Optimization of solar farm using IOT

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ABSTRACT

In solar energy, solar panels are the main generation elements. Whereas gained power from the photovoltaic solar panel is a main factor & reflects the panel performance. This affects by many parameters like dust density, light intensity, ambient temperature. To generate energy at full efficiency timely maintenance like cleaning & solving electrical issues is must. Delay in maintenance causes reduction in generation & even damage to the system. Also by knowing the expected amount of generation of energy from solar panels, it is also possible to manage the utilization & consumption of power in better way.

In this paper, a current and voltage sensors will be use to measure generating power from solar panel. By detecting generation deficiency, we can found defective panels & improve the generation by completing maintenance on-time. By detecting dust in air tentative day of maintenance will be predicted. With the help of vibration sensors physical damage to the panel mounting will be detected. Also safety measures can be taken related to theft by detecting movement of panel. By measuring amount of sunlight, a generation can be predicted for the day so that energy can be manage in efficient way. With the help of IOT all the parameters & alert will be shown on webpage

Keywords: *IoT, Sensors, carbon technology, solar panel*

Introduction

Solar energy has been recognized as the most promising source of renewable energy all over the world. Solar energy possesses the potential to replace highly carbon intensive technology [1]. As per the recent IEA declaration renewable is not a niche fuel any more it has become a mainstream fuel. Solar and wind is surpassing the other renewable energy sources, to be the largest share in renewable market. The drastic decline in the cost of solar PV modules has accelerated its growth and has led the energy enthusiasts all over the world to consider it. Because of the increasing demand for solar energy, the efficiency of solar panels is more important than ever. However, solar panels are very inefficient. Soiling of PV panels drops the panel efficiency even farther. This accumulation of dirt on the panels is a well-documented effect that can cause a loss of efficiency [1]-[6].

Many factors are affecting the solar panel performance. Some factors are proportional positively on the obtained electrical power, while other factors are affecting negatively [1]-[4]. Light intensity level represents an important parameter with respect to the effectiveness of the solar panel, the collected solar energy which converted to the electrical power is proportional with the instantaneous level of light intensity [5]-[7]. Dust density level is the other parameter which represents an obstacle between light beams and the front surface of the solar panel. The dust's particles deposits on the panel which will reduce the amount of radiation falling on the PV cells from the sun light [6]. Besides the variety of dust density in every region, the angle of the surface can collect more dust. The more horizontal is the surface, the more dust particles will be collected on that surface [9]. Ambient temperature has high priority effect on the solar panel effectiveness. In other word, increasing panel temperature value is leading to reduce the delivered power from the panel. Ambient humidity also affects negatively the panel performance [11].

Many electronic monitoring systems are proposed in literature for continuous measuring, recording, and/or controlling functions [12]-[14]. Microcontroller unit is used for the mentioning/controlling functions in many studies due to the easy programming and connection with the personal computer for interaction activities, i. e. programs loading, data collecting and analysis.

Since solar energy generation system is high cost investment, it must be run at full efficiency. In this paper, an automation is performed with the help of sensors to make sure that solar farm run at full efficiency and detect situation in case of any maintenance. IOT technique is used to visualization and alert.

Need of Paper

Solar energy is the best available option to solve the energy crises. Where as to enhance the generation capacity and frequent maintenance is very important to get uninterrupted power. Generation of solar panels affects due to dust which settle on panel surface, of any electrical fault. Since solar panels are costly, any damage in the structure or ground surface may cause to break panel or change the direction of panel which may reduce the amount of sunlight collected by panel. Electrical maintenance is also important for solar systems due to fluctuating amount sunlight throughout the day and year, solar panel generated wide range of voltages. With this, changing environmental conditions may damage the wiring. Since the solar energy generation is limited for day time, prediction of generating solar power may help to manage the consumption.

Objectives of Paper

Since solar energy generation system is high cost investment, it must be run at full efficiency. In this paper, an automation is performed with the help of sensors to make sure that solar farm run at full efficiency and detect situation in case of any maintenance. Objectives of the paper are:

- Measure & monitor power (V*I) generation of each panel and comparing that to known value, low efficiency panel can be detected. Once the faulty panel identified, immediate maintenance can be done.
- By measuring amount of sunlight & atmospheric dust, total generation for the day will be calculated.
- Measure & monitor dust in air, the tentative day of maintenance will be calculated.
- Using the vibration sensor, motion in the solar panel mounting will be detected. With this alert, physical damage to the system can be avoided. It will also protect panel from thief.
- Upload all the parameters & alert on webpage using IOT.

SYSTEM DESIGN

Design of Solar Charge Controller

Output of solar panel depends on amount of sunlight fall on it. More sunlight gives more voltage whereas less sunlight cause reduction in output voltage. Maximum output voltage of panel we are using is 18V. Whereas as per the battery requirement, we need constant 13V dc to charge the battery. To satisfy this requirement, an variable voltage regulator IC as shown in figure bellow.

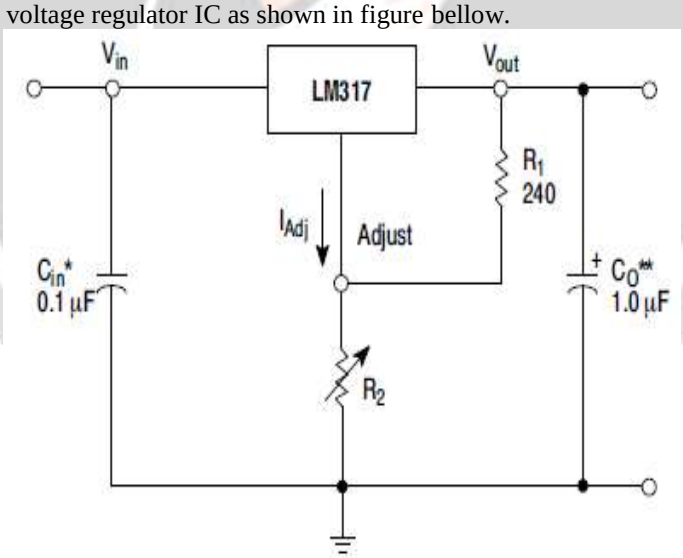

Figure 1: LM317 Basic Configurations

In above figure, C_{in} is required if regulator is located an appreciable distance from power supply filter. C_o is not needed for stability, however, it does improve transient response. Since I_{Adj} is controlled to less than 100 uA. The error associated with this term is negligible in most applications. As per the requirement of 13V output, consider R1=240 ohm. So as per the equation,

$$V_{out} = 1.25\text{V}(\,1 + \frac{R2}{R1})$$

$$13 = 1.25\text{V}(\,1 + \frac{R2}{240})$$

$$R2 = \left(\frac{13}{21.25} - 1\right) * 240$$

R2=2256 Ohm
R2=2.256 KOhm

As there is no resistor of this value, a variable resistor of 10KOhm can be used.

Design of Voltage Measurement Circuit:

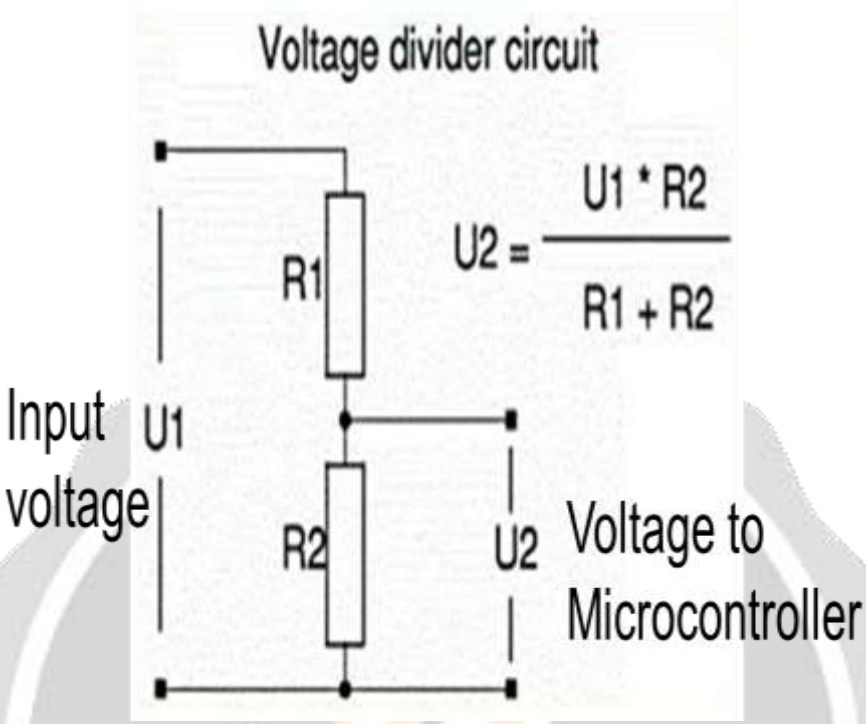

Figure 2: Voltage Divider Arrangement

To measure the voltage coming from panel, it need to be given on analog input pin of microcontroller. But before that its important to bring it bellow 5V. For which an voltage divider circuit is needed. To reduce the voltage to be measured upto 5v max

Insert the values of V1 & V2 chose any value for R2, & calculate value for R1 using formulae,

$$V2= (V1* R2) /(R1+R2)$$

For, V1=18 & V2=4, let R2= 10Kohm

R1= 35 KOhm

Interfacing of Buzer With Microcontroller:

The digital buzer needs a supply of 5V and 50mAmp maximum to generate sound at full intensity. The HIGH signal at the microcontroller output pin generated 5V and 200mAmp maximum current which is sufficient for buzer. So it can be directly connected to the output pin of microcontroller.

Circuit Diagram

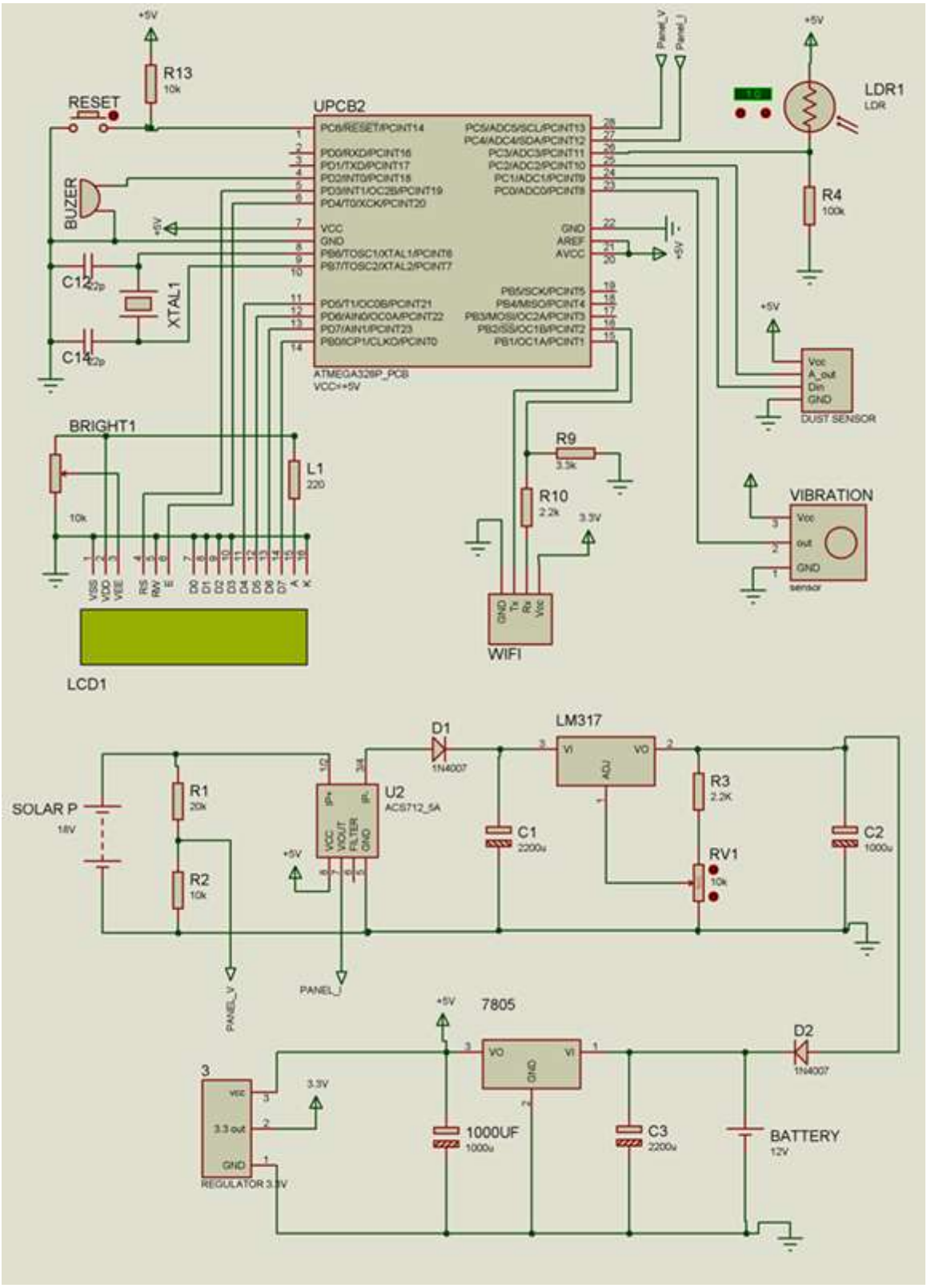

Figure 2: Circuit Diagram of System

Simulation Results

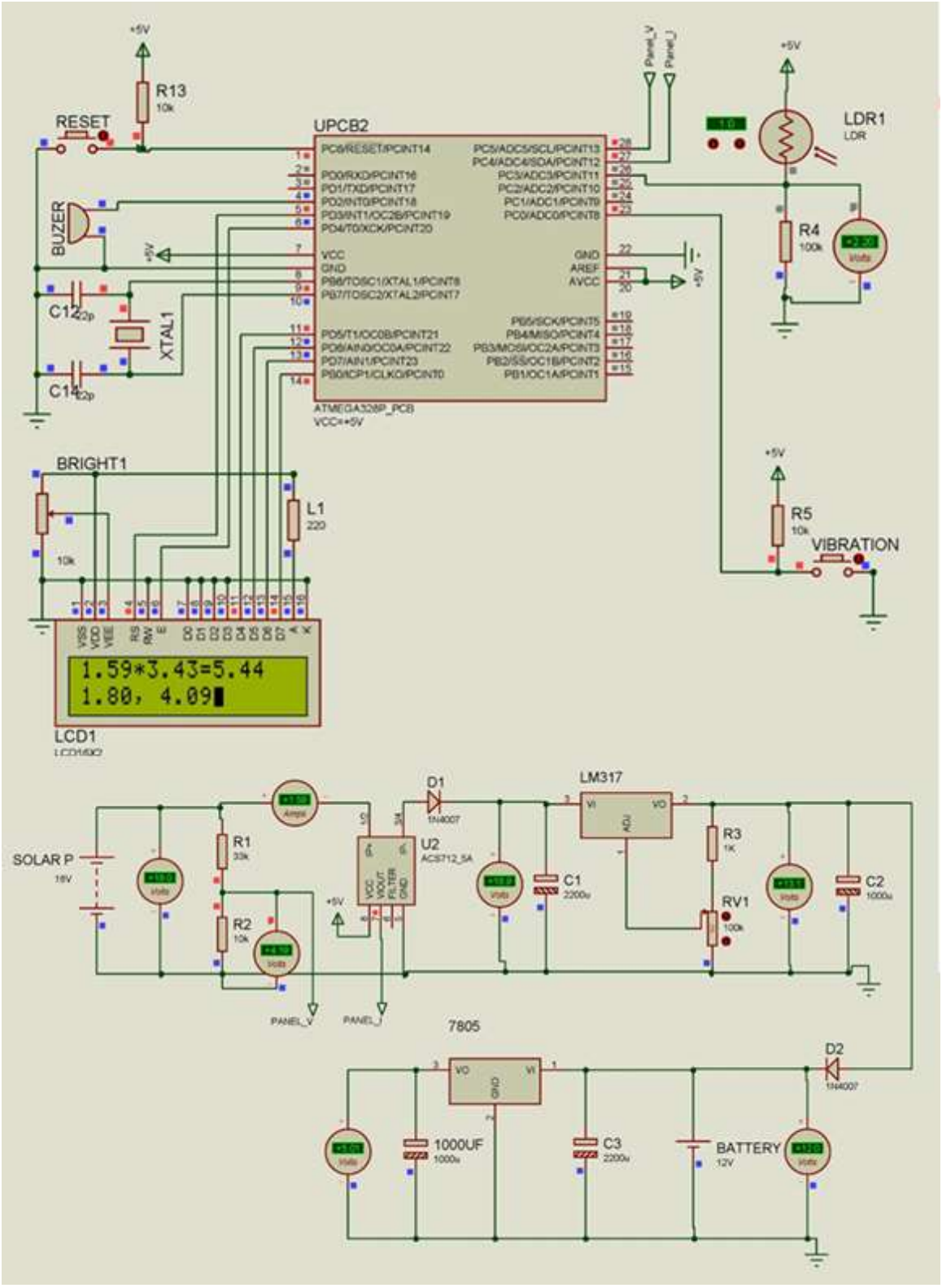

Figure 4: Simulation Results

RESULTS & DISCUSSION

Test Results:

Figure 5: Hardware after power on

Advantages

- Automatic detection of low efficiency panel.
- Improves maintenance speed by providing alert.
- Security from theft & immediate alert.

- Automatic prediction of energy generation for the day.
- Cleaning maintenance prediction.
- Shows all the parameters & alert on webpage using IOT
- No external power source required since system operates on self-generated solar energy
- Provides uninterrupted monitoring 24x7.

Limitations

- Design is complex due to multiple devices and sensors.

Application

- For solar farms
- Domestic solar panels
- Panel testing facilities to detect the faulty panel

Future Scope

Though the paper sounds good, there is always scope for development in future. In this paper a proper interface for webpage or android application can be designed in future.

Conclusion

We believe that this paper will be extremely helpful for increasing the efficiency and maintenance alert for solar power plants. This will ultimately reduce the troubleshooting time and manpower needed for maintenance work. Also with the features of energy generation prediction and cleaning time prediction, it will be easy to manage things. Due to use of IOT, a remote monitoring is possible.

In this paper by considering all the situations and possibility, we decided the objectives for paper and chosen components which are helping to achieve the desire target. Though, design of circuit is critical due to non-availability of some of module in Protius software. Whereas due to the use of Arduino development tools, reduce difficulties during programming & troubleshooting was reduced.

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