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EXPERIMENTAL VALIDATION ON MODERN UTILIZATION OF SOLAR GRASS CUTTER WITH LAWN COVERAGE

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Abstract: ***The smart grass cutter system puts forth a completely automated lawn mower mechanism. The robotic vehicle is equipped with a grass cutter blade that allows for grass cutting at high RPM. The system has a smart functionality that allows it to cover the complete area of a lawn or garden by detecting corners using ultrasonic sensor and moving in a zigzag manner in order to cover the entire area. This efficient system uses a Micro-controller based circuit in order to achieve this functionality. It is a battery operated system that uses 2 batteries. One battery is used to run the vehicle movement DC motors and the other one is used to power the grass cutter motor. Also the system uses a solar panel to demonstrate the charging of vehicle movement battery. The Micro-controller operates the vehicle movement dc motors as well as the grass cutter at the same time as monitoring the ultrasonic sensors. The micro-controller smartly operates the dc motors using the motor driver IC to achieve desired movement based on ultrasonic inputs. The system also uses a gyro sensor in order to achieve perfect 180 degree turns in order to achieve complete lawn/garden coverage. Thus we conclude that it consumes non-renewable sources of energy like petrol, diesel gasoline. It is one form of pollution free and electricity is saved, we use solar energy which is renewable source of energy and reduces human efforts***

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

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I INTRODUCTION

1.1 GENERAL GRASS CUTTING TECHNIQUES:

The first lawn mower was invented by Edwin budding in 1830 in thrupp, just outside Stroud, in Gloucestershire, England. Budding's mower was designed primarily to cut the grass on grounds and extensive gardens, as a superior alternative to the scythe, and was granted a British patent on 31st August 1830 [1]. Budding's first machine was 480 mm wide with a frame made of wrought iron. The mower was pushed from behind. The Cast-iron gear wheels transmitted power from the rear roller to the cutting cylinder, allowing the rear roller to drive the knives on the cutting cylinder; the ratio was 16:1. Another roller was placed between the cutting cylinder and the main or land roller could be raised or lowered to alter the height of the cut [2]. The grass clippings were hurled forward into a tray-like box. It was soon realized, that an extra handle was needed in front to help to pull the machine [3]. Overall, these machines were remarkable and similar to modern mowers [4]. As the machine was the catalyst for the preparation of modern-style like grounds, sporting ovals, grass courts. This led to the codification of modern rules for many sports which includes football, cricket, tennis baseball and others [5]. There are several types of mowers each suited to a particular scale and purpose. The smallest type is up powered push mowers, which are suitable for small residential lawns and gardens. The larger types are electrical or piston engine-powered, push-mower is used for large residential lawns [6].

Riding mowers, sometimes resemble small tractors which are larger than push mowers and are suitable for large lawns, although commercial riding lawn mower such as zero-turn mower can be withstand-on types and after bear little

resemblance to residential lawn tractors being designed to large areas at high speed in short time [7]. The largest multi gang mowers are mounted on tractors and are designed for large expenses of grass such as golf courts and municipal parks, although they are ill-suited for complex terrain. However, hover mowers are power rotary push lawn mowers that use an impeller above the spinning blades to drive air downwards thereby creating an air cushion that lifts the mower above the ground. So the operator can easily move the mower as it floats over the grass [8]. Hover mowers are light in order to achieve the air cushion and it has plastic bodies with an electric motor. It is build to operate on steep slopes, waterfronts and high-weeded areas, so they are often used golf course green keepers and commercial landscapers. Grass collection is often available, but can be poor in some models. The quality of cut can be inferior if the grass is pushed away from the blade by the cushion of air.

Fig 1. Lawn mover

1.2 Smart Solar Grass Cutter With Lawn Coverage:

Grass cutter machines have become very popular today. Most of the times, grass cutting machines are used for soft grass furnishing. The technology is merging with environmental awareness. The consumers are looking for way to contribute to the relief of their own carbon footprints. Pollution is man-made and can be seen in our own daily lives, more specifically in our own house. Here, we propose a model which is Automatic Grass Cutting Machine powered through solar energy, (nonrenewable energy). Automatic grass cutting machine is a machine which is going to perform the grass cutting operation on its own. This model reduces both environment and noise pollution [9].

The working principle of solar grass cutter has a panel arrangement in a such a way that can receive solar radiation with high intensity directly from the sun. The solar panel converts 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. The motor is connected to batteries through connecting wires between these mechanical circuit breaker switch is provided. The breaker switch is used to start and stop the working of the motor [10]. 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 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.

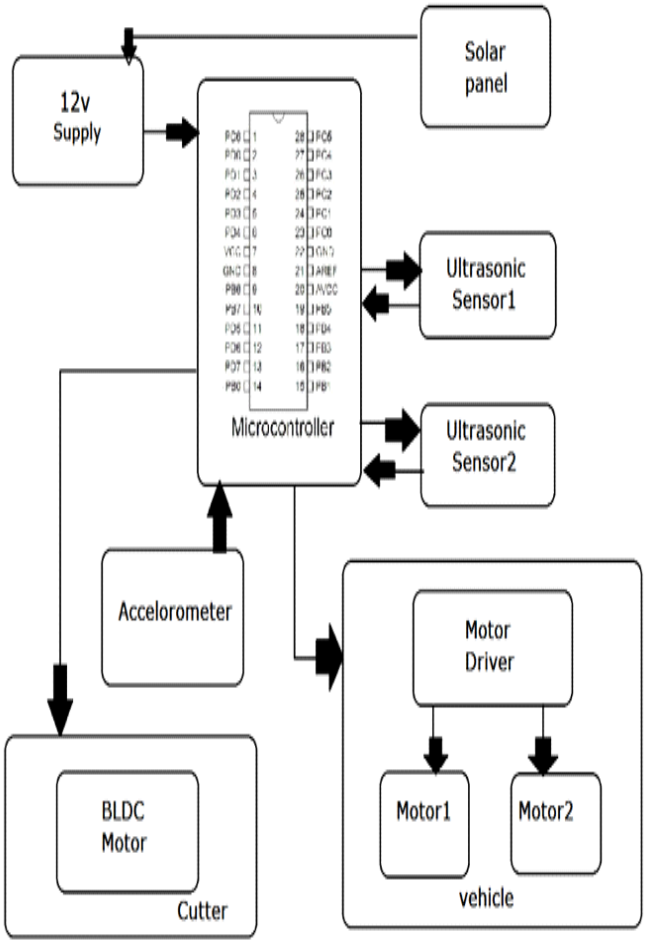

Fig 2.Block diagram

II EXPERIMENT AND METHODS

2.1. Hardware Components:

The Ardino Nano is a compact board similar to the UNO. The Ardino Nano can be powered via mini-B USB connection of 6-20v with unregulated external power supply or 5v regulated external power supply. The power source is automatically selected to the highest voltage source. The memory ATmega328P has 32 KB with 2KB used for the boot loader. The ATmega328P has 2KB of RAM and 1KB of EEPROM. It has 14 digital pins on the Nano of input and output. They operate at 5 volts. Each pin can provide or receive a maximum of 40mA and has internal pull-up resistor of 20-50 k ohms. It has different functions like Serial, External Interrupts, PWM, SPI, LED, I2C, AREF. The communication of Arduino Nano has N number of facilities for communication like computer, another Arduino or other micro-controllers etc. The ATmega328P provides UART TTL serial communication, which is available in digital pins 0 (RX) and 1 (TX). the Arduino software includes a serial monitor which allows simple textual data to send to and from the Arduino board. The digital pins 0 (RX) and 1 (TX) has LED's on the board will flash data is being transmitted via FTDI chip and USB connection to the computer.

The Arduino Nano can be programmed with the Arduino software (Arduino Duemilanove or Nano with ATmega328P from the tools board menu) according to the micro-controller on your board. The ATmega328P on the Arduino Nano comes with pre-burned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. It can also bypass the bootloader and program the micro-controller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar. The Arduino also has automatic software reset rather than pressing the reset button, the Arduino Nano is designed in a way that allows to reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the FT232RL is connected to the reset line of the ATmega328P via a 100 Nanofarad capacitor. This line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload a code by just pressing the upload button in the Arduino Nano board. A Sensor is used to converts the physical parameter into a signal which can measured electrically, two types of sensors are used Ultrasonic sensor and gyroscope sensor[4,5].

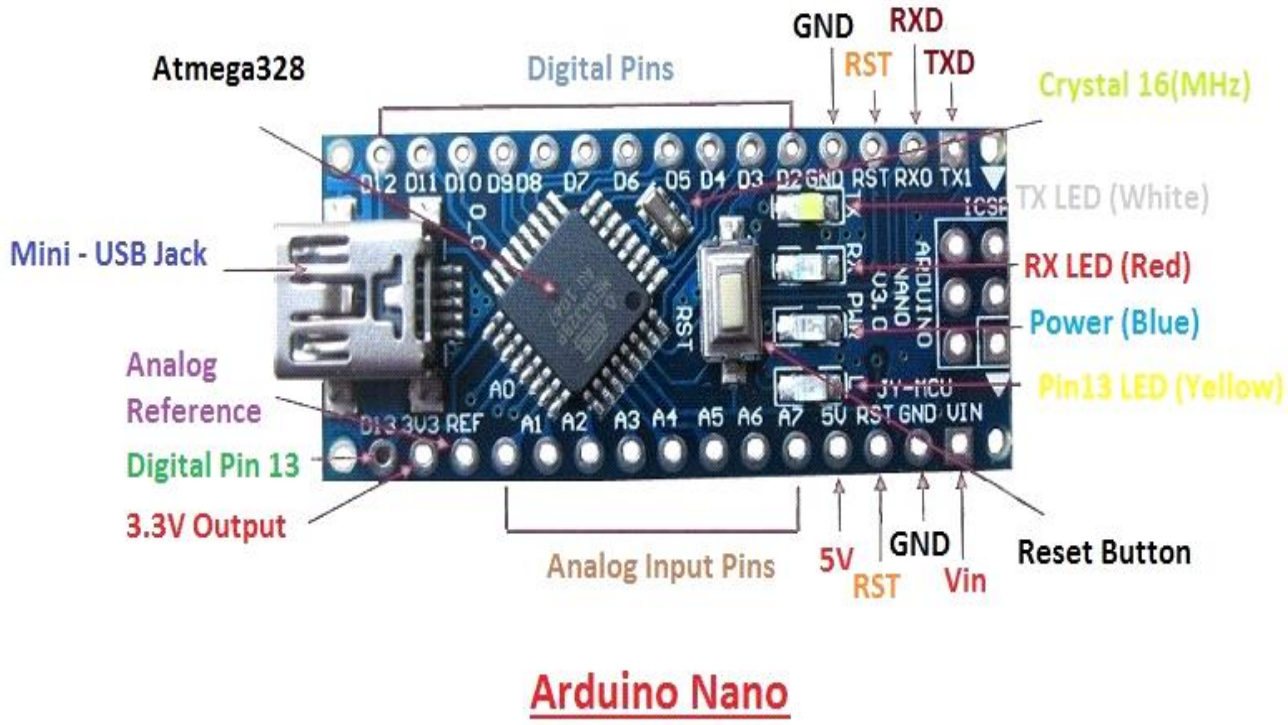

Fig 3. Arduino Nano

2.3. Power Supply:

Some power supplies have a manual switch for selecting input voltage, while others automatically adapt to the mains voltage. For the power supply solar panel and photo-voltaic is used, Solar Panel is used for conversion of energy from sunlight into electricity or directly using photo-voltaic[6].

The first solar cell was constructed by Charles Fritts in the 1880s[7]. The German industrialist Ernst Werner von Siemens was among those who recognized the importance of this discovery[8]. The solar cell efficiency is 4.5–6%[9]Concentrated solar power systems uses lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaic cells convert light into an electric current using photo-voltaic effect [10]. The lead acid battery is also used it is an oldest form of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, it has ability to supply high surge current that the cell have a relatively large power-to-weight ratio. Large-format lead–acid designs are widely used for storage in backup power supplies in cell phone towers etc and the modified version of the standard cell may be used to improve storage and reduce maintenance's requirements. Gel-cells and absorbed glass-mat batteries are common in these roles, collectively known as VRLA (valve-regulated lead–acid) batteries [11]. The machine which is responsible for moving and controlling a mechanism or a system is done by help of actuators. DC motor is used it has 12V DC motor, there are some application of DC motors, It has variable speed motor. Its high torque makes it particularly suitable for a wide range of traction application. Industrial uses are hoists, cranes ,trolley cars, elevators, air compressors

III DESIGN AND MATERIAL

3.1. Design:

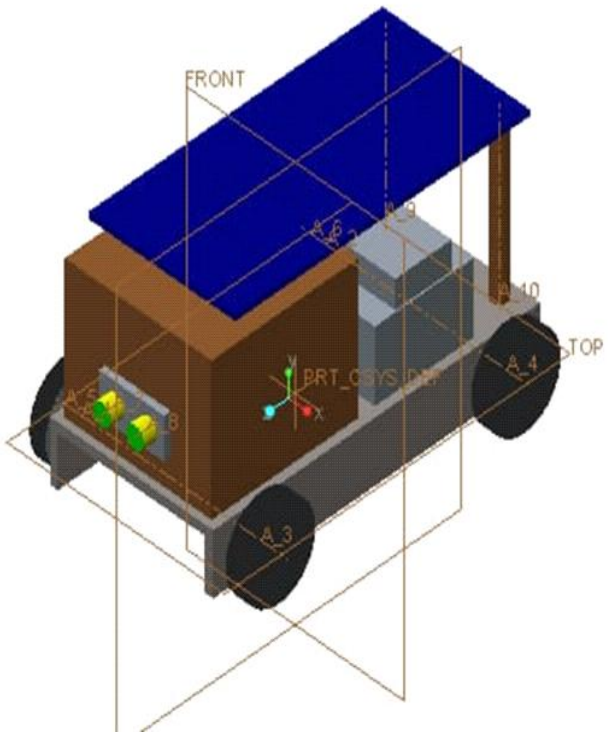

Fig 4. CAD model

The design of smart solar grass cutter is done in solid-works software 2017 based on parameters required and the solar panel is placed on the top of the chassis because the sunlight falls directly on the solar panel.

The battery is placed on middle of the chassis so it balances the chassis. The ultrasonic is sensor is placed on front of the chasse to detect the obstacles while the lawn mower is moving. The four wheels are connecting to the chasse at certain height because the blade is fixed to cut the grass. While cutting the grass the blade should not touch the ground. Based on these parameters the design is done. According to the publisher, over two million engineers and designers at more than 165,000 companies were using SolidWorks as of 2013[12].

3.2. Material:

The grass cutter machine has a chassis which is internal frame, which supports the object like circuit board, other electronics devices are mounted in its construction[13]. This chassis consist of gear, wheels, transmission and blade etc sometimes even the driver seat are included[14]. The design of a pleasure car chassis will be different than one for commercial vehicles because of the heavier loads and constant work use [15]. The wheel is place vertically under a oad-bearing platform, the wheel turning on the horizontal axle makes it possible to transport heavy loads. When mounted on a column connected to a rudder or a chassis mounted on other wheels, one can control the direction of a vessel or vehicle. Connected to a crank, the wheel produces or transmits energy. The blades are first known lawn mover, it sported a cylinder cutting gear made of iron. It was used to mow sporting grounds and wide-ranging gardens. As the manufacturers changed the design and structure of mowers, the cutting blade mechanism was developed and evolved into several varieties, including cylinder, deck blades, lifting blades. The strip like member is rotated in horizontal cutting edge and inclined trailing edge which creates a vortex effect within the housing when the strip is driven by a motor cause grass to assume a more vertical position for cutting. If the cutting edge of the strip strikes an obstacle, it will be deflected into a recess in the housing rather than propelling the obstacle might have resulted if the blade were rigid. The cutting blade becomes frayed the operator withdraws a new piece of the strip from the disc and cuts the used portion. To replace a spent disc, a cover plate on the bottom of the machine is removed and a new disc having a wound strip thereon is mounted on the cover plate after the spent disc has been removed.

3.3 Grass Cutter Working Flowchart:

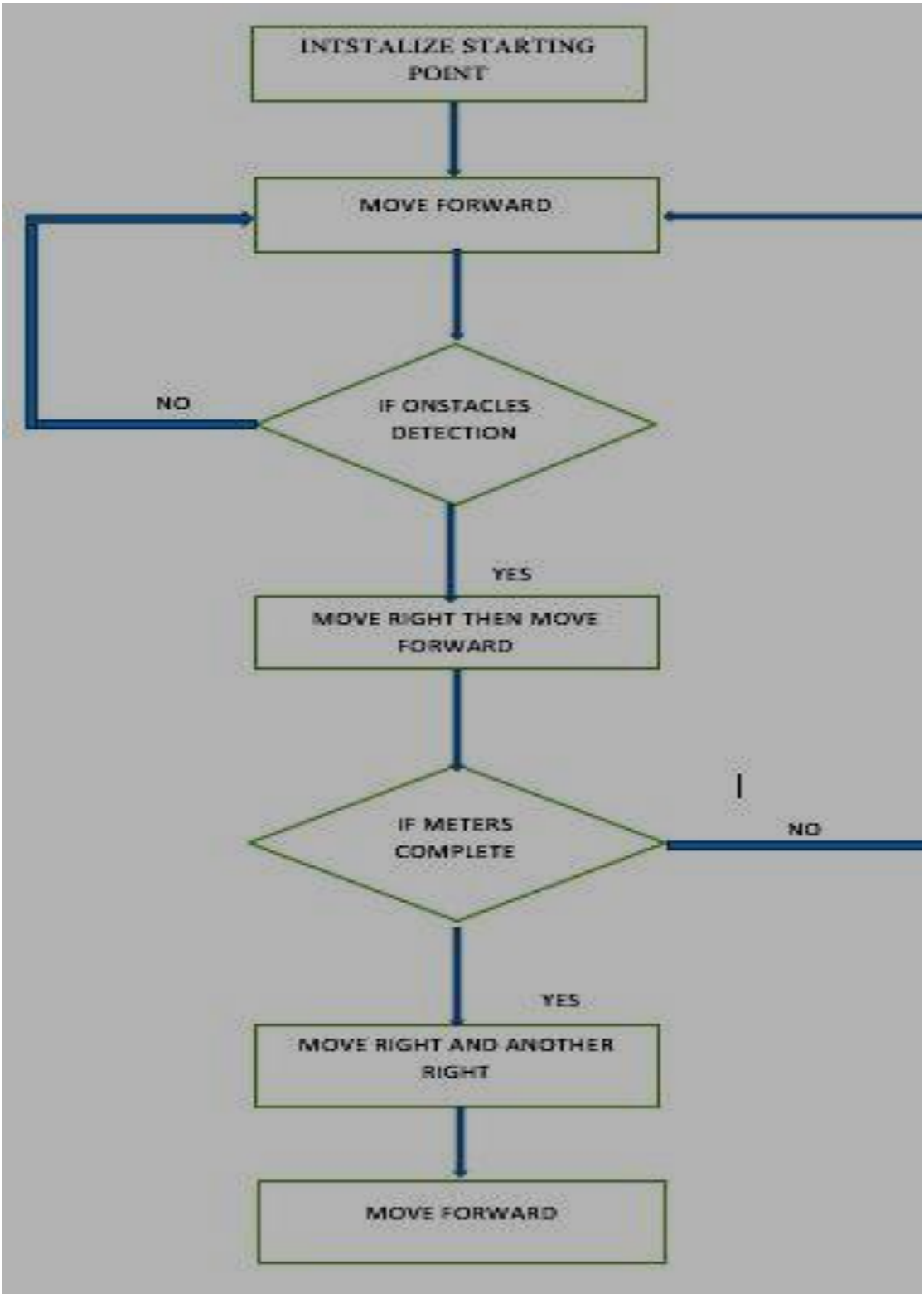

Fig 5. Flow Chart

IV . 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
  }
```

4.3 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. The meters complete then move machine to left and another left or right and another right
5. Move the machine forward.

V RESULT:

Smart Solar Grass cutter with Lawn Coverage is successfully completed and the results obtained are satisfactory. It can also be operated during the night time, as there is a facility to recharge the batteries in day light. This project is more suitable for a common man as it is having much more advantages like no fuel cost, no pollution and less wear and tear, because of less number of moving components. This will give much less physical exertion to the people and it will charge the battery while the grass cutter is in motion. The performance metric is given below which use is according to conditions and direction.

Condition	Direction
1000	Forward
0100	Reverse
0010	Right
0001	Left

VI CONCLUSION:

This Paper concludes that it consumes non-renewable sources of energy like petrol, diesel gasoline. The total energy received from sun so far exceeds our energy demand. It is one form of pollution free and electricity is saved as we have used solar energy which is renewable source of energy and environment hazardous gas powered lawn mower and reduces human effort. Non-skilled person can also use this machine very easily. By using simple switches or by programming. It is highly efficient and accurate because it detects the obstacle and changes the direction or stop functioning as per the instruction given. Therefore, equipment should be protected from damage and reduces risk on human.

REFERENCE:

[1]Athina, D., Kumar, D.K., Kalyani, R.B. and Vittal, K., 2021, February. Solar Grass Cutter Using Embedded Platform An Experimental Validation. In IOP Conference Series: Materials Science and Engineering (Vol. 1057, No. 1, p. 012086). IOP Publishing.

[2]Choudhury, R., Singh, D., Kumar, A. and Singh, Y., 2021. Design and Fabrication of Android Application-Based Grass Cutter Robotic System. In Recent Advances in Mechanical Engineering (pp. 271-281). Springer, Singapore.

[3]Behera, D.D., Design and Modeling of Solar Operated Grass Cutting Machine. Journal of Xi'an Shiyou University ISSN No, 1673, p.064X.

[4]Andersson, P., Labe, F., Mejervik Derander, J., Moen, E., Nitsche, A. and Wennerberg, E., 2018. Smart robot lawn mower Robot lawn mower without need for a boundary cable around the lawn (Bachelor's thesis).

[5]Sultana, A., Fatima, S., Mubeen, H., Begum, R., Sohelrana, K. and Jameel, A., 2020, June. A Review on Smart IoT based Gesture Controlled Grass Cutting Vehicle. In 2020 4th International Conference on Trends in Electronics and Informatics (ICOEI)(48184) (pp. 440-444). IEEE.

[6]Balaji, A., Shanthini, E.R., Rooshan, M.J. and Sivaram, V., 2021, January. Robust Design of Smart Lawn Cutter for Gardening Companion. In IOP Conference Series: Materials Science and Engineering (Vol. 1012, No. 1, p. 012005). IOP Publishing.

[7]Khillare, S.R., Morey, D.P., Bhagyashri, A.G., Thorat, S.S., Pimple, S.D. and Sharma, M.O., 2020. Fully Automated Grass Cutter Using Solar Power. International Journal of Progressive Research in Science and Engineering, 1(4), pp.132-136.

[8]Adeodu, A.O., Daniyan, I.A., Ebimoghan, T.S. and Akinola, S.O., 2018, August. Development of an embedded obstacle avoidance and path planning autonomous solar grass cutting robot for semi-structured outdoor environment. In 2018 IEEE 7th International Conference on Adaptive Science & Technology (ICAST) (pp. 1-11). IEEE.

[9]Chavan, P.M., Khurde, D.V., Adepwar, S.N., Kute, S.S. and Kundu, D.R., Solar Powered Electric Grass Cutter, Pesticides Sprayer and Lighting Unit.

[10]Sinha, Y. and Mathur, S.M., 2020. Development and Performance Evaluation of Solar Powered Lawn Mower. Int. J. Curr. Microbiol. App. Sci, 9(5), pp.3378-3384.

[11]Daniyan, I., Balogun, V., Adeodu, A., Oladapo, B., Peter, J.K. and Mpofu, K., 2020. Development and Performance Evaluation of a Robot for Lawn Mowing. Procedia Manufacturing, 49, pp.42-48.

[12]More, S.M., Pujari, R.K., Jadhav, S.S., Kalli, K.R. and Mali, D.P., Fully Automatic Solar Grass Cutter.

[13]Bhalodi, T., Bhujbal, N., Doshi, K., Goregaonkar, R. and Jagtap, S., 2020. Environmental Friendly Solar Grass Cutter. International Journal of Research in Engineering, Science and Management, 3(7), pp.177-180.

[14]Khillare, S.R., Morey, D.P., Ghoti, B.A., Thorat, S.S., Pimple, S.D. and Sharma, M.O., 2020. A Review of Fully Automated Grass Cutter Using Solar Power. International Journal of Research in Engineering, Science and Management, 3(7), pp.108-111.

[15]Habib, M.R., Ahmed, K., Khan, N., Kiran, M.R., Habib, M.A., Hasan, M.T. and Farrok, O., 2019, July. PID controller based automatic solar powerdriven grass cutting machine. In 2019 International Conference on Computer, Communication, Chemical, Materials and Electronic Engineering (IC4ME2) (pp. 1-4). IEEE.