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Arduino Based System to Measure Solar Power

Mr. Gajanand Sariyam

Senior Lecturer, Department of Electronics and Telecommunication

Government Womens Polytechnic College, Jabalpur, M.P., India

gajanandsariyam@gmail.com

Abstract: *This paper aims to develop a measurement of solar energy using Arduino Board technology. In this research, four parameters that been measured are temperature, light intensity, voltage and current. The temperature was measured using temperature sensor. The light intensity was measured using light dependent resistor (LDR) sensor. The voltage was measured using the voltage divider because the voltage generated by the solar panel are large for the Arduino as receiver. Lastly for the current was measured using the current sensor module that can sense the current generated by the solar panel. These parameters as the input value for the Arduino and the output was display at the Liquid Crystal Display (LCD) screen. The LCD screen display output of the temperature, the light intensity, the voltage and the current value. The purpose of Arduino to convert the analog input of parameter to the digital output and display via LCD screen. Other than that, this project also involve with a design to ensure that device case are easy to be carry around.*

Keywords: Arduino Uno, LCD (Liquid Crystal Display), Light Dependent Resistor (LDR) Sensor, Voltage Generator, Analog Input , Parameter, Digital Output

I. INTRODUCTION

Rising fossil fuel and burning fuel such as coal, global warming and severe weather conditions have compelled many nations to look for alternative sources to reduce reliance on fossil based fuels. Solar energy is one of the most promising renewable sources that is currently being used worldwide to contribute for meeting rising demands of electric power. [1] Solar power is a conversion of sunlight into electricity, sunlight was collect either directly by using photovoltaics or indirectly using concentrated of solar energy. [2] Photovoltaics was initially use as a power source for a small and medium-size applications from the calculator powered by a single solar cell to a remote homes powered by an off-grid rooftop photovoltaics system. As the cost of solar electricity has fallen, the number of grid-connected solar photovoltaics systems has grown into the millions and utility scale solar power stations with hundreds of megawatts are being built. Solar photovoltaic is becoming inexpensive, low-carbon technology to harness renewable energy from the sun. [3] This paper presented by Arindam Bose et. al [4] describe a potential a solar system using two set of stepper motor, the light sensor and the concave mirror. The purpose of this project to improve the power collection efficiency 65% with developing the track of solar panel perpendicular. This paper presented by Mohsen Taherbaneh et. al [5] proposed the method

based on simulation of two fuzzy controllers in order to maximize the generate the output power of solar panel in a photovoltaic system. The output I-V curve from this project are the maximum current is 1.56A nad the maximum voltage are 20V with solar irradiance = 500W/m2 and temperature = 34.5°C. The results of the fuzzy-based maximum power point tracking with 23W with 51% and 11W with 24.5% from the nominal output power. On the other hand, the combination of fuzzy-based maximum power point tracking and fuzzy-based sun tracking is 35W with 78% of the nominal output power. Yi-Hua Liu et.al in [6] presented the maximum power point tracking (MPPT) method for low power photovoltaic system, 87W PV system. The MPPT circuit using the low power operational amplifier (OP-AMP) with high and low irradation line and an analog switch. The simple DC-DC converter using such as the interface the voltage from the PV system. The type of multi-crystalline solar cell KC85T with the nominal open-circuit voltage of 21.7V and the nominal voltage at the maximum power point of 17.4V. The simulation results shows with 1000W/m2 irradiance, 25°C and the maximum power is 87.46W. From experimental results with 1000W/m 2, the maximum power is 87.39W. The advantages of analog MPPT are very simple, the low-power analog component, the fast speed and can

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using to all types of power convertes. This paper [7] propose the method the Fibonnaci search technique for narrow down possible locations. The results shows that 1000W/m 2 is 112.4W with 13% efficiency of panel solar. Mohammad H. Moradi presented in [8] to improve the performance of the maximum power point tracking in solar panel. The PV panel with Aria Solar are 60W, with 25°C,1000W/m2 and the current is 2.5A and the voltage is 23.1V. The proposed algorithm are the set point calculation and the fine turning loops.

II. SPECIFICATION OF COMPONENTS

(i) Solar Cell- In this research, the panel solar is polycrystalline type are be used with 12V, 250mA, 3W as a source [9]. The size of the panel is 145mm X 145mm as shown in Figure 1.

Figure 1- The Solar Panel Polycrystalline Type

(ii) Arduino Board- The Arduino Uno is microcontroller board based on the ATmega328 datasheet as shown in Figure 2. It has 14 digital input and output pins: 6 pins used PWM outputs and 6 pins is analog input such as the clock speed is 16MHz, the ceramic resonator, the USB connection, the power jack, the ICSP header and the reset button [10].

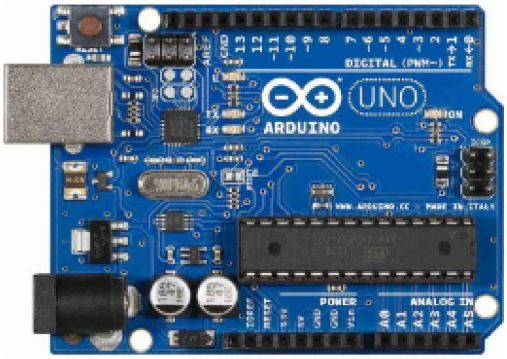

Figure 2- The Arduino Board

(iii) Light Sensor- A Light Dependent Resistor (LDR) or photo resistor is device whose resistivity is a function of the incident electromagnetic radiation which means it is light sensitive devices. These components also called a photo conductors, photo conductive cells or simply photocells [11]. The LDR function on the principle based on photo conductivity which an optical phenomena. Figure 3 shows the resistance vs illumination graph of LDR.

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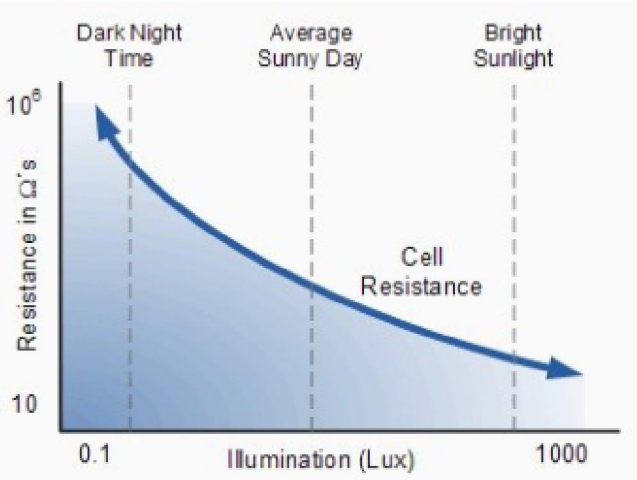

Figure 3- The resistance VS illumination Graph of LDR

(iv) Circuit Simulation- Figure 4(a) and (b) shown the block diagram of the research and the complete of simulation circuit for this project that have been develop by using Proteus 8 Professiona [12-16]. In this simulation circuit, it consist three main parts : the voltage divider, the LED light indicator, the temperature sensor, LDR sensor and the LCD screen display. The power generated from the solar panel is 12V approximately. Inside the circuit have LDR sensor for detect the light intensity. Next, the temperature sensor have detect the temperature changing [17 18, 20]. In this project, the main controller are use the Arduino Uno and its need the power supply [16, 19, 21]. The power supply for this controller is 5V. Then, the Arduino Uno must have coding for it to function as desired. Lastly, the LCD is to display the output that have written in the coding inside the Arduino Uno [22-23].

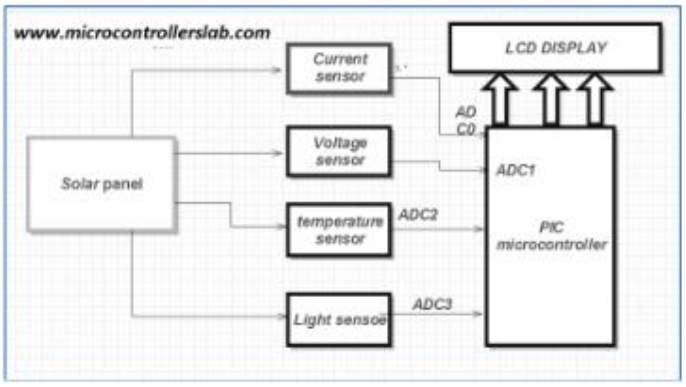

Figure 4(a)- The block diagram of the research

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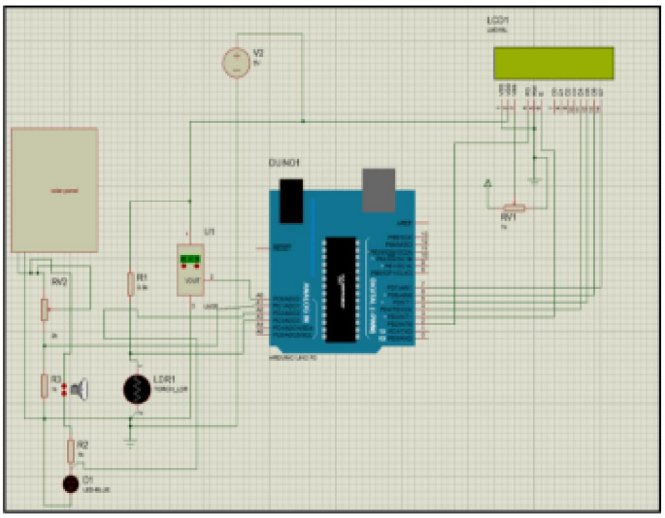

Figure 4(b)- The Simulation Circuit

III. RESULT AND ANALYSIS

(i) Simulation Results- Figure 5 shown the results of the temperature. It varies depend on the temperature sensor setting during the simulation. From the simulation results shown that the circuit are function is very well and can be continue to the hardware development.

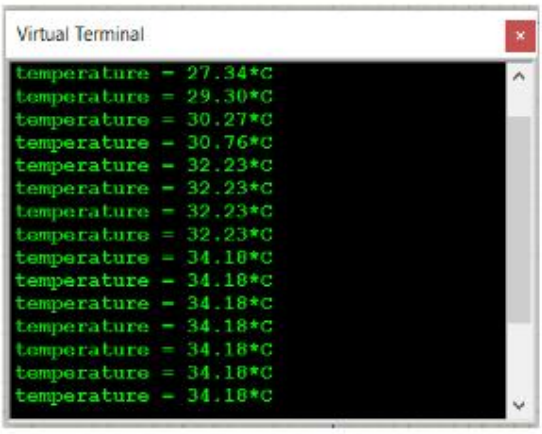

Figure 5- The temperature virtual terminal output

(ii) Results of Light Intensity- The light intensity have been recorded in the three days with the solar panel in the sunrise position as shown in Figure 6. Based on the result, the highest light intensity was 980 Lux at 2.00pm, while the lowest light intensity was 700 Lux at 5.00pm. The light intensity have been recorded in the three days with the solar panel in the sunrise position as shown in Based on the result, the highest light intensity was 970 Lux at 11.00am, while the lowest light intensity was 350 Lux at 5.00pm.

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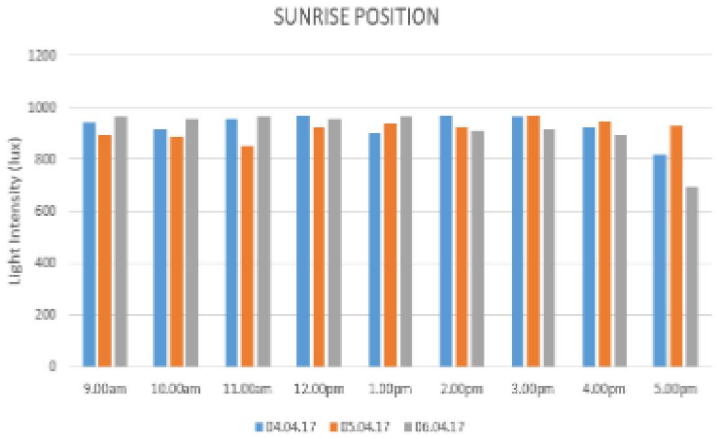

Figure 6- Result of light intensity for sunrise position

IV. CONCLUSION

In the conclusion, the project is achieve all of the objective are : to measure solar panel parameter such as the temperature, light intensity, voltage and current. Using the temperature sensor that sense the changes in surrounding temperature, for the light intensity parameter was by using the LDR sensor, for the voltage parameter was by using the voltage divider method in order to reduce the maximum value of the solar panel to the voltage value suitable for the Arduino of power supply and lastly the current parameter was by using the current sensor module. Next, to find the best position and time for the solar power effectively energize the electricity. The data from measurement part shows that the best position of the solar panel effectively energize was the sunrise position with the highest voltage value which is14.75V at time 11.00am have been recorded. At this time the light intensity was 954 lux and the temperature was at 34.32˚C. Lastly, to develop a portable device for measuring the solar energy can be achieve with developing the light in weight of the casing of the device and the neat arrangement of the electrical component inside the casing.

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