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Autonomous Photovoltaic Solar Cell Using Tracking System Design and Implementation

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Abstract: Nowadays with the rapidly evolving technology, the need for sustainable and clean energy has become evident due to the inadequacy of existing resources or the damage caused by these resources. It is aimed by all countries that the minimum effect of these resources on the environment and maximum efficiency. This situation makes renewable energy sources valuable and this study, a solar tracking system was designed and prototyped in servo motor control with the help of photoresistors which will serve as a sensor to increase the energy capacities produced by solar panels.

Keywords: *Photoresistor, Solar Energy, Renewable resources, Photovoltaic*

1. Introduction

These days and in the past, this process has resulted in global warming, climate changes and acid rain with decreasing resources and harmful effects of fossil fuels such as petroleum, coal and natural gas. Renewable energy resources' importance is not ignored anymore. On the other hand, the energy requirement in the World could be maximum because of the increasing population and technology. The countries have started to choose reusable energy resources and their aim is increasing their efficiency.

The largest source for heating the houses and obtaining electricity, the product of thermal power plants, is coal. When latent fossil fuels are burned, harmful gases such as carbon dioxide and carbon monoxide are released into the atmosphere. After years, societies cause respiratory diseases and global warming in the World.

Solar energy is one of the energy production options without any adverse effects and can be renewed at the same time. Photovoltaic batteries are semiconducting materials used to convert solar radiation directly onto the surface of the earth. They are a kind of battery that stores solar energy.

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The average output of a standard photovoltaic battery is the amount of energy consumed by devices that will consume less power. Solar panels are required in large dimensions, which combine photovoltaic batteries for devices that will draw much more power. Increasing the size has always caused problems in practice. Rather than increasing the size of the panel, it is reasonable to maximize the efficiency of each photovoltaic cell.

The efficiency of solar cells depends on two main factors;

1) The intensity of radiation on the cell from the source
2) The cell efficiency

One of the most important factors limiting efficiency is the materials from which photovoltaic batteries are produced. These materials limit the performance of the photovoltaic cell. However, changing the ratio of the amount of light falling on the photovoltaic cell from the source is more convenient and cheaper. The first thing to do to increase the light intensity is to always keep the panel surface clean and controlled. If the panel is always clean, the energy obtained is maximum. It is aimed to provide an approach that requires little maintenance and very little money to clean the solar panel systems that do not require commercial maintenance using minimum water and power.

The movement of the sun changes depending on the season and day length. Depending on these two parameters, the maximum number of photons falling on the solar panel surface during the day cannot be expected, and therefore algorithms have been developed by these parameters.

Kelly and Gibson's work has increased the efficiency of the solar panel in cloudy weather as a result of the solar tracking system. By improving this work after their first work, Kelly and Gibson provided adaptation of the system to various environmental conditions and seasons. In other words, after the feasibility of the work done, productivity increased [1].

In those same years, Chong and Wong tried to increase sensitivity to follow the collector, which acts as a sensor to track the sun [2].

Subsequently, Abdallah and Badran studied the efficiency of the solar tracking system concerning the use of stationary systems in their study [3].

With Abdallah and Nijmeh PLC control, they designed a solar tracking system that can move two axes. For control purposes, they measured the position of the sun four times during the day and estimated the speed of the sun as the result of the measurement. My site is rotated at the estimated speed. The energy obtained from the moving system was compared with the energy generated from the fixed solar panel located at an inclination angle of 32 ° in the south direction. As a result, it was observed that the moving solar panel produced about 41% more energy than the fixed solar panel. However, it has been understood that the energy they spend to pursue has passed 3% of the energy they produce [4].

Huang and Sun have increased the solar panel output power by about 23% with the reflector with low condensation rate, which they place in the uniaxial three positions (morning, noon, afternoon) solar tracking system [5].

With PLC control Abu-Khader worked on a solar tracking system that can move two axes. During the day the sun has rotated four times according to its position. The yield according to the fixed system ranges from 30 to 45%. The energy expenditure for the follow-up system is less than 3% of the total generated energy [6].

2. Photovoltaic Battery

Solar batteries are semiconductor materials that convert the sunlight that falls on their surfaces into electrical energy. The surfaces of the solar cells, whose surfaces are found in various geometric shapes, are about 100 cm2 in area, with thicknesses of 0.2-0.4 mm [7]. The solar cell is shown in Figure 1.

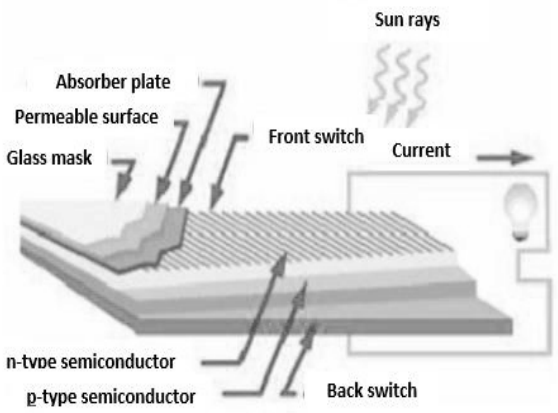

Figure 1: Structure of photovoltaic battery

The copper that is material is generally preferred. The coating layer is under the switches and it isn't reflector. Reflecting radiation that falling on the battery surface prevent to produce energy. That is, the covering layer prevents reflection from the battery surface. The front faces of the battery are shaped like pyramids and cones to better capture the reflected rays [8].

Under the non-reflecting layer, a portion where the electric current of the battery occurs. It creates two different layers. The N-layer is the negative part of the battery and consists of silicon and phosphor. The P-layer is the positive part of the pili, as well as the silicon and the bend. Between the P-layer and the N-layer, there is a region where the charges compare. The rear surface of the battery serves as a rear contact and is a positive contact [8].

A silicon solar battery produces about 0.5 V of electricity. The voltage batteries to be obtained are connected in series. Generally, when 30-40 solar cells are connected in series, they can output 15-18 V [7].

This voltage is enough to charge 12 volts of the current [8]. A photovoltaic cell with a diameter of 1 dm in sunny weather produces approximately 1 Watt.

2.1. The Effects and Factors of Solar Light

The Sun is approximately 58000 K temperature, it spreads a high amount of energy. There are two components of sunlight. These are direct radiation and stray radiation. Direct radiation (also called beam radiation) the sun is the undisturbed sun rays (causing the shadow). Direct radiation overflows about 90% of solar energy, and the rest floats "stray sunlight". Stray radiation is spread with solar radiation (full radiation on cloudy days). The reflected glow is reflected from the earth. The sum of the rays, scattered and reflected radiation is considered as global radiation on a surface. When much of the energy is in direct sunlight, raising the accumulation to the highest level requires the sun to reach the panels for as long as possible. It depends on the deflection angle, hour angle, sun height, sun angle.

3. System Design

In terms of the overall operation, the application of solar tracking system with servo motor control with LDR followed by an algorithm of sun position during the day was carried out to take the energy generated by the solar panel to the maximum level during the day and keep it at that level.

Two servo motors are used for the dynamic movement of the solar tracking system. The amount of light intensity from the source varies with the value of the resistance generated in the photocell, and this analogue information is transferred to the microprocessor. In this system, the sensor serves as a circuit element. The analog information obtained from the sensors is converted into digital information to be compared within the microprocessor. The software in the microprocessor is positioned concerning the light source, the sun, with the help of panel servo motors. As a result, placed in the middle of the edges of the solar panel and the intensity of the falling light were calculated.

According to the difference, the direction of rotation of the motor is decided. The flow diagram of the system is shown in Figure 2.

Figure 3 shows the detailed circuit diagram. RA0, RA1, RA2 the input is four LDR sensors that are indirectly connected to the RA3, which can read the analog signal and convert it to a digital signal (pulse).

For example, if the East LDR sensor reads more light intensity than the western density, the engine rotates east until it is equal to the two readings from the sensor.

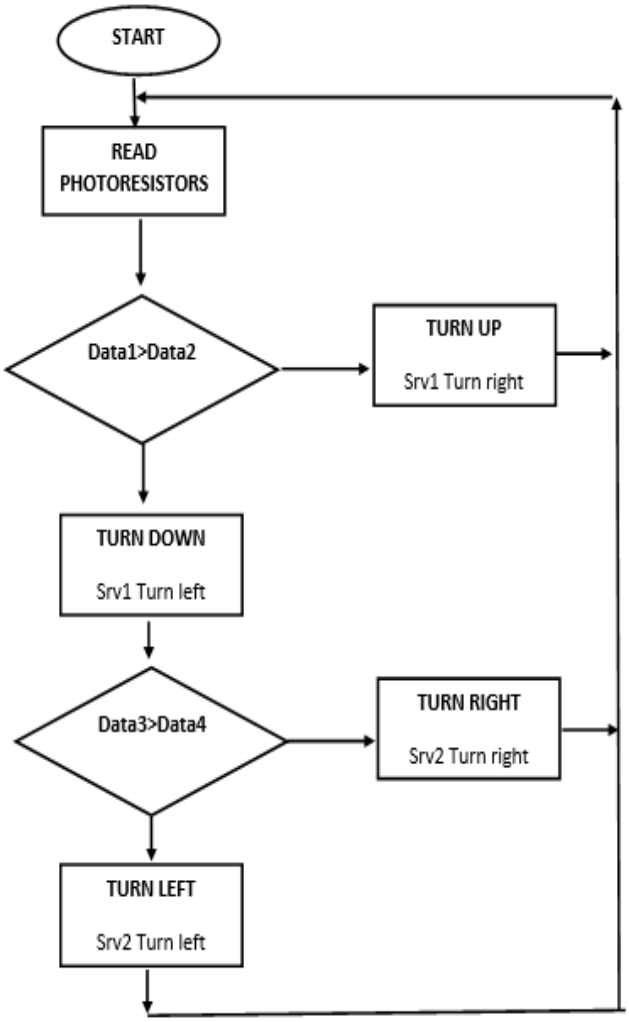

Figure 2: Flow diagram of the system

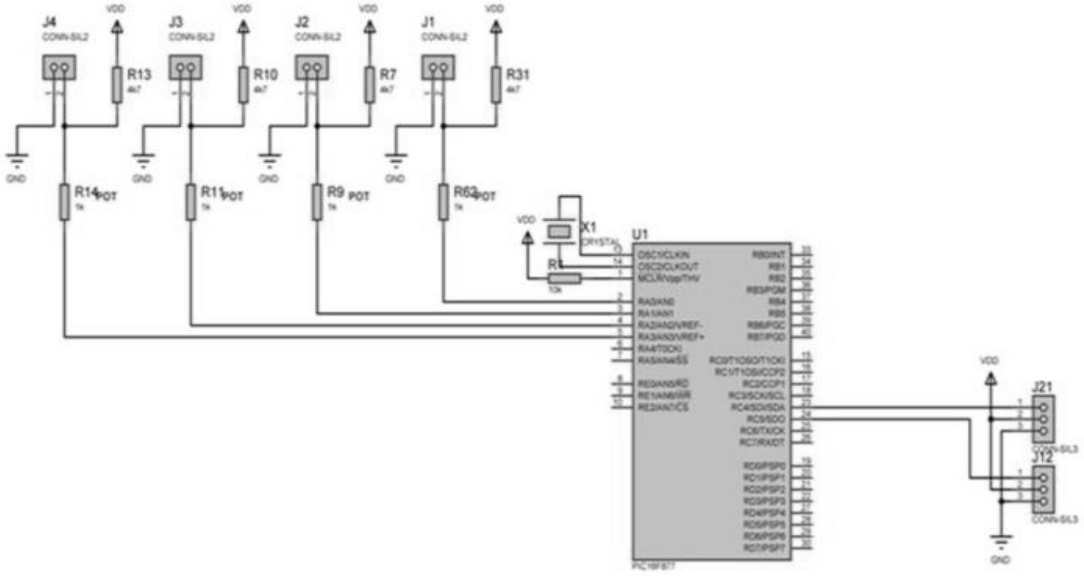

Figure 3: Circuit diagram

The reason for choosing PIC16F877 among the PIC types in the designed system is; reliability, speed, and flash. If you have Flash ROM, it shows that the installed program can be deleted, and another program can be installed. It is a microcontroller unit with input-output ports that will work with minimum hardware for every area used. It has a working speed of 20 Mhz, three timers and a 10-bit A / D converter [9].

Jal is a high-level programming language manufactured by Microchip to be compatible with PIC microcontrollers. There is no need for extra descriptions thanks to the libraries available inside. This will help speed up and improve the project.

There are various "USB pic programmers" available for loading microprocessor with "Hex" extension. MicroPro is preferred among these programmers.

With the help of "Microbrn", USB / serial port is created between microprocessor. By selecting the microprocessor series that we want to load, it is written into the file with "hex" extension.

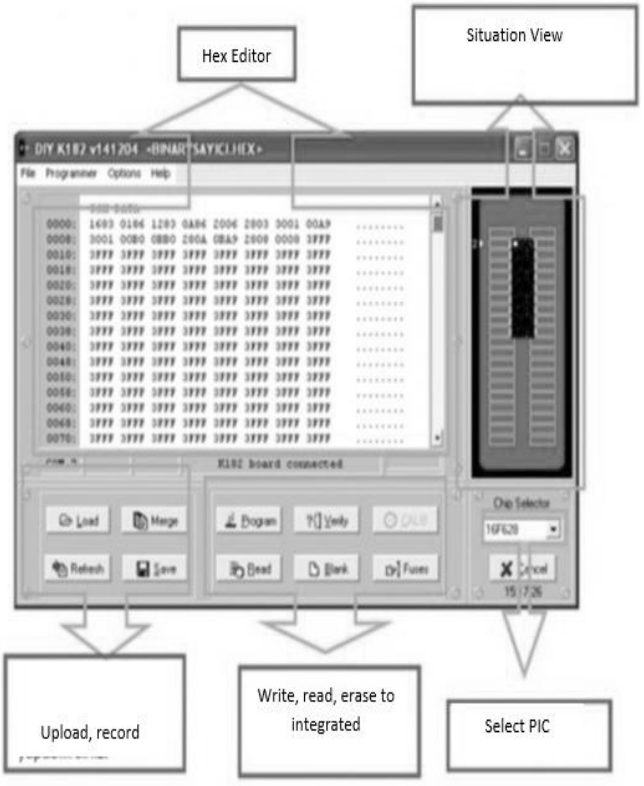

Figure 4: Microbrn interface

Figure 5: Designing system

4. Conclusion

An autonomous solar tracking system based on photovoltaic batteries has been designed and implemented. At the same time, the system's tolerance values should be paid attention. Continuous active motion of the system can cause too much energy to be expected. Selection motors are important with system design.

At the next stage of the system, a kind of cleaning system will be designed with a sun tracking system. The photoresistor which is a sensor works again like a sensor. When it could be dirty, it could not pass the light and the cleaning system will be active. Designing wipers start to work for cleaning.

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