Smart Solar Grass Cutter

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Abstract: *In today's era the home decorations' integral part is lawn. Manual grass cutting demands significant labor and time and often results in uneven grass height. To address these problems, it is crucial to develop an automated system capable of mowing the grass without human intervention. This proposed system implements robot which has solar powered mechanism with battery backup which can be charged by solar energy. The system drives robot that works in automatic as well as manual mode. A user has to select initial starting point from which the grass cutting of lawn is to be stared. The robotic system then automatically decides path by detecting obstacles by ultrasonic sensors. The navigation system then decides which direction to go further by internal logic. The system can also be operated using android phone's application. The grass cutter uses a solar based energy source to charge the battery, which is easier to use, more advantageous compared to other energy source especially for gas based source of power.*

Keywords: **Android, Bluetooth Module, Grass Cutter, Solar Energy, Gear DC Motors, Servo Motor, Ultrasonic Sensor.**

I. INTRODUCTION

Pollution is a global issue, often caused by manmade activities, such as using gas lawn mowers. These lawn mowers release harmful emissions and have high fuel costs. Lawn cutters powered by solar energy provide a solution by harnessing natural sunlight. Traditional motor-powered mowers and electric mowers can be inconvenient and hazardous. Solar-powered lawnmowers are designed to reduce power consumption and pollution, making them environmentally friendly, quieter, and cost-effective.

The smart grass cutter system is a fully automated lawn mower. It features a high-RPM grass cutter blade and uses ultrasonic sensors to detect corners, moving in a zigzag pattern for complete coverage. Powered by a battery and controlled by a microcontroller, it operates both the vehicle's DC motors and the cutter motor. The system includes a solar panel for battery charging. A gyro sensor ensures precise 180-degree turns, allowing the system to cover the entire lawn or garden efficiently. This automation removes the necessity for human involvement, simplifying lawn maintenance.

A smart solar grass cutter is a modern, sustainable solution for lawn maintenance. By using solar power, it reduces environmental impact and saves costs through renewable energy. Its autonomous operation, guided by smart navigation algorithms, ensures precise and consistent lawn coverage. Features like automated scheduling and rain sensing enhance convenience, allowing for efficient lawn care without supervision. With a user-friendly interface and safety measures like collision avoidance, the smart grass cutter combines innovation and efficiency. This eco-friendly technology promotes environmental conservation by reducing chemical use and fostering green technologies, offering a sustainable approach to landscaping.

II. METHODOLOGY

A. Proposed System

The figure below shows the block diagram of Proposed System.

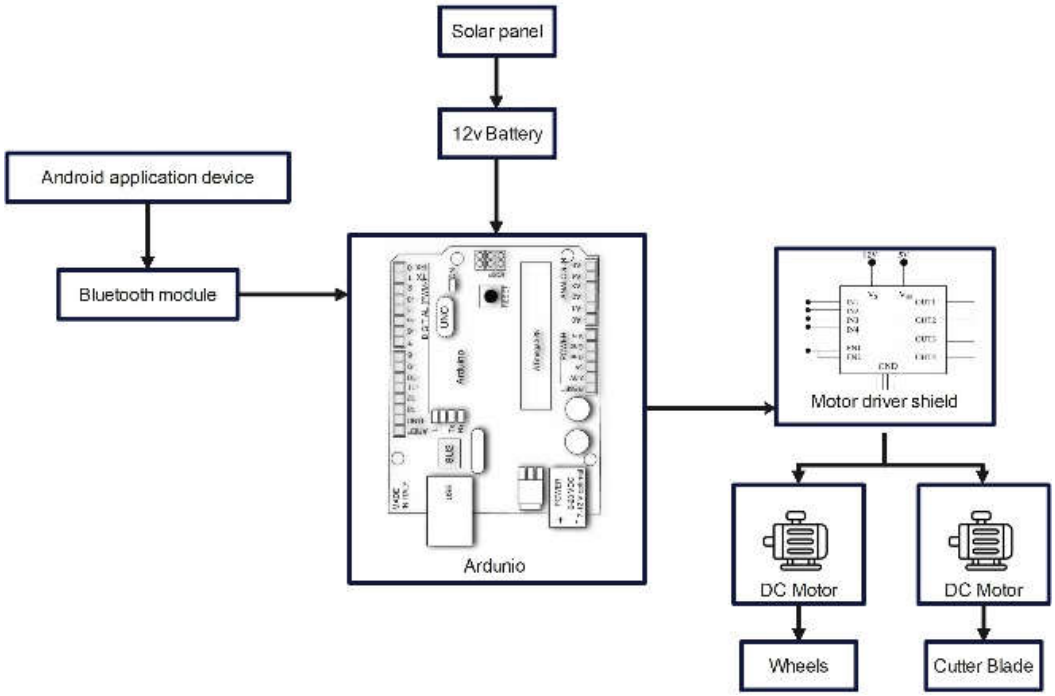

Figure 1. Block Diagram

As shown in fig.1, Solar Panel is connected to battery. The battery delivers a 12V DC supply to the system, which can be reduced to 5V DC using a voltage regulator. The Arduino is operated with 5V DC voltage. The Bluetooth module, DC motors, buzzer are connected with output pins of ATmega328P microcontroller.

Block diagram consist of following components:

1. Microcontroller (Arduino UNO)
2. Obstacle sensor (Ultrasonic sensor)
3. Battery
4. L298N motor driver
5. Solar panel
6. Gear DC Motors
7. Blade Motor
8. Servo Motor
9. HC05 Bluetooth Transceiver Module
10. DC-DC Step-Up Module
11. DC-DC Step-Down Module
12. Relay Module

B. Component Description

1. Microcontroller (Arduino UNO)

The Arduino Uno is an official microcontroller board designed by Arduino, built around the ATmega328P microcontroller. The system includes 14 digital input/output pins, with 6 capable of functioning as PWM outputs, 6 analog input pins, a 16 MHz quartz crystal, a USB port, a power jack, an ICSP header, and a reset button.

2. Obstacle sensor (Ultrasonic sensor)

An ultrasonic sensor is a device that uses sound waves to measure distance to an object. It emits ultrasonic waves and measures the time it takes for the echo to return, allowing for precise distance calculations. Commonly used in robotics, automotive, and industrial applications for obstacle detection and distance measurement.

3. Battery

Lithium-ion (Li-ion) batteries are a type of rechargeable battery commonly used in portable electronics, electric vehicles, and various other applications. They are recognized for their high energy capacity, minimal self-discharge rate, and extended cycle lifespan.

4. L298N motor driver

L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module features an L298 motor driver IC and a 78M05 5V regulator. The L298N module can manage up to four DC motors or two DC motors with both directional and speed control.

5. Solar panel

This system uses 12V, 10-Watt solar panel. The frame is made of aluminum, and the surface is constructed with tempered glass. This panel is composed of monocrystalline silicon. Compared to other panels with similar ratings, it is more compact, lightweight, and cost-effective.

Table 1. Comparison of solar system with fuel system

Sr. No.	Solar System	Fuel System
1	Totally free from pollution	Pollution is a great factor
2	No fuel consumption	Fuel is the important need
3	No. of reciprocating parts are less	No. of reciprocating parts are more
4	Friction is greatly reduced	Friction between the parts are high
5	Low cost and maintenance	Maintenance is difficult & costly
6	Load carrying capacity is low	Load carrying capacity is high
7	Continuous ride for hours together is not possible	Continuous ride is possible
8	Ratio of speed reduction more when weight increases very much	Speed reduction ratio is less and it does not vary

6. Gear DC Motors

A gear motor combines an electric motor and a power reducer, reducing revolutions while increasing torque. Commonly used in modern machines, these motors are versatile for various equipment. Hybrid models offer practicality and durability, with plastic housings and metal gears, minimizing noise. They operate on voltages from 12 to 24 V.

7. Blade Motor

The blade motor is employed to perform the grass-cutting operation. These motor have more Speed than the other 4 motors. These Motor has speed of about 10000 rpm. Blades are the cutting components of lawn mowers. These blades are very sharp. We utilize a rotating blade for this system.

8. Servo Motor

A servo motor is a rotary or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration in a mechanical system. It essentially combines a regular motor with a feedback mechanism and a control circuit. This combination allows the servo motor to rotate to a specific angle and hold that position.

9. HC05 Bluetooth Transceiver Module

The HC-05 Bluetooth Transceiver Module is a versatile device for serial data transmission, enabling Bluetooth connectivity between microcontrollers, smartphones, and other devices. Supporting Bluetooth 2.0+EDR, it features easy AT commands for configuration and operates on a 3.6V to 6V power supply. It is ideal for applications like wireless data logging, remote control, and IoT projects.

10. DC-DC Step-Up Module

A DC-DC step-up module, also known as a boost converter, is a circuit that takes a lower DC voltage and increases it to a higher DC voltage. It's essentially a tiny power supply that can be used in various applications to power electronics that require a voltage higher than the available source.

11. DC-DC Step-Down Module

A DC-DC step-down module, also called a buck converter, is the opposite of a step-up module. It takes a higher DC voltage and reduces it to a lower DC voltage. Think of it as a voltage regulator that scales down the power for your electronic devices.

12. Relay Module (Singal Channel Relay)

A relay is an electromechanical device which activates between circuits and transfer using an electr7ic current. The single-channel relay module is more than just a simple relay; it includes additives which facilitate switching and connecting easier, and also indicators that display if the module is charged and whether the relay is operational or not.

C. Flowchart

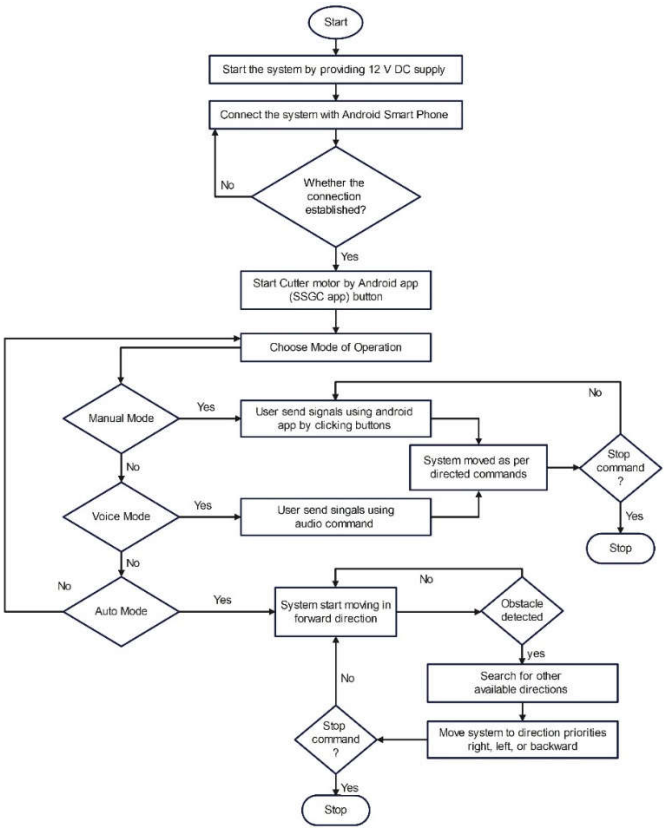

Figure 2. Flow Chart

The flowchart describes the operation process of a Smart Solar Grass Cutter (SSGC) system controlled by an Android smartphone app (SSGC app):

As shown in figure above, initially the 12 V battery supply needed to start. The voltage regulator will convert this supply into a 5V DC output, which will then be supplied to the microcontroller. Next, the Bluetooth module will be activated and connected to an Android smartphone. Once the connection between the smartphone and the system is established, the process can continue. If the connection is not established, retry the connection process. If successful, proceed to the next step.

Using the Android app (SSGC app), start the cutter motor. Next, choose the mode of operation: Manual, Voice, or Auto.

In Manual Mode, the user sends signals via the app by clicking buttons to control the system's movements. The system moves according to these commands. If a stop command is issued, the system halts; otherwise, it continues moving as directed.

In Voice Mode, the user sends movement commands using audio through the app. The system moves according to these voice commands. As with Manual Mode, the system stops if a stop command is received; otherwise, it continues following the voice commands.

In Auto Mode, the system automatically starts moving forward. If no obstacle is detected, it continues moving forward. If an obstacle is detected, the system searches for alternative paths and moves in a prioritized direction (right, left, or backward) to navigate around the obstacle. This process repeats until a stop command is issued, at which point the system halts.

The process ends when a stop command is received, bringing the operation to a close.

III. RESULT AND DISCUSSION

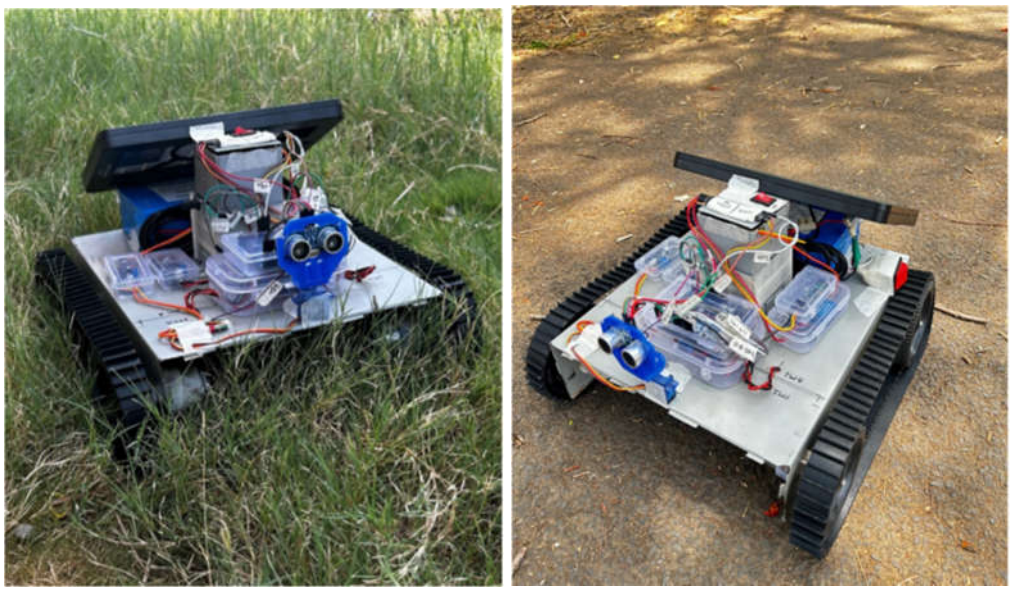

Figure 3. Flow Chart

The fig. 3 shows final version of system. It was successfully implemented and working in all modes of operation. You may visit the url "youtube/google drive url of video" to see it's full working.

Screenshots of SSGC app:

The figures shows Smart Solar Grass Cutter app has a user interface designed to control a grass cutter device using a Bluetooth connection:

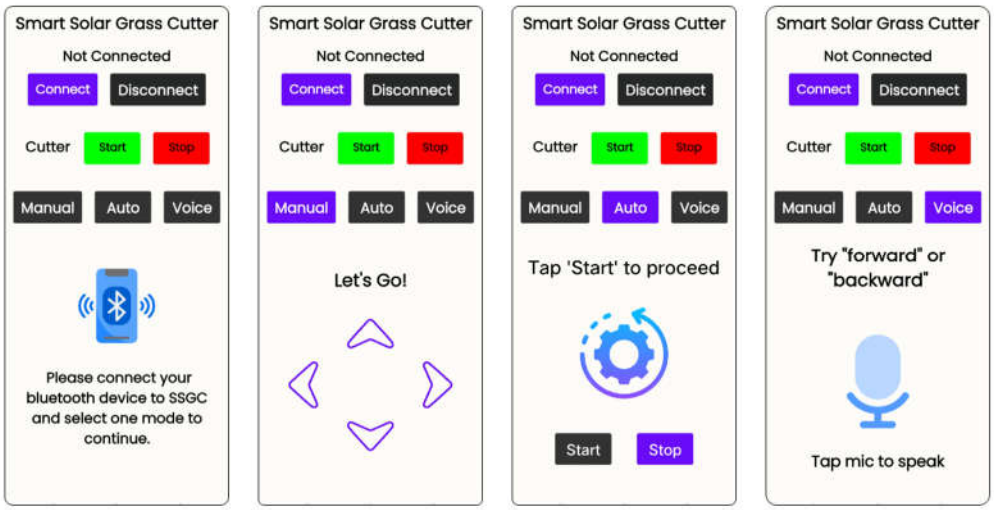

Figure 4. SSGC App

The fig. 4 shows Smart Solar Grass Cutter app has a user interface designed to control a grass cutter device using a Bluetooth connection:

The Smart Solar Grass Cutter app provides a seamless and intuitive interface for controlling your grass cutter device. To connect to the device, users can tap the "Connect" button to initiate a Bluetooth connection or the "Disconnect" button to terminate it. Once connected, users can control the cutter motor with the "Start" and "Stop" buttons to turn it on and off, respectively.

The app offers three modes of operation: Manual Mode, which allows users to control the grass cutter manually using the app's directional buttons; Auto Mode, which enables the grass cutter to operate automatically; and Voice Mode, which permits control via voice commands. The app displays a status message indicating whether the device is connected. If not connected, it prompts the user to connect their Bluetooth device and select a mode to continue.

The main functionality revolves around connecting to the grass cutter via Bluetooth, starting and stopping the motor, and choosing the operation mode.

III. PROS, CONS AND APPLICATIONS

A. Pros

i) Eco-friendly: Utilizes solar power, reducing carbon emissions and dependence on fossil fuels.

ii) Cost-effective: Saves on fuel costs since it uses free solar energy.

iii) Low maintenance: Fewer moving parts and less wear and tear compared to gasoline-powered mowers.

iv) Quiet operation: Reduced noise pollution compared to traditional lawn mowers.

v) Autonomous operation: Can operate independently with minimal human intervention, saving time and effort.

vi) Energy efficient: Optimizes energy use by converting sunlight directly into electrical energy.

B. Cons

i) Initial cost: Higher upfront cost compared to conventional grass cutters.

ii) Weather dependent: Efficiency can be reduced on cloudy or rainy days due to limited sunlight.

iii) Battery limitations: Limited runtime based on battery capacity; may require recharging for larger lawns.

iv) Complexity: More complex technology may require specialized maintenance and repairs.

v) Power limitations: May not be as powerful as gasoline mowers for very thick or overgrown grass.

B. Applications

i) Residential lawns: Ideal for maintaining small to medium-sized home lawns efficiently and quietly.

ii) Parks and gardens: Suitable for public parks and gardens where noise reduction and eco-friendliness are important.

iii) Commercial properties: Useful for maintaining the lawns of commercial properties, such as office parks and hotels, where consistent maintenance is required.

iv) Sustainable projects: Perfect for eco-friendly and sustainable landscaping projects.

v) Remote areas: Useful in areas where traditional fuel supplies are difficult to obtain or expensive.

IV. CONCLUSION

The smart solar grass cutter reduces human effort and maximizes efficiency. It can replace gasoline-powered cutters, making lawn and garden maintenance easy. This device conserves non-renewable energy sources like petrol and gasoline, reduces air and noise pollution, and saves electricity by using abundant solar energy. As an IoT-enabled solution, it optimizes its path based on monitored coverage, enhancing efficiency and user control for simplified lawn maintenance.

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