DESIGN AND IMPLEMANTATION OF AUTOMATIC SOLAR TRACKING SYSTEM

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Abstract—**Energy indispensable part of our lives. Energy needs in the coming year will be more than the current total. Renewable energy sources are depleted day by day. So we have to start using renewable energy sources. Photovoltaik system is a renewable energy sources and photovoltaic is a system turning wave energy that it takes from sun into electric energy. In this article describes how to run a photovoltaic system, how it has been described that generate electricity and provide maximum energy production under what conditions. It also mentioned some cases where the photovoltaic system will be adversely affected and the geographical location is shown as used in the most efficient manner. Described all those developed in line with the subject moving narrative photovoltaic system design and all of the components have been introduced.**

Key Words: Photovoltaic systems, solar tracking

I. INTRODUCTION

The importance of solar energy has increased in each year. World population and energy need have linearly increased. When twentieth century is reviewed, world pollution has increased four times as energy need has increased sixteenth times. Energy need which is now required over world is 13 terawatt (tw). If population growth and energy need in further years are reviewed, we will need much more than it [1,2].

Total wind energy over world is 2-4 tw, hydroelectric energy source is 0,5 tw, geothermal energy source is 12 tw, energy which will be produced by getting benefit from tides and ocean current is 2 tw, solar energy is 120.000 tw. The data reveal that we need to increase the necessary importance towards to solar energy.

Solar cell is a photovoltaic tool which turns light directly to electric current. solar cells are semiconducting diodes and it can generate electric energy directly from internal energy included in sun as a result of photoelectric reactions. The main material of photovoltaics is si which has got 24.5% efficiency. As the efficiency rate of photovoltaic could not be increased, one of the most efficient ways to increase photovoltaic performance is to increase the efficiency of light which falls on surface. Photovoltaic systems are the most proper way to increase the efficiency of solar panels by qualifying solar cell and panels to position of sun.

In [3] single- axes and three-positioned mechanism are designed and tested. Pva module maintains itself by those determined three angles as the mechanism occurs in morning, at noon and in the afternoon.

The system's power output and performance using a different way of pv solar tracking are searched in [4]. The study reviewed the system in the way as calculating optimum stable angle by the direction of sunrise and sunset depending on seasons.

The designed and built-up solar tracking systems are reviewed in [5]. There were 12 solar panels in $6m^2$ area which it would generate for a tractor. This system provided system's heliotropic case with micro controller with the use of solar tracking systems with ldr and it generated electric of 540 w on April. This result have generated much more energy of 30% than a stable system for April.

In this paper, micocontroller based automatic solar panel tracking system is designed. The system maintains angle and position of solar angle by intensity angle of light which comes automatically. It provides the highest energy conversion. The experimental results indicated that the design tracking solar system increases pv's (photovoltaic) energy generation.

II. THE WORKING PRINCIPLE OF PHOTOVOLTAIC

Photovoltaic cells are connected as electrically serial and parallel in order to obtain higher current, voltage or power level. Photovoltaic modules include photovoltaic cells which are added to each other in a way to provide tightness against effects to

environment. Photovoltaic panels include photovoltaic modules in many numbers or in two numbers which are connected to each other by electric cables [6,7]. Photovoltaic series are energy generation equipments including photovoltaic module or panel.

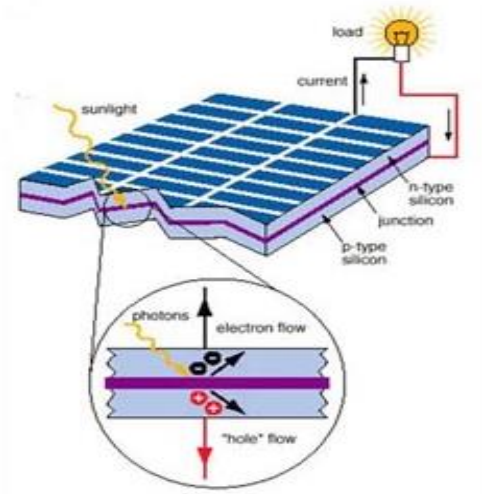

Figure.1. The Internal System of Photovoltaic

Surface od solar panel is blue one as it is indicated on Figure 1. Blue surface is a PN-added diode. These solar cells absorb most solar light. Solar panels are covered by anti-reflecting materials. Solar panels generate an electron pair when they are absorbed in a place near to photo PN and electric current occurs in terminals. PV panels can be compounded with the building's cover vertically (on frontispiece) or horizontal (on roof). Module's gauge, forms and colors are features which affect on the design in the use of PV panels in buildings [8]. Factors are such as position, routing and surface slope's angle, shadowing, panel type, care. The current-voltage and power-voltage characteristics of a photovoltaic cell are shown in Figure 2.

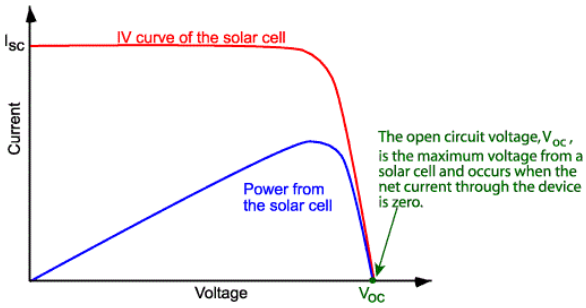

Figure.2. Solar Cell I-V and P-V Characteristic

III. THE GENERAL PERFORMANCE OF PHOTOVOLTAIC SYSTEM

PV panels with vertical building envelope (facade) or horizontal (on the roof) can be combined. Module sizes, forms and colors, the design features that affect the use of PV panels in the building. The location, orientation and tilt angle of the surface, shading, panel type, maintenance and cleaning, and factors such as temperature occurs behind the module will be provided by the PV panel performance / efficiency affects.

A. The Position

As earth has got a geoid shape, declination angle, solar light on the world differs in regions [9]. Thus, a region's annual sunshine values that a building which PV panel design will be done on its cover is seen as affection directly in energy that will be obtained from panel (Figure 3). According to world's sunshine map; countries having the highest performance in terms of sun are seen in Africa and as it is gone to poles, sunshine duration and also using solar energy rates decrease.

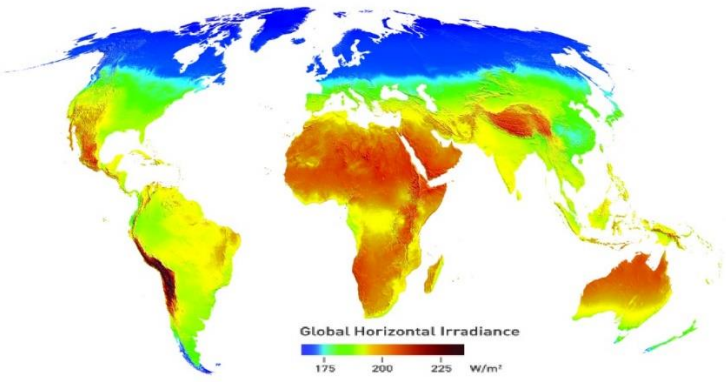

Figure.3. World annual Sun Time

B. *Routing and Surface Slope's Angle*

Energy amount which we will obtain from panel differs in the building's latitude and inclination angle that panel makes it with surface [10,11]. The directions which panels need to be implemented are south in arctic circle and north in antarctic circle. But, the implementation can be done in directions of South-East, South-Western, North-East, North-East in consideration with lowest of performance. Optimum placing angle is 30 degree by summer and winter averages of PV panels in Turkey. Panel angle differs in country position. The declination of performance in PV panels located in different direction and angles differ in module types. Annual performance differency between 10 and 30 degrees may not pass over 15% in conditions of Turkey.

C. *Shadowing*

The performance of PV panels may be affected by many factors but one of the most important factors is shadowing. Factors that cause shadowing can be accepted as adjacent buildings, trees and bushes and telegraph post. Especially due to the closed positioning in city centers, they overshadow on each other. On the other hand, sometimes due to design, it is possible to shadow itself for the building. As such cases will decrease performance of panel, correct decisions should be taken during the design. and PV panel system should be projected. Another factor which would cause shadowing is trees. Trees around the environment should be well analyzed during the design and also if it is possible, trees which drop leaves in winter should be preferred. Thus it becomes easy to drop sunray with lower angle on panel in winter.

D. *Panel Type*

PV panel's esthetics in terms of modular geometry , their features, sizes, color and montage system (with frame or without frame) affect on energy values which would be obtained both from the structure's appearance and system. Solar cells are generally produced in colors of blue, navy blue and black. Grey, green, red, yellow and orange colors can be generated. But these colors are generally more expensive than others as these colors do not have a standard production. Moreover, material being used in doing cell is one of important factors which affect on the performance. Performance values of solar cells which are produced of different materials and their area necessity were given on Table 1.

Table I. Produced Solar Cells Performance of Different Materials

Panel Type	Performance (%)	Area (m²/kWp)
High-Performance	17-18	6-7
Monocrystalline Silicon	12-15	7-9
Polycrystalline Silicon	11-14	7-10
Thin film Copper Indium Solenoid	9-11	9-11
Thin Film Cadmium Tellurium	6-8	12-17
Thin Film Amorphous Silicon	5-7	14-20

IV. The Design of Heliotropic Solar Panel Project

Sun ray in a day comes with constantly varying angles to panels. These angle differences affect extensively on performance due to radiation differences on panel. Panels in moving photovoltaic system are aimed for generating maximum energy as getting sun ray constantly with right angle. While designing moving mechanism, servo motors get the demanded angle in two axes and LDR Light sensors turn mechanism by radiation.

A. *The Design of Mechanism*

The system which is showned in Figure 4 is a design of the completed PV system following sun. Controller, 6V Micro Servo Motors, sensing system and mechanic components were used in this system. Driving motor is 6V DC Micro Servo Motor. Panel needs to regulate in order to get sun rays axially in right angle in the event that controller system works in full efficient in this system. At the same time, it makes panel move to get sun rays vertically as axial in East-west directions by sunrise and sunset. It provides maximum productivity that sun rays come to sun panels with right angle. Operational study plan of the solar tracker is given in Figure 5.

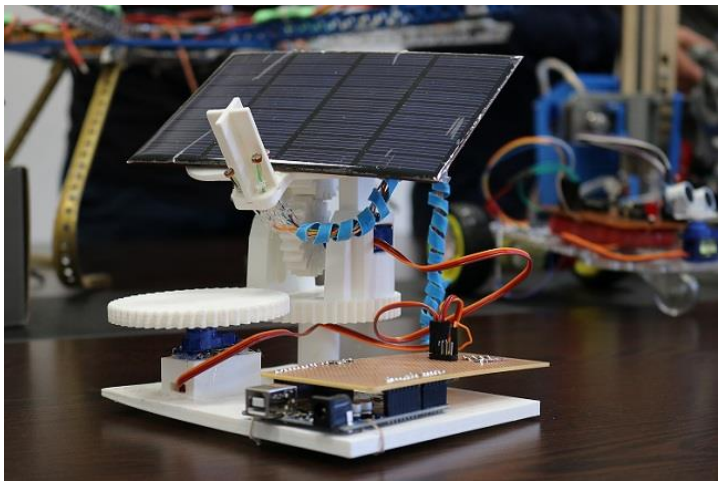

Figure.4. Moving Solar Panel Mechanism

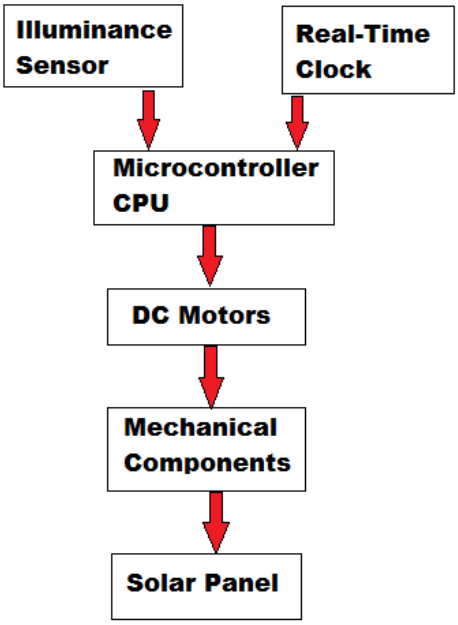

Figure.5. Study Plan PV system to automatically turn lights

LDR sensor gets light and then, it sends to micro controller processor used in real time and CPU generates a PWM output in accordance with information and it is conveyed to motors which provides the system's movement. The system is over after DC motors whih are used bring panel in a position to get light with right angle.

B. The Pieces Used

1) Solar Panel: In this system, 7 cm solar panel as shown in Figure 6 was used. These solar panels are 12 V- 1.5W solar panel and ideal panels for projects with high-rate conversion, high-fficiency output and small diameter.

Power: 1.5 W

Voltage: 12v

Material: Polycrystallie

Size: 115x85mm

Weight: 38g

Figure.6. 7cm Solar Panel

2) Arduino Uno: Arduino is a micro controller card with open source code as shown in Figure 7. It has got main MCU Atmel base. (a mini program-bootloader was loader previously to MCU). Robotic and electronic implementations with the card can be easily make

There are several reasons that it has got such a popular. These are:

- Have got open source code. (from circuit plan to programming interface.)
- To develop program is simple. It is really simple. It can be programable and also testable through the same card.
- Programming language which are used in Arduino is also simple. There are plenty of examples.
- And there is quite common user as the most important. Namely, projects that we want to do were possibly done previously. You can exchange information more easily with other project makers. You need to provide firstly proper work environment in order to use Arduino or any micro controller system. Requirements for Arduino group's micro controllers :
- Card is an Arduino card such as Arduino UNO, PRO Mini, Mega, Leonardo...
- USB cable which proper to card. It will require USB printer cable or micro USB cable.
- It would be a little difficult to run Arduino IDE program in compatible with old-model computers of a computer Arduino card which will work in compatible with Arduino without running in difficult way. Especially, this problem disappeared with Leonardo series.

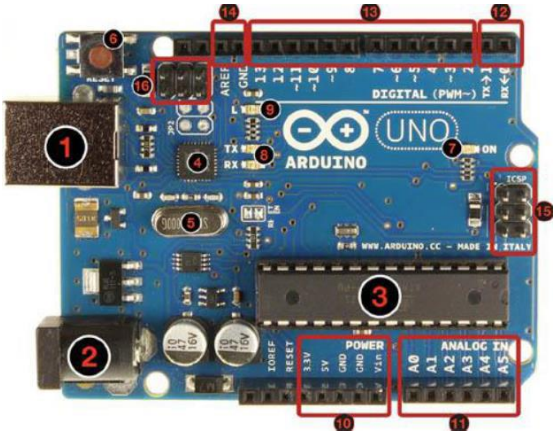

Figure.7. Arduino UNO

3) LDR Sensor: LDR (The Light Depended Resistor) Sensors are photocell light controlled variable resistances as shown in (Figure 8). LDR's resistance is inversely proportional with light intensity which falls on it. The relationship LDR resistor between light intensity which falls on LDR was showed at Table 2. LDR light sensors were used in the Project. More qualified and much more light sensors can be used in order to increase precision. The more sensors is used, the more precision will increase [8]. Figure 9 represents the resistance value of the photo resistor with the Light intensity of LDR.

Table II. LDR Resistor-Light Relationship

Light Comparison	Ambient Light	Photocell Resistance (Ω)
Dim Hallway	0.1 lux	600K Ω
Moonlit Night	1 lux	70K Ω
Darkroom	10 lux	10K Ω
Dark Overcast Day/Bright Room	100 lux	1.5K Ω
Overcast Day	1000 lux	300 Ω

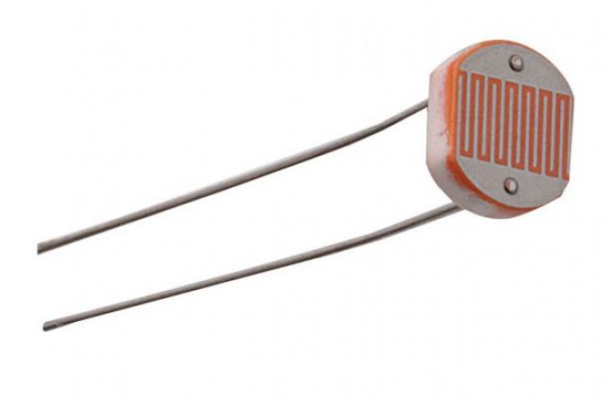

Figure.8. LDR Sensor

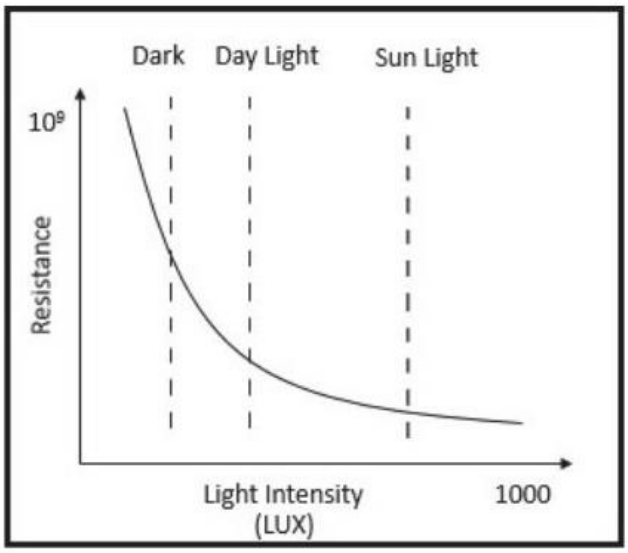

Figure.9. Resistance v/s Light Intensity

4) Servo Motor: D.C servo motors can be generally controlled by servo drivers which are named with "electronic moving controllers" as shown in Figure 10. Servo drivers controlling the movement of servo motor. Sizes which are controlled are position controlling mostly from point to point, rate controlling and acceleration programming. Pulse width modulation named with PWM technique is generally seen on robot controlling systems, on numerical control systems.

Figure.10. Servo Motor

V. CONCLUSION

The increase in fossil energy sources used over world every passing day puts our world into a way which has not got returns, which destroys nature and which has got irreparable damage as giving significant damages. If renewable energies are preferred instead of fossil oils, you can obtain an energy which does not know to be consumed, which does not destroy nature and does not give damage on people's health. The solar source which has got the most energy potential among renewable energy sources. Energy which will be obtained during the dayglow will give opportunity for a cleaner environment for our next generations as decreasing dependency on unrenewable energy sources with the proper-designed projects which have been created Sand great-comprehensive implementations which have been done.

In this paper, an automatic controller design and imlemenatation dual-axis tracking of the sun's position based microcontroller system is presented. It has provided to generate maximum energy with the help of panels in moving photovoltaic system as getting sun ray constantly with right angle. The designed solar tracking is constructed in a intelligient system design so that tracker is initialized by itself starting position of LDR and it reduces the energy consumed by panel driving servo motor. However, the number of LDR's can be increased for practical case. The proposed system dual-axis solar tracking system can work properly and achieve maximum energy efficiency.

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