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PID CONTROLLER BASED SOLAR LAWN MOWER

Adersh Remesh[1,a)], Amarjith S[2,b)], Amjed Ali P[3,c)], Ashly S Pathirikal[4,d)], Deena George[5,e)]

[1,2,3,4,5] Department of Electrical and Electronics Engineering, Mar Athanasius College of Engineering, Kothamangalam, Ernakulam, India

Abstract: An automatic grass cutting machine is designed and implemented that uses solar energy as its primary source. The proposed grass cutter is lightweight and portable. It has two major parts: one is a motor-powered base and the other is cutting blades with motor. Its default mode is automatic although it can be operated manually if necessary. By using a magnetomet that is compass and with a GPS module location of the plot of land can be identified and is able to move automatically towards the grass by its motorized controlled base. As soon as the motor driven cutting blade comes close to the grass, it starts cutting and continue until all grasses around it is being cut down. The prototype of the grass cutter is tested experimentally. Two degree-of-freedom PID controllers are proposed to control the motor speed of the prototype. PID controller is simulated in MATLAB SIMULINK software. Bluetooth devices can be used to communicate with the owner of grass cutter through smartphone. The hardware is tested using prototype.

Keywords: Lawn Mower, GPS Module, Set Speed, PID Controller

I. INTRODUCTION:

In the time where technology is merging with environmental awareness, consumers are looking for ways 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 homes. Gas powered lawn mower are in 90 percentage of U.S. home and they create 5 percentage of the total U.S. pollution. Green technology initiatives are being support by both the government and cooperates business. Our new design for an old and outdated habit will help both the consumer and the environment. This project of a solar powered automatic lawn mower will relieve the consumer from mowing their own lawns and will reduce both environmental and noise pollution. This design is meant to be an alternate green option to the popular and environmentally hazardous gas powered lawn mower. Ultimately, the consumer will be doing more for the environment while doing less work in their daily lives. The hope is to keep working on this project until a suitable design can be implemented and then be ultimately placed on the market. Many research works have been done regarding solar power-driven grass cutter. A stainless-steel blade is used for grass cutting purpose which is powered by a dc motor. The rechargeable battery is used to store the energy for the time duration of insufficient/unavailable sunlight. Battery charging from ac source is used for emergency use. The trimmed grass is collected into a specific bag to put outside the lawn . The Schmitt-trigger is used for the comparator in the controlling circuit. A radio frequency wireless sensor-based control system is used, which remains in water. The water sprinkled over the trimmed grass area after the grass has been cut.

In this paper, an effective, lightweight, and portable solar power-driven automatic grass cutter is proposed. A lawn mower is a machine used to mow grass or plants. This machine is commonly used to tidy up the garden and also to clear the fields from grass or other types of grass. The commonly used lawn mowers are made of thin, hard and very sharp iron plates, so they can easily mow the grass. As trained manpower is becoming a problem nowadays, planning of automatic system is the smart solution. Moreover, a small battery storage is inserted in the device to make the system workable on rainy day which also makes it functional at night. To

achieve good visibility, an automatic flash light with a sensor is mounted. The proposed grass cutter is suitable for small land area, such as in garden, house, office, etc.

II. METHODOLOGY:

Cutting grass manually is time consuming task and causes lot of fatigue for the operator due to the vibrations and noise created. This study focuses on building a battery powered autonomous lawn mower which can be used in residential and corporate lawns, golf carts and playgrounds. Existing machines in the market needs a guide wire around the lawn, does not move in even pattern, cannot handle a inclination and very expensive. This study will work to overcome all these limitations.

SYSTEM CONFIGURATION:

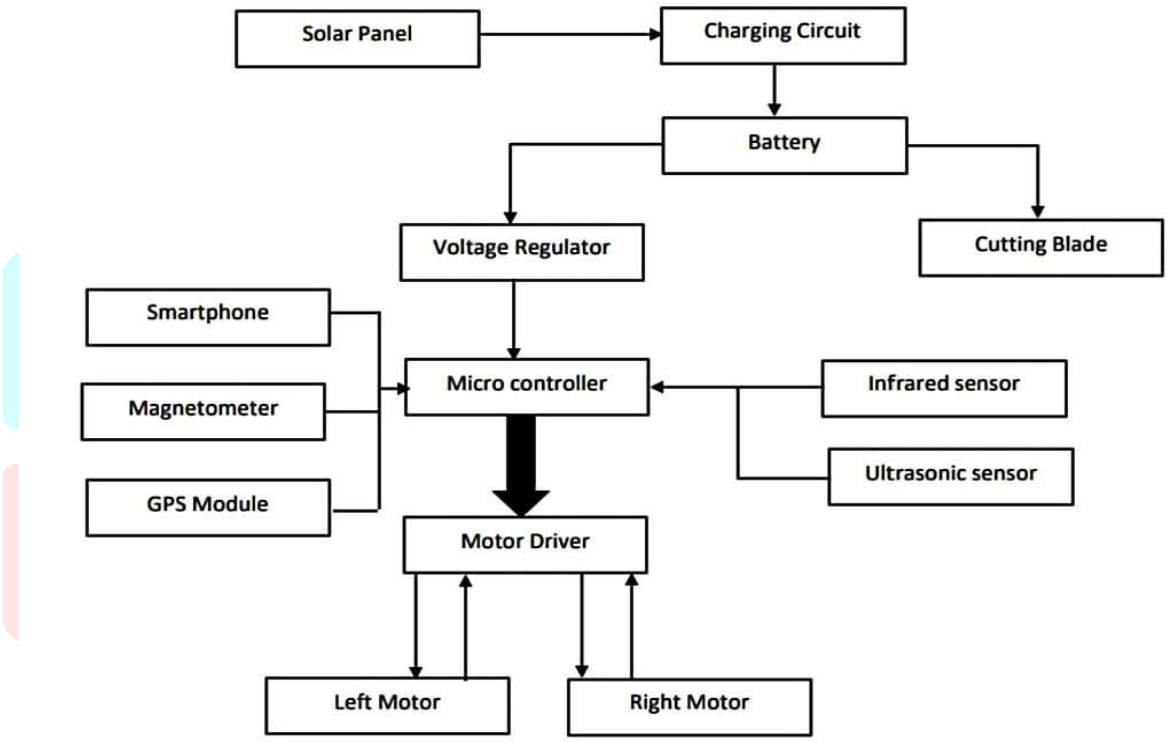

Figure2.1: Block diagram Representation

The use of solar power as an alternative source of energy has been in existence long before now but has not had diverse application methods due to other frequently used sources of energy. Solar energy involves the process of harnessing radiant light and heat from the sun using a range of ever evolving technologies such a solar thermal energy and photovoltaics. These technologies are broadly characterized as either passive solar or active solar depending on how the energy is converted to solar power. The effectiveness of these technologies have made solar energy a very important source of renewable energy and thereby giving room for new developments in its wide range application processes. In the world today, world's power consumption is taking a shift from the use of common sources of energy such as fossil fuel and wood fuels to solar energy. The change in energy consumption trend was due to the awareness of fossil fuel pollution and its contribution to global warming, and also the fact that fuel energy is non-renewable and unsustainable. The solar powered lawn mower involves the use of solar energy to charge a direct current battery which supplies the current stored to the motor which in turn enables rotation of the blade for mowing. The solar panel receives energy from the sun, when the sun shines, the solar panel or photo voltaic cell will generate or produce voltage.

III. SIMULATION:

The simulation of robot is done on Proteus 8 Professional. In order to design a Lawn Mower, various sources of power like solar PV, battery are connected and charging circuit are implemented. All these sources are connected to ensure the efficient power management of the Mower.

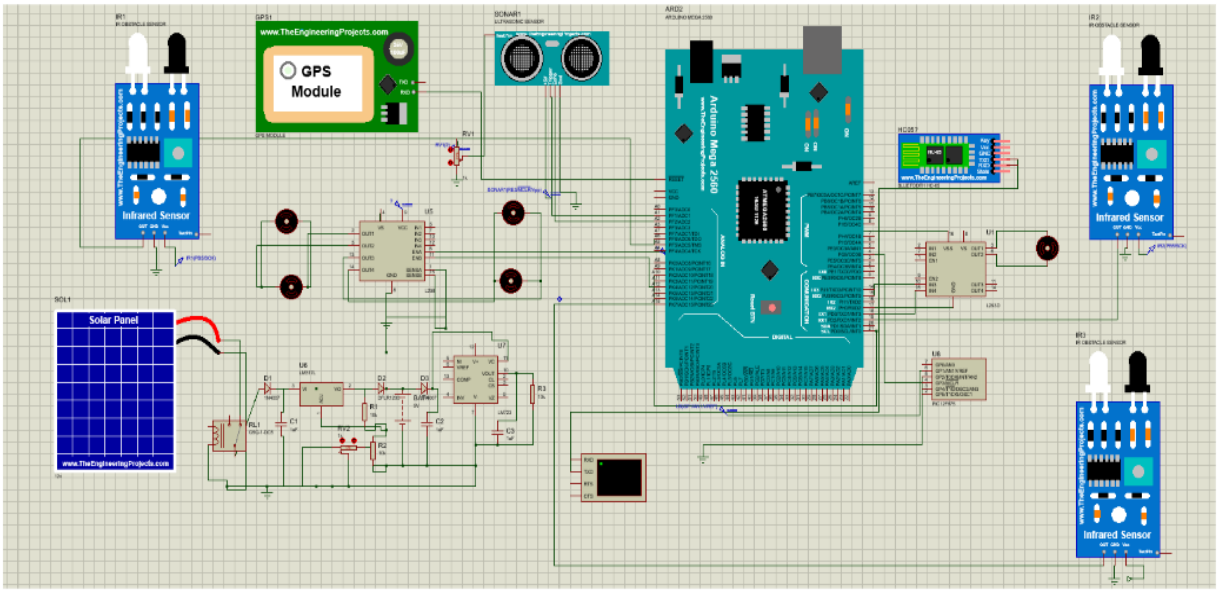

Figure 3.1: Circuit Diagram

The solar powered lawn mower involves the use of to charge a direct current battery which supplies the current stored to the motor which in turn enables rotation of the blade for mowing. The solar panel receives energy from the sun. When the sun shines, the solar panel or photo voltaic cell will generate or produce voltage. An ultrasonic sensor is implemented to measure the distance of a target object and identify the obtacles on the path of the lawn mower. A colour Senor is used to sense the green colour. A bluetooth module is connected which can be used Communicate with the Owner of grass cutter through smartphone. Thus the lawn mower can have 2 modes of operation, manual mode and automatic mode. Figure 3.1 shows the circuit diagram.

SIMULINK MODEL:

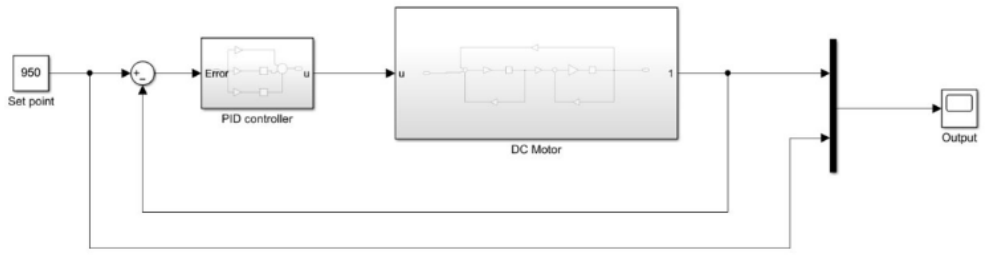

Figure 3.2: Simulink Model

The 775 DC Motor is Controlled by PID Controller is simulated in MATLAB/SIMULINK and the Simulink model is shown in Figure 3.2.

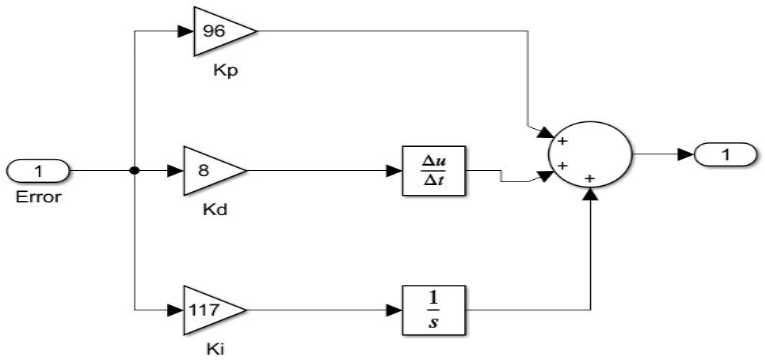

Figure 3.3: Inner Block Of PID Controller

This Figure 3.3 shows the inner block of PID Controller with Kp 96, Ki 117 and Kd as 8.

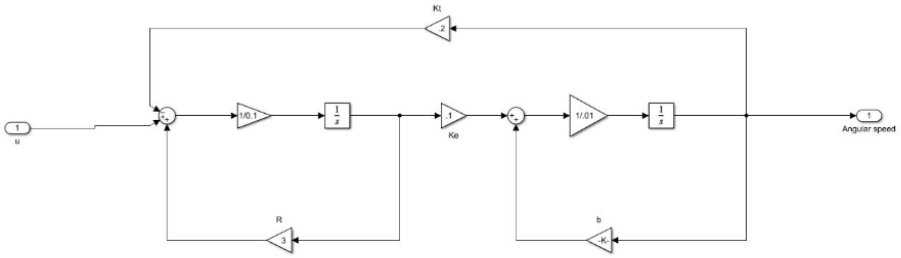

Figure 3.4: Inner Block Of DC Motor

Figure 3.4 represents the internal model of a dc motor. In this model various values related to motor like moment of inertia (j) , back emf constant, coefficient of friction (b) etc are used to get the performance of the given motor.

SIMULATION RESULT:

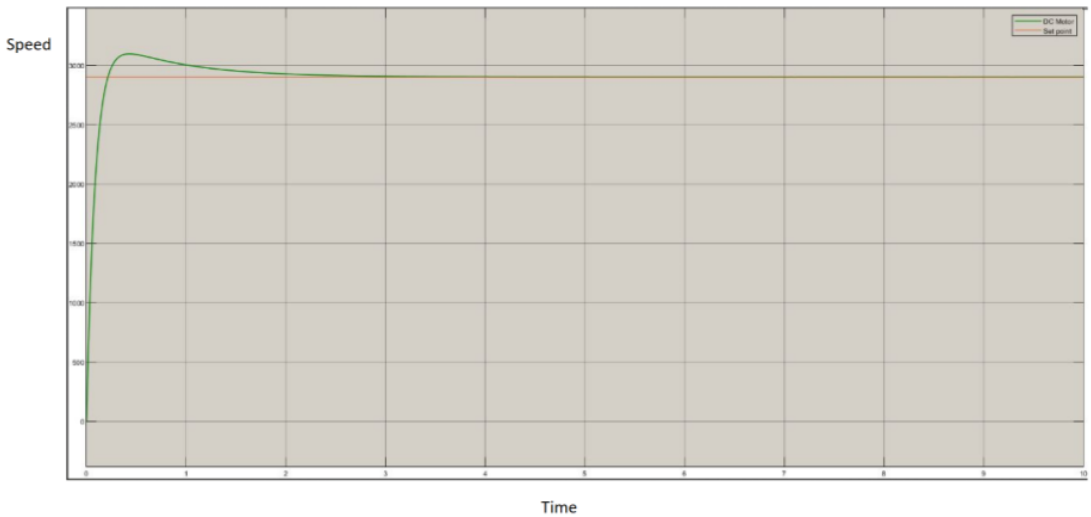

Figure 3.5: Simulation Result

A set speed of 2900 RPM is given to the PID Controller which is connected to the motor. Then at normal times motor rotate at 2900 RPM but when it cuts dense grass its speed reduces. Then to compensate that speed PID Controller is used. Simulation result is shown as Figure 3.5.

IV. HARDWARE SETUP:

A lawn mower is a machine that uses cutting blades or strings which is used to cut the grass in gardens or yards at an even length. The working principle of the lawn mower is to provide a high speed rotation to the blades, which aids in cutting the grass through generated kinetic energy.

Figure 4.1: Hardware setup of Lawn Mower

The body consist of a cutting blade, solar panel, ultrasonic sensor and different other sensors for detection of obstacles and cutting purpose.

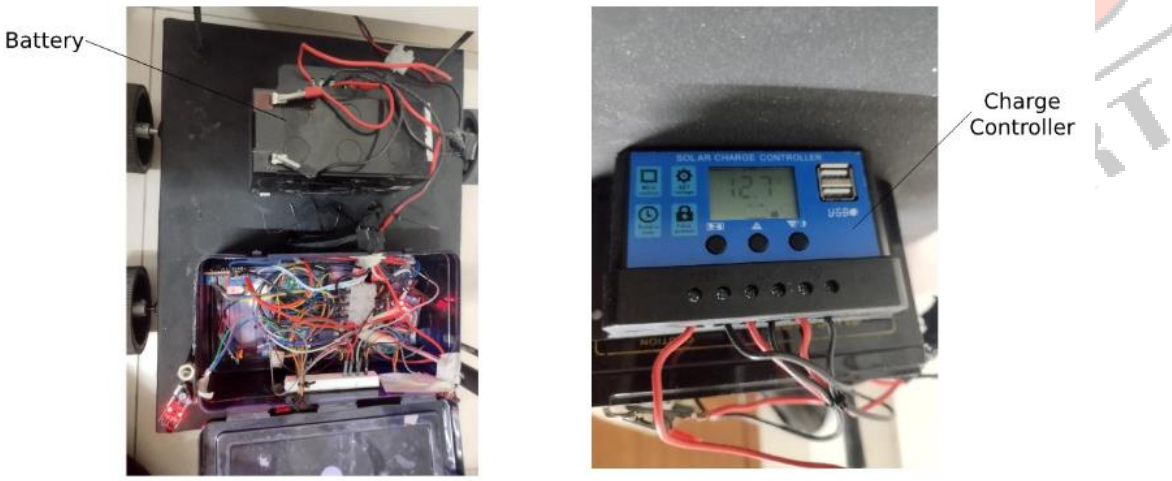

Figure 4.2: Battery And Other Components

Different views of Solar Lawn Mower is shown in Figure 4.2. Showing the connection of other components to the battery and the charge controller.

Figure 4.3: Cutting Blade

The cutting blade is a part of the machine for cutting the grass as the Lawn Mower moves on its path. Here a hard steel blade is used for the cutting purpose. For the movement of the blade a 12v 1000rpm OG555 DC motor is used. cutting blade is shown in Figure 4.3.

V. CONTROLLER APPLICATION:

Figure 5.1: Connected State Of Application

BUTTONS AND FUNCTION

a) Connect button : Connect the phone to the lawn mower circuit.

b) Disconnect button : Disconnect the phone from lawn mower circuit.

c) Forward : Move the mower forward.

d) Backward : Moves the mover backwards.

e) Right : Turns mower by a small angle to the right.

f) Left : Turns mower by a small angle to the left.

g) 90 degree right : Turns mower 90 degree towards right.

h) 90 degree right : Turns mower 90 degree towards left.

i) Auto mode : Set the lawn mower on complete automatic mode.

j) Manual mode : Set the mover on complete app control mode.

k) Mower on: Turns on the cutting motor on during manual mode.

l) Mower off: Turns on the cutting motor off during manual mode.

m) Stop : Completely terminate all functions on mower immediately.

n) Get current location button : Search for current location and store it in the map \indent on the app.

o) Toggle map : Make the arrow keys disappear and show the stored location that \indent is the current location on a map.

p) Set way point button : Store the location at the time of hitting the button as \indent way points for the mower to navigate.

q) Done button : End the storing of wave points into the array so as to start \indent navigation.

r) Go to waypoint button : Initiate the navigation of the lawn mower through the \indent stored way points.

s) Clear all way points button : Reset the array to store new way points.

t) Calibrate button : Calibrates the compass inside the mower.

u) Set heading button : Store the current angle of compass as heading.

v) Compass drive button : Ensure travelling of the mower in the given heading with \indent a tolerance limit of 5 degrees.

In the application if click on the get current location button, it will search for the current location and store it in the map on the app. Then as the toggle map button is activated it will make the arrow keys disappear and shows the stored location, that is the current location on the map.

V. CONCLUSION:

An ecofriendly solution for lawn mowing is provided. From observations, it may be concluded that, the system is more efficient considered to earlier designs, as it eliminates need of man power as well as it is pollution free. The system works very well on flat surface lawn, however in case of uneven surface; obstacle detection stage fails to detect objects near to the system. Also, for patchy lawn surface, the system halts when no grass is detected and requires manual control. PID Controller based Lawn Mower helps to maintain the same speed to the cutting motor as it cut dense grass. The lawnmower design is achieved minimum working time, minimize the cost, minimum energy consumption, and mixed operation mode. By implementing a magnetometer and GPS module, the current location and direction of the Lawn Mower can be identified by a application in mobile phone. The theory proposed in path planning has been verified with experiments. In future a grass collection box can be mounted.

VI. ACKNOWLEDGEMENT

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