Performance Analysis on Smart Solar Grass Cutter with Lawn Coverage

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Abstract.

The intelligent grass cutter system is a proposed method for the future of lawn care. The robotic vehicle's engine is coupled to a grass cutter blade, enabling the equipment to spin at very high speeds. These systems are designed with a clever functioning technique that enables them to cover a complete lawn by finding the edges using an ultrasonic sensor and then traversing the grass in a zigzag pattern. This capability is made possible with the aid of a Micro-controller based circuit, and the powering of these systems is provided by two AA batteries. The DC motors that propel the vehicle and the lawn cutter are both powered by separate batteries. Similarly, the system relies on solar panels for both development and battery charge. The Micro-controller is responsible for coordinating the dc motors that propel the vehicle and the grass cutter, as well as for keeping an eye on the ultrasonic rangefinder. In response to ultrasonic inputs, the micro-controller intelligently manipulates the dc motors, therefore assisting the motor driver IC in reaching the required position. To ensure that the whole lawn is watered, these systems include a gyro sensor that allows a maximum turn radius of 180 degrees. That means it runs on fossil fuels like gasoline and diesel. We employ solar energy, a sustainable source of energy that also helps to save on power costs and requires less work from the human side of things.

Keyword. Ultrasonic sensor, DC motor, Gyroscope sensor and Micro-controller.

1. INTRODUCTION

1.1 General Grass Cutting Techniques

Edwin Budding of England is credited with inventing the first practical lawn mower in the 1830s. Budding's mower, a better alternative to the scythe, was patented in Britain on August 31st, 1830. It was designed to cut grass of various types on large lawns and gardens.

The original machine for planting seeds is 480 millimetres wide and has a wrought iron frame. Mowers need to be pushed from behind to operate. Transmission of power from the back roller to the cutting cylinder occurred through Cast-iron gear wheels, with a 16:1 ratio enabling the rear roller to drive the cutting cylinder's blades. Cutting height was adjusted by inserting a second roller between the cutting cylinder and the main or land roller. Grass cuttings were launched forward into a tray-like container. It was quickly understood that the machine would be easier to pull if there was another handle up front. Amazingly comparable to today's mowers, these devices were really astonishing [1, 2]. Because it is the impetus for the present way of preparing fields, sports ovals, grass courts, and so on. As a result, numerous sports, including football, cricket, tennis, baseball, and others, adopted current sets of rules [3].

Figure 1. Lawn mover

1.2 Smart Solar Grass Cutter With Lawn Coverage:

Generally Grass cutters have become very popular for now a day. Many of the times, grass cutting machines are used for soft grass furnishing. The technology is merging along with environmental awareness. Then consumers are looking for the view to contribute to the relief of their own carbon footprints. One of the cause is population is man-made and can be seen in our own daily lives, more specifically in our own house. Here, we initiate the model which is Automatic Grass Cutting Machine generated through solar energy, (nonrenewable energy).These models eliminate both the environment as well as noise pollution.

The operation of solar grass cutter has a panel arrangement in a way that can receive solar radiation with high intensity directly observed from the sun. The solar panel changes to solar energy into electrical energy. This electrical energy is stored in batteries by using a solar charger. The main function of the solar charger is to increase the current from the panel while batteries are charging. This motor is connected to batteries through connecting wires between these mechanical circuit breaker switch is provided. The main breaker switch is used to start and stop the working of the motor. From the motor, power transmits to the mechanism and this makes the blade to rotate the shaft and cuts the grass.

The designed solar power lawn mower comprises of direct current (d.c motor), a rechargeable battery, solar panel, a stainless-steel blade and control switch. Rotation is achieved by the electrical motor which provides the required torque needed to drive the stainless steel blade which is coupled to the shaft and gears to the motor. Gears are used to increase the rpm and to reduce the power consumption. The solar power lawn mower is a operated by the switch on the board which closes the circuit and allows the flow of current to the motor which in turn drive the blade used for mowing. The battery recharges through the solar charging controller and performance evaluation of the developed machine was carried out with different types of grasses.

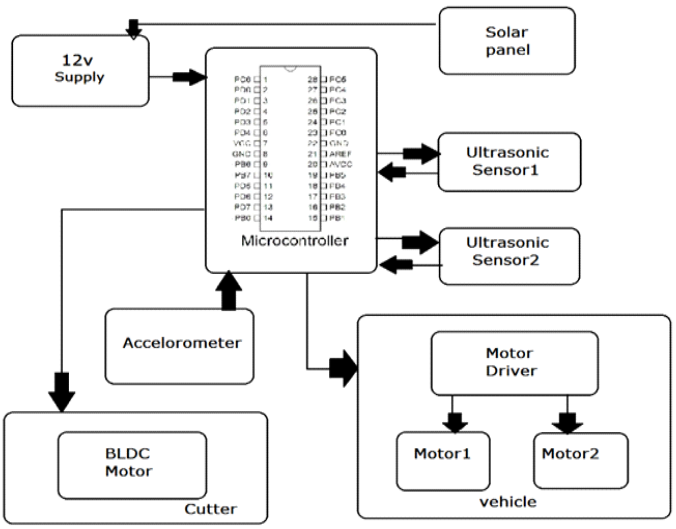

Figure 2.Block diagram

2. EXPERIMENT AND METHODS.

2.1. Hardware Components:

In the same vein as the UNO, the Ardino Nano is a small, compact board. The Ardino Nano accepts power through a mini-B USB connector, and it may be supplied by an unregulated external power source between 6 and 20 volts, or by a regulated supply between 3.3 and 5 volts. When a power outage occurs, the greatest voltage available will be used. The boot loader takes up 2 KB of the 32 KB of RAM available on the ATmega328P microcontroller. The ATmega328P has 1KB of EEPROM and 2KB of RAM. There are 14 digital I/O pins on the Nano for various purposes. The voltage requirement for them is just 5 volts. Each pin has a 20-50 k ohm internal pull-up resistor and may provide or receive up to 40 mA. Functions such as Serial, External Interrupts, PWM, SPI, LED, I2C, and AREF are included. To facilitate interaction with other devices like a computer, another Arduino, or other micro-controllers, the Arduino Nano is equipped with N communication ports. Digital pin 0 (RX) and 1 (TX) on the ATmega328P may be used for UART TTL serial communication (TX). The Arduino IDE has a built-in serial monitor for exchanging basic textual information with the board itself. When data is being communicated from the computer to the board through the FTDI chip and the USB cable, the LEDs located next to digital pins 0 (RX) and 1 (TX) will flash.

According to the micro-controller on your board, the Arduino Nano can be programmed using the Arduino software (Arduino Duemilanove or Nano with ATmega328P from the tools board menu). The ATmega328P on the Arduino Nano has a boot loader pre-burned into it, thus no extra hardware programmer is required to install fresh code. The system is compatible with the original STK500 protocol for communication. The ICSP (In-Circuit Serial Programming) header allows the microcontroller to be programmed without first loading the boot loader, using an Arduino ISP or a compatible device. The Arduino Nano is built in a manner that enables it to be reset through software running on a linked computer, eliminating the need to physically push the reset button. Through a 100 nF capacitor, one of the FT232RL's hardware flow control lines (DTR) is linked to the reset line of the ATmega328P. By taking this line low (assertion), the reset line is temporarily disconnected, which resets the chip. This feature is used by the Arduino software to make code uploads to the Arduino Nano board as simple as clicking a button. Two kinds of sensors are employed to turn the physical parameter into an electrical signal for measurement. Sensors that use both sound waves and rotational motion are referred to as "ultrasonic" and "gyroscope"[4, 5].

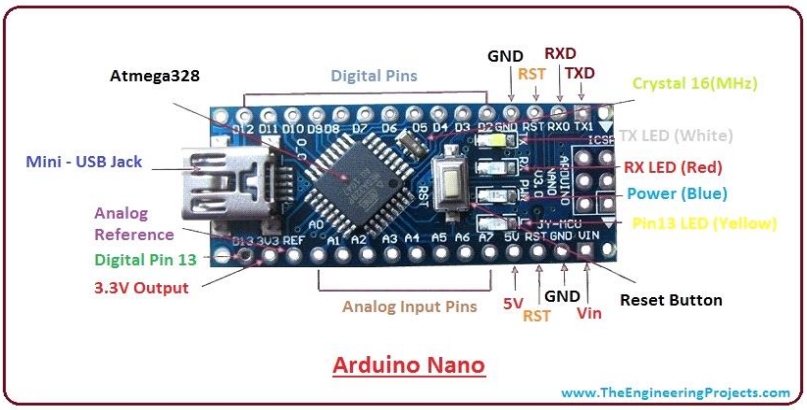

Figure 3. Arduino Nano

2.2. Power Supply:

Some power supplies need the user to manually set the input voltage, while others can sense and adjust to the standard wall outlet voltage. Solar panels are used to convert sunlight into electricity, whereas photovoltaic cells may be utilised directly as a power source[6]. Charles Fritts built the first solar cell in the 1880s[7]. One of the first to realise the significance of this finding was German entrepreneur Ernst Werner von Siemens[8]. The efficiency of solar cells is between 5% and 6% [9]. Concentrated solar power systems concentrate sunlight from a wide area into a narrow beam using lenses or mirrors and tracking devices. The photo-voltaic effect is used by photovoltaic cells to turn sunlight into electricity [10]. Additionally, lead acid batteries are used. It's one of the first types of rechargeable battery. Although the cell has a poor energy density and a small energy density compared to its volume, its high power-to-weight ratio allows it to generate a huge surge current. The modified version of the standard cell may be utilised to enhance storage and minimise maintenance needs in applications where large-format lead–acid designs are already in widespread use, such as backup power supplies in mobile phone towers, etc. VRLA (valve-regulated lead–acid) batteries, which include gel-cells and absorbed glass-mat batteries, are often used in these applications [11]. Actuators are machines used to move and operate a

mechanism or system. There are several uses for DC motors, and this one features a variable speed motor with a 12V DC motor. Because of its high torque, it may be used in a variety of traction applications. Hoists, cranes, trolley cars, elevators, air compressors, and so on are all examples of industrial applications.

3. DESIGN AND MATERIAL

3.1. Design:

The solar panel is mounted on the top of the chassis, where it receives direct sunlight, and the rest of the smart solar grass cutter is designed using solid-works software 2017 according to the specified criteria. To ensure that the chassis remains stable, the battery is positioned in the centre. The ultrasonic sensor is mounted in front of the chasse and is used to identify and avoid obstructions. Since the height at which the blade is set to cut the grass is fixed, the four wheels are connected to the chasse at that height. If you want a clean cut of grass, the mower blade shouldn't contact the ground. The design is finalised after considering these factors. As of 2013, the publisher claimed that more than two million engineers and designers at more than 165,000 firms were using SolidWorks. [12]

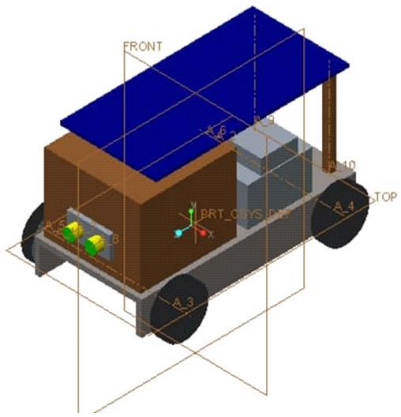

Figure 4.CAD model

3.2. Material

The chassis of the grass cutter is an interior frame that holds components such as the circuit board and other electrical devices[13]. Gear, wheels, gearbox, blade, and occasionally the driver seat are all part of the chassis[14]. Due to the larger weights and more frequent usage required of commercial vehicles, the design of a pleasure car chassis will vary from that of a commercial vehicle [15–18]. Turning the wheel on its horizontal axle while it is placed vertically beneath a load-bearing platform allows for the transportation of big loads. One may steer a ship or car by sitting atop a column attached to a rudder or a chassis on wheels. The wheel may generate or transfer power when coupled with a crank. Iron cylinder cutting gears were included on the initial blades of the earliest known lawn mower. It was put to work cutting grass on large gardens and athletic fields. Several different types of cutting blade mechanisms, including as cylinder blades, deck blades, and lifting blades, have emerged as mowers have altered form and function throughout time. When propelled by a motor, the strip-like element rotates such that its cutting edge is horizontal and its trailing edge is inclined, creating a vortex effect inside the housing that forces the grass to stand up straight so that it may be cut. If the strip's cutting edge collides with an obstruction, rather of forcing the obstruction forward as it could if the blade were rigid, it will be redirected into a recess in the housing. When the cutting edge wears down, the operator replaces it by pulling a fresh strip from the disc and cutting it to size. When a disc has to be changed, the old one is taken out, and then the new one, which has a winding strip on it, is installed on the bottom of the machine.

4. CODE ILLUSTRATION

4.1 Smart Grass Cutter Code

```
#define trigPin 4 //Sensor Echo pin connected to Arduino pin 13
#define echoPin 5 //Sensor Trip pin connected to Arduino pin 12
void setup()
{
Serial.begin(9600); // BAUD RARE is set to 9600(Serial communication from pc to Arduino Nano)
pinMode(trigPin, OUTPUT);// Ultrasonic sensor sending sound signal
pinMode(echoPin, INPUT); // ultrasonic sensor Receiving the echo sound signal
pinMode(8, OUTPUT);   // Wheel 1 motor config
pinMode(9, OUTPUT);   // Wheel 2 motor config
pinMode(10, OUTPUT);  //Wheel 3 motor config
pinMode(11, OUTPUT);  //Wheel 4 motor config
digitalWrite(8, HIGH);   // turn the LED on (HIGH is the voltage level)
digitalWrite(9, LOW);   // turn the LED on (HIGH is the voltage level)
digitalWrite(10, HIGH);   // turn the LED on (HIGH is the voltage level)
digitalWrite(11, LOW);   // turn the LED on (HIGH is the voltage level)
  }
void loop() {
long duration, distance; // defining two variables of datatype long
digitalWrite(trigPin, LOW); // ULTRASONIC sensor not sending sound signal
delayMicroseconds(2); // wait for 2 microseconds
digitalWrite(trigPin, HIGH); // Ultrasonic sensor sending sound signal
delayMicroseconds(10); //wait for 2 microseconds
digitalWrite(trigPin, LOW); //
duration = pulseIn(echoPin, HIGH); // time of flight for sound signal is taken
distance = (duration/2) / 29.1; // time is converted in to distance
Serial.println(distance); // printing the distance in serial monitor of Arduino IDE
if(distance<60)
  {
digitalWrite(8, LOW);   // turn the LED on (HIGH is the voltage level)
digitalWrite(9, LOW);   // turn the LED on (HIGH is the voltage level)
digitalWrite(10, LOW);   // turn the LED on (HIGH is the voltage level)
digitalWrite(11, LOW);   // turn the LED on (HIGH is the voltage level)
Serial.println("stop");
delay(100);
digitalWrite(8, HIGH);   // turn the LED on (HIGH is the voltage level)
digitalWrite(9, LOW);   // turn the LED on (HIGH is the voltage level)
digitalWrite(10, LOW);   // turn the LED on (HIGH is the voltage level)
digitalWrite(11, HIGH);   // turn the LED on (HIGH is the voltage level)
delay(1000);
digitalWrite(8, HIGH);   // turn the LED on (HIGH is the voltage level)
digitalWrite(9, LOW);   // turn the LED on (HIGH is the voltage level)
digitalWrite(10, HIGH);   // turn the LED on (HIGH is the voltage level)
digitalWrite(11, LOW);   // turn the LED on (HIGH is the voltage level)
   }
else
if(distance>60)
  {
digitalWrite(8, HIGH);   // turn the LED on (HIGH is the voltage level)
digitalWrite(9, LOW);   // turn the LED on (HIGH is the voltage level)
digitalWrite(10, HIGH);   // turn the LED on (HIGH is the voltage level)
digitalWrite(11, LOW);   // turn the LED on (HIGH is the voltage level)
Serial.println("front");
  }
delay(250); //pause to let things settle
  }
```

4.2 Grass Cutter Working Flowchart:

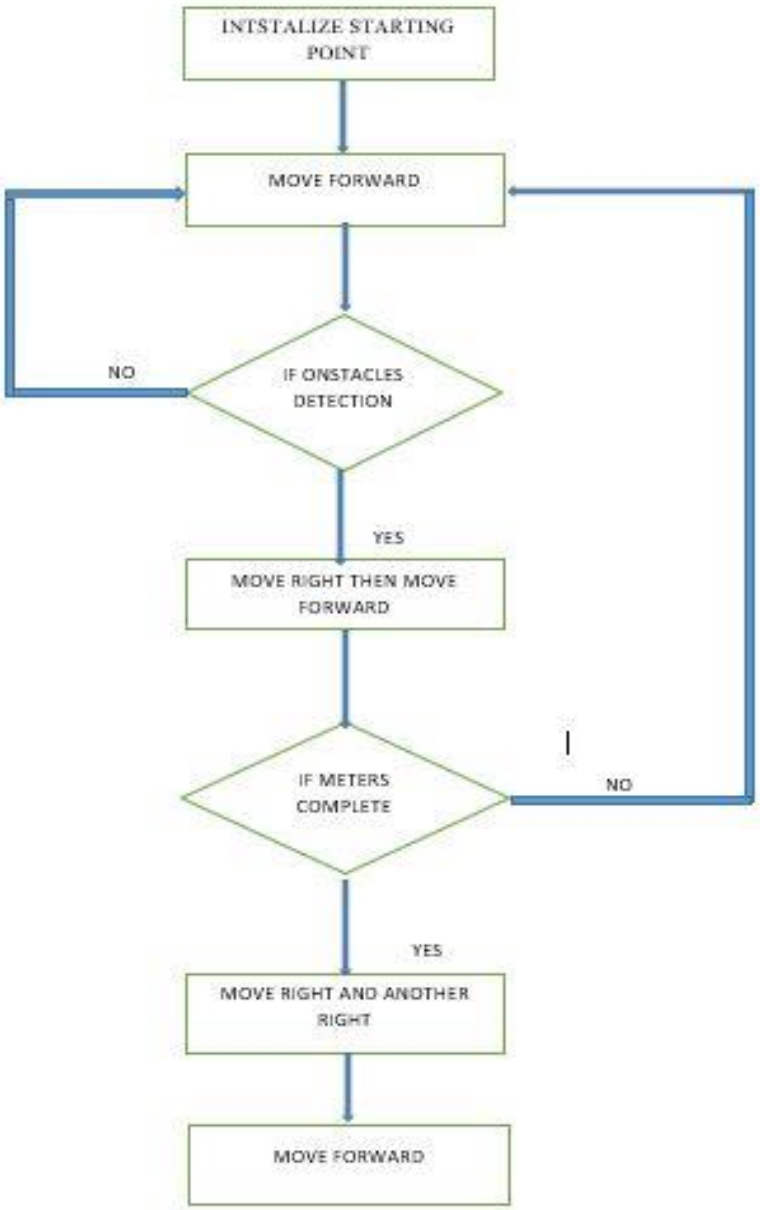

Figure 5. Flow Chart

4.3 Algorithm:

1. Start the system.
2. Move the system forward by changing the direction of transmitter circuit to down.
3. If obstacle occurs then move the grass cutter according to our convenience that is to left, right, reverse and if there is no obstacle then move forward.
4. When meters complete then move machine to left and another left or right and another right.
5. And move the machine forward.

5. RESULT

Completed with good results, the "Smart Solar Grass cutter with Lawn Coverage" project has been published. The batteries may be charged throughout the day so it can be used at night. As there are fewer moving parts and less of an initial investment is required, this project is more suited to the average person. While the grass cutter is moving, the battery will be charged, reducing the amount of work required of the workers. Below, you'll find a performance statistic that may be used differently depending on context.

Condition	Direction
1000	Forward
0100	Reverse
0010	Right
0001	Left

6. CONCLUSION

The overall energy obtained from the sun thus far surpasses our energy consumption, leading us to believe that it uses non-renewable forms of energy such as petrol, diesel fuel, etc. Our usage of solar energy, a sustainable source of energy, has eliminated the need for polluting fossil fuels and cut down on the time and work required to maintain our lawn. This machine requires little in the way of training even for a non-expert user. With the help of buttons and code, of course! In the face of an obstruction, it immediately adjusts course or ceases operations, making it both fast and precise. As a result, it is important to safeguard machinery in a way that both preserves its functionality and minimises the potential for harm to users.

7. REFERENCE

[1] Adeodu, A. O., et al. "Development of an embedded obstacle avoidance and path planning autonomous solar grass cutting robot for semi-structured outdoor environment." 2018 IEEE 7th International Conference on Adaptive Science & Technology (ICAST). IEEE, 2018.

[2] Trim, Phillip. Pooled resources: an experimental investigation of salt production and pottery manufacture within the LIA and Romano-British landscape of Poole Harbour, Dorset. Diss. Bournemouth University, 2019.

[3] Sandor, Daniel. Water conservation practices for irrigation of turfgrass lawns. University of Arkansas, 2018.

[4] Bijoor, Neeta S., et al. "A comparative study of the water budgets of lawns under three management scenarios." Urban Ecosystems 17.4 (2014): 1095-1117.

[5] Papoutsidakis, Michail G., et al. "Motion Sensors and Transducers to Navigate an Intelligent Mechatronic Platform for Outdoor Applications." Sensors & Transducers 198.3 (2016): 16.

[6] Yamashita, Kazuhiko, et al. "Hotsale Men Shoulder Bag Clear PVC Messenger Bag." Surgical Infections 20.8 (2019): 665.

[7] Movahed, Yasin, et al. "Investigation of single-storey residential green roof contribution to buildings energy demand reduction in different climate zones of Iran." International Journal of Green Energy 18.1 (2021): 100-110.

[8] Yamashita, Kazuhiko, et al. "Company Destk Calendar Business Calendar Wholesale with Custom Printing." Surgical Infections 20.8 (2019): 665.

[9] Yamashita, Kazuhiko, et al. "Company Destk Calendar Business Calendar Wholesale with Custom Printing." Surgical Infections 20.8 (2019): 665.

[10] Chatterjee, Soumendu, et al. "Simulating micro-scale thermal interactions in different building environments for mitigating urban heat islands." Science of the Total Environment 663 (2019): 610-631.

[11] Yamashita, Kazuhiko, et al. "Solid Liquid Separator Automatic Membrane Filter Press Manufacturers." Surgical Infections 20.8 (2019): 665.

[12] Charlesworth, Sue M. "A review of the adaptation and mitigation of global climate change using sustainable drainage in cities." Journal of Water and Climate Change 1.3 (2010): 165-180.

[13] Assmann, Jakob J., et al. "Vegetation monitoring using multispectral sensors—Best practices and lessons learned from high latitudes." Journal of Unmanned Vehicle Systems 7.1 (2018): 54-75.

[14] Couceiro, Micael S., and David Portugal. "Swarming in forestry environments: collective exploration and network deployment." Swarm Intell. Princ. Curr. Algoritm. Methods 119 (2018): 323.

[15] Hargey, Daniel Francis. Establishment and Management of TurfgrassUnder Municipal Water Restrictions. Diss. 2015.

[16] Kamal, S., Ramapraba, P. S., Kumar, A., Saha, B. C., Lakshminarayana, M., Sanal Kumar, S., ... & Erko, K. G. (2022). Optimization of Solar Panel Deployment Using Machine Learning. International Journal of Photoenergy, 2022.

[17] Dhanraj, J. A., Mostafaeipour, A., Velmurugan, K., Techato, K., Chaurasiya, P. K., Solomon, J. M., ... & Phoungthong, K. (2021). An Effective Evaluation on Fault Detection in Solar Panels. Energies, 14(22), 7770.

[18] Maheswaran, U., Kallam, R. B., Arathi, B., Prawan, K., & Anitha, G. (2021). Efficient plant leaf disease identification Material Fabrication using lightweight device. Materials Today: Proceedings, 47, 381-386.