Autonomous Solar Powered Agro Based Cleaning Bot Using Image Processing Technique

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Abstract-The Solar Panel can be employed in any condition as long as the rays of the sun are reaching its surface .There are several factors which affect the efficiency of solar panels among which one of the major factors is the presence of dust particles. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces by as much as 50%, if the module is not cleaned for a month. In order to regularly clean the dust, an automatic cleaning system has been designed, which senses the dust on the solar panel and also cleans the module automatically. In terms of daily energy generation, the presented automatic cleaning scheme provides about 30% more energy output when compared to the dust accumulated PV module. The device consist of one single brush which is going to perform the necessary cleaning. The arduino microcontroller will make sure that the brush cover the entire length of solar panel and provides efficient cleaning. A sprinkler system is also attached to the side of the panel module which will sprinkle water at regular interval to the surrounding crops. The sprinkling time is further controlled by IC555 timer module. Thus in total the device ensures a multifunctional role i.e cleaning the solar panel as well as providing water to the surrounding crops.

Index terms: Solar Energy, Cleaning System, Automatic system

I. INTRODUCTION

As the range of applications for solar energy increases, so does the need for improved materials and methods used to harness this power source. There are several factors that affect the efficiency of this collective process. Major influences on overall efficiency include solar cell efficiency, intensity of source radiation and power storage techniques. Temperature rise also affects the efficiency of PV cells due to intrinsic characteristics of semiconductor material This makes it particularly difficult to make considerable improvements in the performance of the cell, and hence restricts the efficiency of the overall collection process. Therefore, the most attainable method of improving the performance of solar panel modules is to increase the mean intensity of radiation received from the source. There are three major approaches for maximizing power extraction in medium and large scale systems. They are sun tracking, maximum power point tracking or both. The solar tracker, a device that keeps photo voltaic or photo thermal panel in an optimum position perpendicularly to the solar radiation during daylight hours, can increase the collected energy from the sun by up to 40%. Usually the fixed PV panels cannot follow the sun movement. The single axis tracker follows the sun's East West movement, while the two-axis tracker follows the sun's changing altitude angle too. Sun tracking systems have been studied with different applications to improve the efficiency of solar systems by adding the tracking equipment to these systems through various methods. A tracking system must be able to follow the sun with a certain degree of accuracy, returns the panel to its original position at the end of the day, and also tracks during cloudy periods

1.1. Objectives

Thus in order to prevent this energy reduction due to the accumulation of dust particles and ensure a smooth and proper functioning of the solar panel at full efficiency. The following objective are listed below-

- To clean the solar panel effectively.
- To avoid manual work.
- To avoid dust associated problems on solar panels.
- To improve overall solar panel efficiency.
- To ensure a multifunctional role.

II. LITERATURE REVIEW

In a study, (ISSN No:-2456-2165 Dinesh Kumar P Assistant Professor of Department of Instrumentation and Control Engineering Dr. Mahalingam College of Engineering and Technology, Pollachi, INDIA) it was found that the systems cleaned after one year of exposure to dust and dirt using pressurized distilled water spray with brushing showed 6.9% energy generation efficiency.

Article in European Journal of Science and Technology October 2019- The dust accumulation on the solar panel is so severe that the overall efficiency reduces up to 50%, depending on the environment.. Efficiency can be further reduced due to temperature rise of the panel.

 DOI : 10.35291/2454-9150.2021.0558

According to research daily-Per day energy loss along a year caused by dust is around 4.4% . During long periods without rain, daily energy loss can be higher than 20%.

III. MAIN COMPONENTS

3.1 Frame

A wooden platform is going to surround the solar panel module whose size depends upon the dimensions of the solar module that is required to be cleaned. The wooden platform supports two motors .Both the motors are connected to a flexible rods which is further attached to the brush. The platform also consists of a slider system so the motor wheel can rotate and creates some displacement for the brush to reach from one end of the panel to other.

3.2 Brushes

Brushes are the key components that perform the actual cleaning. Total of 2 brushes are used here. These brushes are made to move in such a manner so that the entire area of the solar panel can be covered.

3.3 Battery

Sealed lead acid battery with voltage 12V and nominal capacity of 7A is used for the energy storing purpose. The battery usage and maintenance is of free type .The battery is charged during the day in the presence of sun (i.e., solar energy) and used when necessary. The battery after charging can be used up to 5-6 hrs continuously.

Fig1:Battery

3.4 DC gear motor-

A gear motor is an all-in-one combination of a motor and gearbox. The addition of a gear head to a motor reduces the speed while increasing the torque output.(Power (P) = Speed x Torque)The movement of the bot along the wooden platform does not need high speed but large torque so that the bot can carry heavy loads. This large torque is obtained using gearbox. (Torque is inversely proportional to speed).

Rating-

Speed - 30 rpm

Voltage - 12 V DC

Fig2:DC motor gear

3.5 IR sensor-

Ir infrared obstacle avoidance sensor module has a pair of infrared transmitting and receiving tubes. When the transmitted light waves are reflected back, the reflected ir waves will be received by the receiver tube. The onboard comparator circuit does the processing and the green indicator obstacle comes to life. The module features a 3 wire interface with vcc, gnd and an output pin on its tail. It works fine with 3.3 to 5v levels. Upon hindrance/reflectance, the output pin gives out a digital signal (a low level signal). The onboard potentiometer helps to fine tune the range of operation, effective distance range is 2cm to 80cm.

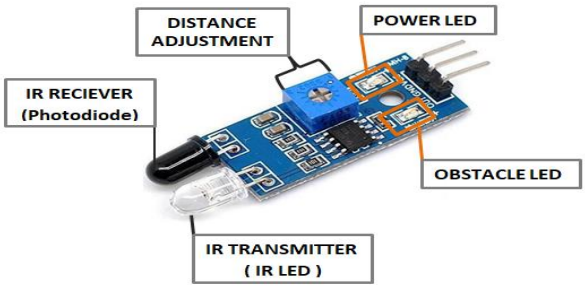

Fig3:IR sensor

3.6 Solar Panel-

Solar panel of 20 watts 12volts,1.4amps.Photovoltaic solar panels absorb sunlight as a source of energy to generate electricity

Fig4:Solar Panel

 DOI : 10.35291/2454-9150.2021.0558

3.7 L298N Motor driver module

Since the geared DC motors being used work on 12 V DC input , whereas the microcontroller works on 5 V DC. So the function of the motor driver is to take a low current signal and then turn it into a high current signal which can drive the motor.

L298N Based Motor Driver is a high power motor driver perfect for driving DC Motors and Stepper Motors.

It uses the L298 motor driver IC and has an on-board 5V regulator by which it can supply to an external circuit.

It can control the speed and direction of a 2-phase bipolar stepper motor or two 3-30 V DC motors with the L298 dual H-Bridge chip.

Specifications :

Operating Voltage(V DC) : 5~35

Peak Current (A) : 2

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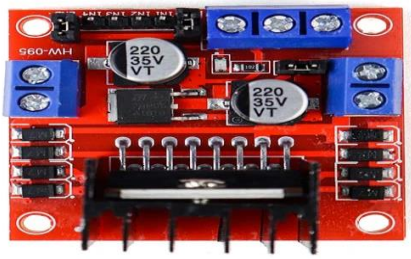

Fig5:Motor driver module

3.8 Arduino microcontroller

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment) It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

Technical Specifications

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)
- PWM Pins: 6 (Pin # 3, 5, 6, 9, 10 and 11)
- UART: 1
- I2C: 1
- SPI: 1
- Analog Input Pins: 6
- Clock Speed: 16 MHz

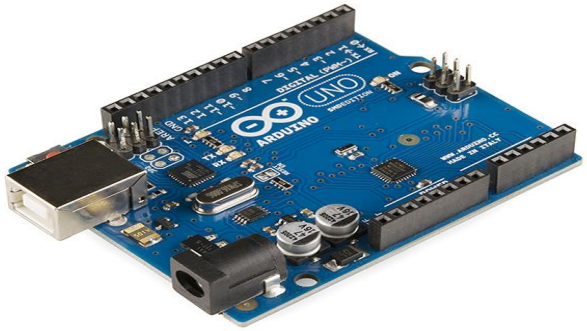

Fig:6:Arduino Uno

3.9 IC555 Timer

IC555 timer is a well-known component in electronic circles. It is one of the most widely used ICs in electronics and is used in various electronic circuits for its robust and stable properties. It works as a square-waveform generator with duty cycle varying from 50% to 100%, Oscillator and can also provide time delay in circuits..

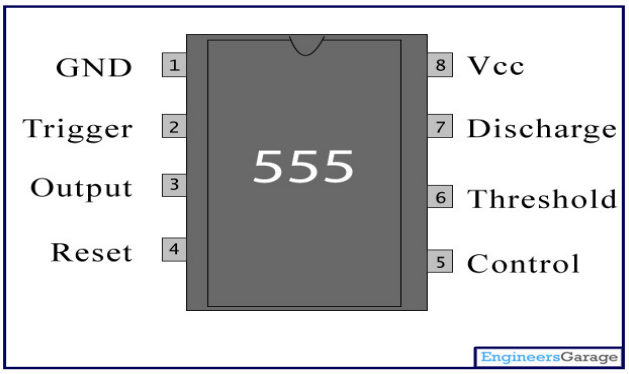

Fig 7 555 timer pin diagram

3.10 Micro Submersible Pump Mini water pump-

Micro DC 3-6V Micro Submersible Pump Mini water pump for Fountain Garden Mini water circulation System DIY project. This is a low cost, small size Submersible Pump Motor which can be operated from a 3 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect the tube pipe to the motor outlet, submerge it in water and power it.

Fig 8 Pump:

 DOI : 10.35291/2454-9150.2021.0558

Specifications:-

- Operating Voltage : 3 ~ 6V
- Operating Current : 130 ~ 220mA
- Flow Rate : 80 ~ 120 L/H
- Maximum Lift : 40 ~ 110 mm
- Continuous Working Life : 500 hours
- Driving Mode : DC, Magnetic Driving
- Material : Engineering Plastic
- Outlet Outside Diameter : 7.5 mm
- Outlet Inside Diameter : 5 mm

IV. WORKING

The solar powered battery will store electrical energy while it is in standby state. The bot is incorporated with the HC-05 bluetooth module, for wireless communication with bluetooth enabled devices like smartphones.. The module communicates with the microcontroller using serial communication (USART). Only the activation of the bot by a bluetooth signal is manual, rest all the operations involving the cleaning of panel arrays are automatic.

The NE555 2 - channel timer delay relay module is incorporated with 555 timer IC chip. Its operating voltage is 5V DC. Rated voltage is 10 A 250 VAC and 10 A 30V DC. It is given a 5 V DC power from the microcontroller, and triggering pulse is given after a delay time decided by the arduino code provided to the microcontroller. The delay is approximated to be 5 seconds. The relay is connected to two water pumps (water sprinkler system) which when turned on sprays water on the panel (for wet cleaning) at regular intervals of 3 to 10 seconds. The R(resistor) and C(capacitance) values of the 555 timer circuit decide the timing operation of the timer by the formula T=RC. The 555 timer is made to work as an astable multivibrator with 20 to 80 % duty cycle.

The cleaning unit moves on the locomotive frame on the panel in a back and forth motion. The cleaning of the panel array is a three stage process consisting of the bot moving back and forth on the panel and the locomotive frame moving parallel to the edge of the solar panel to reach the uncleaned part of the panel array. The back and forth motion of the bot is accompanied with wet cleaning of the panel. The cylindrical brush mounted on the cleaning unit rotates in the clockwise direction along with water pumps spraying water on the panel in an interval of 3 to 10 seconds.

When it is activated, by a bluetooth signal, the cleaning unit along with the rotating brush moves along the solar panel towards the bottom of the panel. The two water pumps sprinkle water on the panel at regular intervals to perform wet cleaning. Along the entire path, it washes away any kind of dust dirt and cleans the surface of the panel off any bird droppings etc. The brushes are so placed on the frame, that they do not put any load on the panel surface.

The lower and the upper edges of the panel are marked with any distinct object (simple black coloured tape). Once the cleaning unit reaches the lower end of the panel, the IR sensor(connected to the microcontroller) detects this black tape or any distinct object for that matter, thereby concluding the first process of cleaning. This indicates the end of the first cleaning process of the panel. The microcontroller then kills the bot and the relay for a certain delay time.

After the delay the relay is switched on by the microcontroller and the bot automatically returns back to the top of the panel washing and cleaning the panel surface continuously along the entire path. Once it reaches the top of the panel the IR sensor detects the black tape and the cleaning unit stops there. This concludes the second stage of the cleaning process of the PV panel.

Now the locomotion units come into action. The wheels on the frame move in direction parallel to the edge of the solar panel and carries the entire frame and thus the bot horizontally until it reaches the part of the panel array that is not cleaned.

This entire 3 stage cleaning process is repeated until the bot reaches the end of the PV array. Then, the device is returned to the parking station and begins to charge, and water is restored in its tank, until an activation command is again received. The working is depicted through the flowchart below-

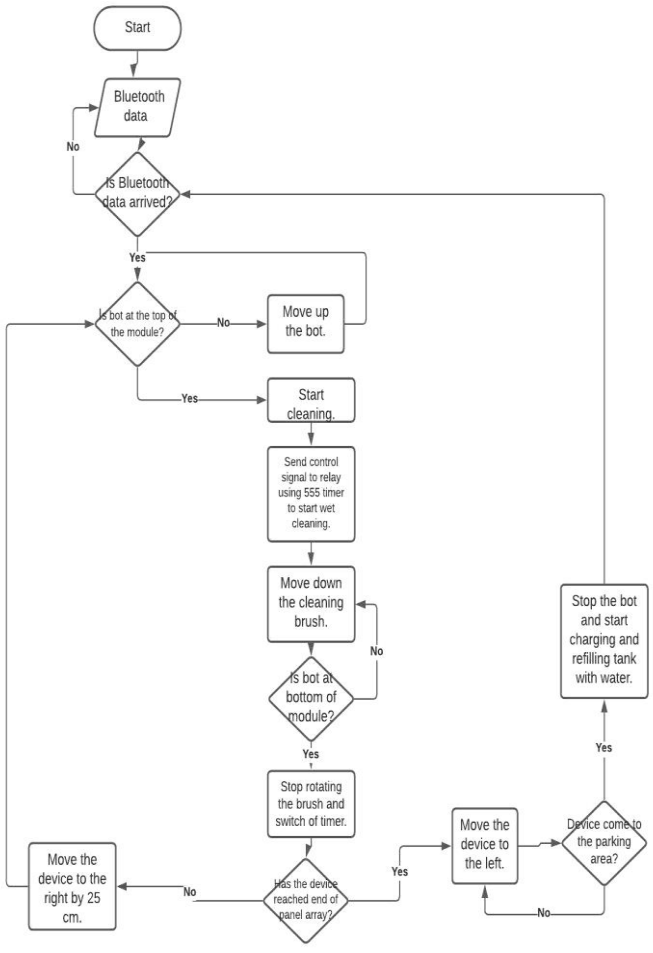

Fig9:Block Diagram

Further a sprinkler system is attached at the top which would sprinkle water at the nearby crops as well thus fulfilling a multipurpose role. The time duration of water spray is controlled by another timer.

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V. CONCLUSION

Existing automated cleaners mainly focus on large arrays and in general are unsuitable for installing on smaller arrays namely residential roofs. This idea serves as a huge advantage for those smaller sites. This system can be installed for rooftop solar panels. Advanced technologies like AI and Ml(Image processing technique)can also be used in future to enhance the efficiency of the product, so that the bot can automatically distinguish between wet and dry cleaning. Since the sprinkler system which controls the spray of water to regular intervals prevents unnecessary wastage of water. This way we can save water by carefully utilising the bot for wet and dry cleaning purposes. This Device is going to cover each and every area of the panel since a angle brush is made to operate along the length as well as along the width. A bluetooth sensor is also incorporated enabling the user to control the device with a remote or an mobile app.

VI. ACKNOWLEDGEMENT

We consider it as a privilege to articulate a few words of gratitude and respect to all those deserving individuals who guided us in this project. First and foremost, we would like to extend my profound gratitude and my sincere thanks to our guide Prof. Yaswanth kumar professor, electrical department, Bangalore Institute of Technology , Bangalore ; Who constantly supported and encouraged us during every step of dissertation. We really feel highly indebted to him for constantly guiding us to continue our work and giving us short term goals.

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