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Automatic Cleaning of Solar Panel with Maximum Power Tracking by using Arduino

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ABSTRACT*:* The sun energy has tremendous scope for solar energy. Solar energy is the best form of energy to fulfill the energy needs of India and bridge the energy demand-supply gap. Solar energy is the endless source in which PV is the third renewable source in terms of global capacity. Due to the transition of the Sun from east to west, the fixed solar panel may not be able to generate the optimum energy. As the solar PV modules are generally employed in dusty environments, it reduces the power generation capacity of the module. 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. This automated system is implemented by using Arduino UNO. Also to have optimum utilization of solar energy the output power should be maximized. This is done by using Maximum Power Point Tracking (MPPT) System. This project is to overcome the disadvantage of the existing system. The proposed work maximizes the power output as well as cleans the dusty part on the panel automatically which reduces the labors and maintenance cost, improves solar energy consumption and increases the efficiency.

KEYWORDS: Solar Photovoltaic Panel; Maximum Power Point Tracking; Perturbation and Observation Algorithm

I.INTRODUCTION

Population growth is increasing day by day. Electricity is also required for this purpose. But the demand for electricity in India is increased. India stands a fourth place in producing electricity and stands a third place in consuming electricity. Electricity consumed only by a person in India for one year is 248 MW. In modern days, all area of industries is going to be automated, economically and environment freely to reduce the global warming problem. Arduino is a prototype platform based on an easy to use hardware and software which is used to write and upload the computer code to the physical board.Solar power is an alternative technology that will hopefully lead us away from our petroleum dependent energy sources.

The major problem with solar panel technology is that the efficiencies for solar power systems are still poor and the costs per kilo-watt-hour (kWh) are not competitive, in most cases, to compete with petroleum energy sources. Solar panels themselves are quite inefficient (approximately 30%) in their ability to convert sunlight to energy. However, the charge controllers and other devices that make up the solar power system are also somewhat inefficient and costly. This can be caused by factors that area part of the integrated system or a member of the atmosphere. Furthermore, this leads to the lowering of efficiency in the system.

Some of the problems that drag the output of the panels require into consideration that a different material needs to be introduced that can be utilized to its maximum potential. However, problems as such including effect of dust, effect of humidity can be minimised and the efficiency of solar panels can be optimized by cleaning of the panels. Various methods have been introduced with their own pros and cons whosesole purpose lies on improving the efficiency through cleaning.

Solar panel cleaning can be both automated and manual. Manual cleaning demands extensive labour. Moreover, manual cleaning maybe practical to household with few solar panels. For large scale projects the situation favours an unmanned automated cleaning system that can take in the real time data with respect to the dust accumulated, power generated and clean henceforth. The many automated systems built as of today are dependent on the landscape of the place where the solar panels are situated. They also rely on the structure of the panels. Depending on these factors, many technologies have come to surface that optimizes the performance of solar panels by cleaning them.

Our goal is to design a Maximum Power Point Tracker (MPPT), a specific kind of charge controller that will utilize the solar panel to its maximum potential. The MPPT is a charge controller that compensates for the changing Voltage Current characteristic of a solar cell. The MPPT fools the panels into outputting a different voltage and current allowing more power to go into the battery or batteries by making the solar cell think the load is changing when you really are unable to change the load. The MPPT monitors the output voltage and current from the solar panel and determines the operating point that will deliver that maximum amount of power available to the batteries.

II.MODEL DEVELOPMENT

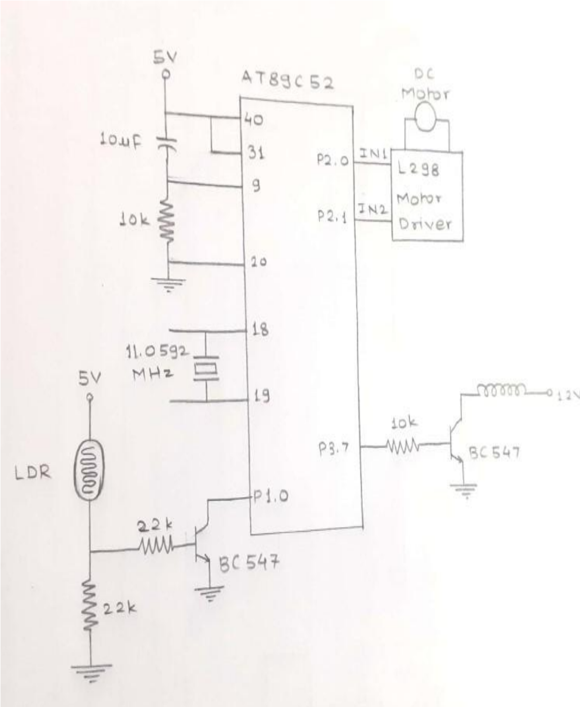
The Motor Driver IC and Relay requires 12V supply which is given through adapter. But the Arduino requires 5V supply; therefore, we used 7805Voltage Regulator which provides required voltage to the Arduino.

When the supply is made on through adapter, switches for MPPT and cleaning circuit made on. When the LDR, placed on one side of the panel, detects light (at day time), LDR has low resistance so the current flowing through it is high. This current causes switching of the transistor because it goes to saturation region. Its collector is connected to pin P1.0 and emitter isgrounded. So the pin experiences ground so the controller understands that it is day time. Now the arduino gives signal to the L298 motor driver to turn on the pump with 3sec delay and water will spread on the panel. After 3 sec delay, the arduino will give signal to the motor driver again to turn on the motors and rotate them in downward direction of the panel and complete the cycle. The arduino will turn on the motor through a relay, which energizes due to action of the transistor connected to P3.6 which acts as switch. The reverse happens when the LDR detects dark (at night time).

Now, the LDR has high resistance causing low current conduction through it and hence the transistor goes to cut off region. This will give input high signal to the arduino pin P1.0. With 3sec delay the pump spreads water on the panel and after 3 sec the motor driver turns on the motors and rotates them in upward direction of the panel. Here, we used L298 Motor Driver IC to run the motor in forward and reverse direction by using the signals from the controller. This IC is connected to pins P2.0 and P 2.1of arduino. This process completes the cleaning action.

The battery is charged by solar panel through the MPPT circuit. When the battery is charging from the solar panel then the cutoff point is o14.5V and that from supply mains is 13.60V. The MPPT is based on the principle of trickle charging. Trickle charging means a fully charged battery at a rate equal to its self-discharge rate, thus enabling the battery to remain at its fully charged level; this state occurs almost exclusively when the battery is not loaded, as trickle charging will not keep a battery charged if current is being drawn by a load. To maintain the gravity of the battery, after some time of intervals automatic charging on/off is essential, this purpose is fulfilled by trickle charging, which is done by MPPT. The circuitry of MPPT provides constant current charging without breaking up to when the battery set point voltage is below 13.60V. And when battery reaches 14.5V, the charging is done as per requirements with breaking in current by PWM (Pulse Width Modulation) method.

The working of MPPT circuit is:
There are two voltage setting pots for battery and panel. The circuit have inbuilt 6 channel ADC and from that we used only 2 channels for the voltage setting pots. It checks the voltage from panel as well as the battery, and decides the total workout from PWM. If the panel voltage is above 12V, then the PWMproperly starts charging the battery in incremental order. And if it is providing lesser current, it provides current base charging. The actual values of voltage and current of both solar panel and battery is shown on the LCD display. It has opto-coupler which isolates the reverse voltage from the panel because the digital pins of ADC may get damaged due to this reverse voltage. This opto-coupler then drives the gate of MOSFET. As the switching of PWM starts, the on/off mechanism of MOSFET starts accordingly. The PWM depends on panel output and battery voltage, it compares the voltages between panel and battery and accordingly charging starts.



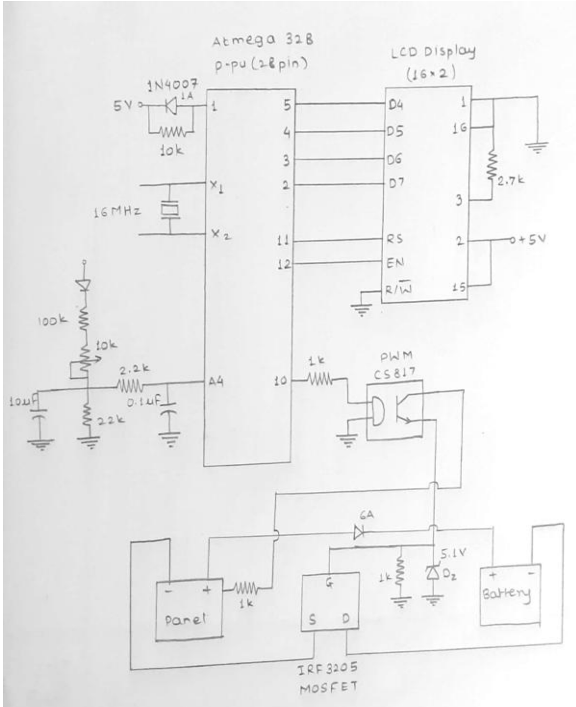


Fig. 01: Circuit Diagram of Cleaning Circuit Fig. 02: Circuit Diagram of Cleaning Circuit

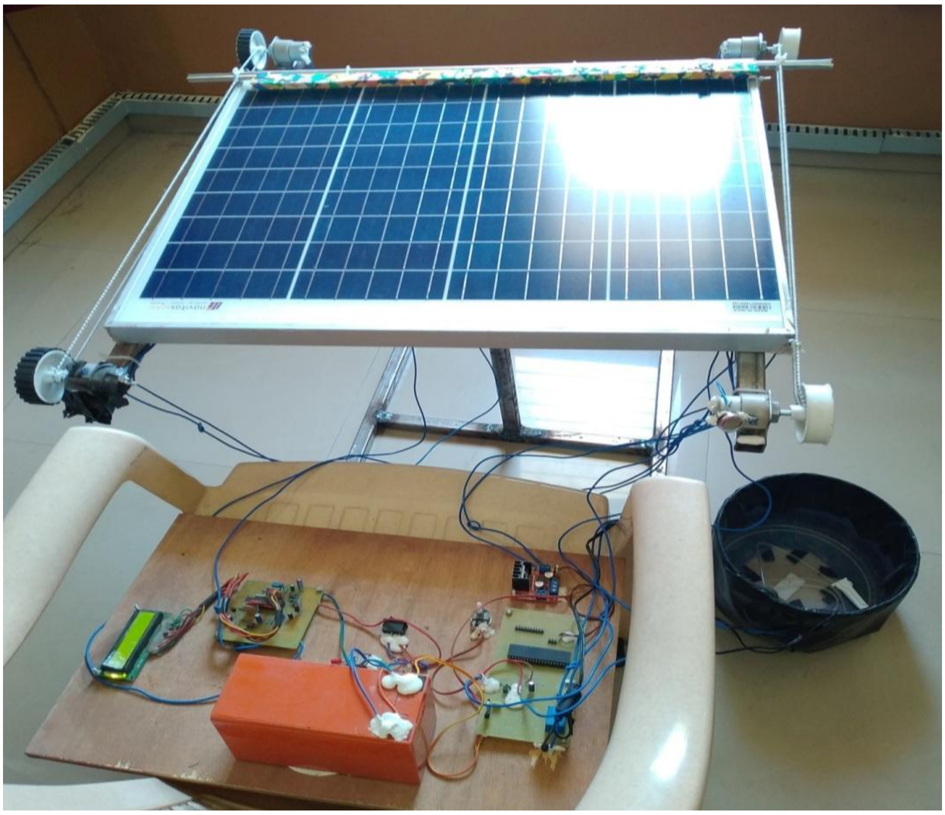


Fig. 03:Hardware

III.PROGRAM CODE

A. Code for Cleaning:

```
ORG 0000h
 MOV SP,#70H
 MOV IE,#00H
 MOV IP,#00H
 MOV P2,#00H

MOV P1,#0ffH
 CLR P3.7
 LCALL LOOP
 LCALL LOOP
 AGA:
 JB P1.0,$
 SETB P3.7
 LCALL LOOP
 LCALL LOOP
 LCALL LOOP
 CLR P3.7
 LCALL LOOP
 SETB P2.0
 LCALL LOOP
 LCALL LOOP
 LCALL LOOP
 LCALL LOOP
 LCALL LOOP

LCALL LOOP
 LCALL LOOP
 LCALL LOOP
 CLR P2.0
 JNB P1.0,$

SETB P3.7
LCALL LOOP
LCALL LOOP
LCALL LOOP
CLR P3.7
LCALL LOOP
SETB P2.1
LCALL LOOP
LCALL LOOP

 LCALL LOOP
 LCALL LOOP
 LCALL LOOP
 LCALL LOOP
 LCALL LOOP

LCALL LOOP
CLR P2.1
 LJMP AGA

 DELAY L; 5ms DELAY
 SETB PSW.4; SELECT BANK 2
```

```
 MOV R7,#80
 HDH:
 MOV R6,#40
 DJNZ R6,$

DJNZ R7,HDH
 CLR PSW.4; DEFAULT BANK
 RET

LOOP:; 1 SEC DELAY
 MOV R7,#100
 LOOP1:
 CALL DELAYL
 CALL DELAYL

DJNZ R7,LOOP1
RET

END
```

B. Code for MPPT:

```
#include <LiquidCrystal.h>
LiquidCrystallcd(12, 11, 5, 4, 3, 2);
constintvoltsIn = A5;
float volts;
constintpv = A4;
floatpvolts;
intpwm = 250;
constintpwmpin = 10;
constint ctrl = 6;
int pwm1 =250;

void setup()
 {
       pinMode(voltsIn, INPUT);
       pinMode(pwmpin, OUTPUT);
       pinMode(ctrl, OUTPUT);
       pinMode(pv, INPUT);
       digitalWrite(ctrl, HIGH);
       lcd.begin(16,2);
       lcd.print ("P & O ALGORITHM");
       lcd.setCursor(0,1);
       lcd.print("BATTERY CHARGER");
       delay(5000);
       lcd.clear();
       analogWrite(ctrl, pwm);
       //analogWrite(pwmpin, pwm);
}

void loop()
 {
       samplevolts ();
       if(pvolts> 14.50)
       {
             //analogWrite(pwmpin, 0);
             digitalWrite(pwmpin, LOW);
```

```
            //intpwm = 0;
            lcd.setCursor(10,1);
            lcd.print("CH.CUT");
            delay(2000);
        }

        if(pvolts< 13.60 )
        {
            digitalWrite(pwmpin, HIGH);    //analogWrite(pwmpin, 250);
            lcd.setCursor(10,1);
            lcd.print("CH.ON");
        }
    }

voidsamplevolts ()
    {
        floatpvoltSum = 0.0;
        for (inti = 0; i< 10; i++)
        {
            pvolts = map(analogRead(pv), 0, 1023, 0, 500);
            pvoltSum = pvoltSum + pvolts;
            delay(2);
        }

        pvolts = pvoltSum /100.0;
        lcd.setCursor(0,1);
        lcd.print("p=");
        lcd.print(pvolts);
        lcd.print("V");
    }
```

IV. RESULTS

Panel Voltage: 17.7 V
Battery, Overcharge Cutoff: 14.5 V
Charging Current: 2.5 A (Max.)

Time	Without Mechanism		With Mechanism	
	Current	Voltage	Current	Voltage
10 AM	1.1 A	11.9 V	1.5 A	13.0 V
11 AM	1.4 A	12.3 V	1.8 A	13.5 V
12 AM	1.7 A	12.7 V	2 A	13.9 V
01 PM	1.9 A	13.0 V	2.3 A	14.2 V
02 PM	2 A	13.5 V	2.5 A	14.5 V
03 PM	1.6 A	13.1 V	2.2 A	14.3 V
04 PM	1.2 A	12.9 V	1.8 A	14.0 V

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V. CONCLUSION

The dirt makes a disturbance for the panel, and it can make temporary fail in the panel. Dry cleaning can' not remove all the dirt on the surface of the solar panel; therefore use of water can help in some extent. Cleaning solar panel with water increases the efficiency by removing majority of the dirt deposited on the panel. Also frequent periodic cleaning ensures that the solar panel works with a good transmittance consistently at all times.

In the present work, an attempt is made to operate solar cell at maximum power point and the following conclusions are drawn. Hence this work is focused on capturing or tracking the maximum power point. A basic hardware model illustrating the concept of enhancement of power output from solar cells with MPPT than those of solar cells without employing MPPT is demonstrated. It is found that the power output is maximum by employing the concept of MPPT than that of the module without MPPT.

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