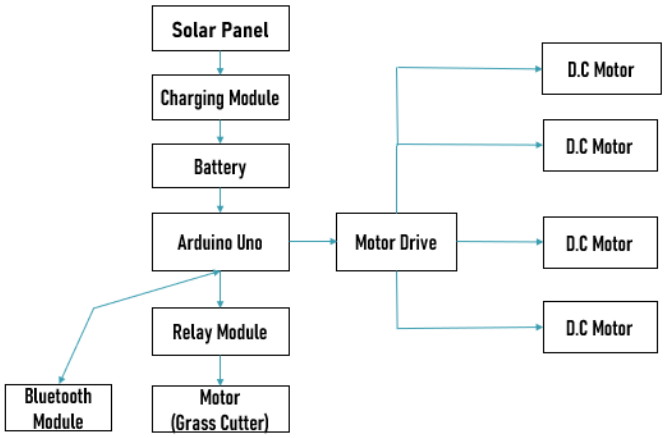
Connecting wires are insulated electrical conductors used to create temporary or permanent point-to-point connections between components in an electronic circuit or system. They serve as the electrical pathways for transferring signals, power, and ground references.
These wires consist of a solid or stranded conductive core, typically made of copper or copper alloy, surrounded by an insulating jacket made of materials like PVC, PTFE (Teflon), silicone rubber, etc. The insulation prevents short circuits and provides protection against environmental factors.

12. 18650 LITHIUM BATTERY PROTECTION BOARD

Figure 12: 18650 Lithium Battery Protection Board

The 18650 Lithium Battery Protection Board is a crucial component in safeguarding the performance and longevity of lithium-ion batteries. Designed specifically for use with 18650 cylindrical cells, this protection board offers comprehensive protection against overcharging, over-discharging, short circuits, and overcurrent conditions. It features a compact form factor and integrates a range of protection mechanisms including overvoltage protection, undervoltage protection, and temperature monitoring.

3. BLOCK DIAGRAM OF SOLAR GRASS CUTTER



The system operates by harnessing solar energy through a solar panel, which converts sunlight into electrical energy. This electrical energy is then fed into a charging module responsible for regulating and controlling the charging process of the battery using the power generated by the solar panel. The battery serves as the primary energy storage unit, supplying power to the various components of the system when needed, ensuring continuous operation even during periods of low or no sunlight.

At the heart of the system is the Arduino Uno microcontroller board, acting as the central control unit, managing the operations of the entire setup. The Arduino Uno interfaces with motor drive circuits or modules, which provide the necessary power and control signals to drive separate DC motors. The DC motor is specifically dedicated to operating a grass cutter mechanism, used for lawn mowing.

In addition to controlling the motor drives, the Arduino Uno also governs a relay module, which contains relays (electrically operated switches) that can turn the grass cutter motor on or off based on commands from the microcontroller. This allows for precise control and operation of the grass cutter mechanism according to predetermined conditions or user input.

Furthermore, the system incorporates a Bluetooth module connected to the Arduino Uno, enabling wireless communication and remote-control capabilities. This feature enables users to send commands or monitor the system's status from a mobile device or computer via a Bluetooth connection, providing a convenient and flexible interface for managing the system's operations.

The system is designed to be powered primarily by the solar panel and battery combination, making it a self-sustaining and environmentally friendly setup. The solar panel generates electrical energy from sunlight, which is used to charge the battery through the charging module, ensuring a reliable and renewable power source for the entire system. This approach not only reduces the reliance on traditional energy sources but also contributes to a more sustainable and eco-friendly operation.

4. CODE

//This program is used to control a robot using a app that communicates with Arduino through a bluetooth module.

```
#define in1 5 //L298n Motor Driver pins.
#define in2 6
#define in3 10
#define in4 11
#define LED 4
#define RelayPin 3;
int command; //Int to store app command state.
int Speed = 255; // 0 - 255.
int Speedsec;
int buttonState = 0;
int lastButtonState = 0;
int Turnradius = 0; //Set the radius of a turn, 0 - 255 Note:the robot will malfunction if this is higher than int Speed.
int brakeTime = 45;
int brkonoff = 1; //1 for the electronic braking system, 0 for normal.
void setup() {
  pinMode(in1, OUTPUT);
  pinMode(in2, OUTPUT);
  pinMode(in3, OUTPUT);
  pinMode(in4, OUTPUT);
  pinMode(LED, OUTPUT); //Set the LED pin.
  pinMode(RelayPin, OUTPUT);
  Serial.begin(9600);   //Set the baud rate to your Bluetooth module.
}

void loop() {
  if (Serial.available() > 0) {
    command = Serial.read();
    Stop(); //Initialize with motors stoped.
    switch (command) {
      case 'X':
        grass();
      case 'Z':
        nograss();
      case 'F':
        forward();
        break;
      case 'B':
        back();
        break;
      case 'L':
        left();
        break;
      case 'R':
        right();
        break;
      case 'G':
        forwardleft();
        break;
      case 'I':
        forwardright();
        break;
      case 'H':
        backleft();
        break;
      case 'J':
        backright();
        break;
      case '0':
        Speed = 255;
        break;
      case '1':
        Speed = 255;
        break;
      case '2':
        Speed = 255;
        break;
      case '3':
        Speed = 255;
        break;
      case '4':
        Speed = 255;
        break;
      case '5':
        Speed = 255;
        break;
      case '6':
        Speed = 255;
        break;
      case '7':
```

```
      Speed = 255;
      break;
    case '8':
      Speed = 255;
      break;
    case '9':
      Speed = 255;
      break;
    case 'q':
      Speed = 255;
      break;
  }
  Speedsec = Turnradius;
  if (brkonoff == 1) {
   brakeOn();
  } else {
   brakeOff();
  }
 }
}
void forward() {
 analogWrite(in1, Speed);
 analogWrite(in3, Speed);
}
void back() {
 analogWrite(in2, Speed);
 analogWrite(in4, Speed);
}
void left() {
 analogWrite(in3, Speed);
 analogWrite(in2, Speed);
}
void right() {
 analogWrite(in4, Speed);
 analogWrite(in1, Speed);
}
void forwardleft() {
 analogWrite(in1, Speedsec);
 analogWrite(in3, Speed);
}
void forwardright() {
 analogWrite(in1, Speed);
 analogWrite(in3, Speedsec);
}
void backright() {
 analogWrite(in2, Speed);
 analogWrite(in4, Speedsec);
}
void backleft() {
 analogWrite(in2, Speedsec);
 analogWrite(in4, Speed);
}

void Stop() {
 analogWrite(in1, 0);
 analogWrite(in2, 0);
 analogWrite(in3, 0);
 analogWrite(in4, 0);
}
void grass(){
 digitalWrite(RelayPin, LOW);
        delay(3000);
}
void nograss(){
 digitalWrite(RelayPin, HIGH);
        delay(3000);
}

void brakeOn() {
 //Here's the future use: an electronic braking system!
 // read the pushbutton input pin:
 buttonState = command;
 // compare the buttonState to its previous state
 if (buttonState != lastButtonState) {
  // if the state has changed, increment the counter
  if (buttonState == 'S') {
   if (lastButtonState != buttonState) {
    digitalWrite(in1, HIGH);
    digitalWrite(in2, HIGH);
    digitalWrite(in3, HIGH);
    digitalWrite(in4, HIGH);
    delay(brakeTime);
    Stop();
   }
  }
  // save the current state as the last state,
  //for next time through the loop
  lastButtonState = buttonState;
 }
}
void brakeOff() {
```

5. CONCLUSIONS

In conclusion, the creation of a solar-powered grass cutter is a possible alternative to standard gas-powered lawn mowers. This unique design eliminates the need for fossil fuels by harvesting solar energy using photovoltaic panels, reducing greenhouse gas emissions and noise pollution.

One of the key advantages of the solar grass cutter is its environmentally friendly operation. With no direct carbon emissions during use, it aligns with sustainability goals and the transition towards renewable energy sources.

Despite some current limitations in battery life and cutting capacity for larger areas, continued research and development can address these challenges. Overall, the solar-powered grass cutter represents a step towards more sustainable landscaping practices and a reduced environmental footprint for residential and commercial groundskeeping operations.

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