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Energy Saving From Sunlight with Microcontroller Using Proteus Software Design

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Abstract-- This paper focuses on the optimization of the electric energy production by photovoltaic cells through the development of a Dual axis sun-tracking system. The developed tracking system is innovative in relation to the usual sun tracking systems available in the market. In fact, the developed solution has many advantages in relation to similar existing devices, in this paper; a new proteus software design using micro-controller based solar-tracking system is proposed, implemented and tested. The scheme presented here can be operated as independent of the geographical location of the site of setting up. The system checks the position of the sun and controls the movement of a solar panel so that radiation of the sun comes normally to the surface of the solar panel. The developed-tracking system tracks the sun both in the azimuth as well as in the elevation plane. PC based system monitoring facility is also included in the design. As this system is autonomous regarding the information needed to process the optimal orientation and is intelligent in a way that it performs on-line monitoring of the photovoltaic energy production. An experimental prototype is built and field results have proven the good performance of the developed tracking system.

Keywords-- *Elevation, Azimuth, Altitude, LDR, AutoCAD, Sketch Up, Proteus, Arduino Microcontroller.*

I. INTRODUCTION

A solar collector or photo-voltaic module receives the maximum solar-radiation when the Sun's rays strike it at right angles. Tilting it from being perpendicular to the Sun will result in less solar energy collection by the collector or the module. Therefore, the optimal tilt angle for a solar energysystem depends on both the site latitude and the application for which it is to be used. Many solar applications mounted either on a fixed rack or on a tracking rack. Fixed collectors or modules producing heat or electricity throughout the year are usually installed and tilted at an angle equal to the latitude of the site in which the collector or module faces directly the Sun. Of course, the optimal position is suitable for the time when the Sun is at midpoint in the sky (i.e. spring and fallseasons). The energy collected by the solar system in both winter and summer is far less due to several reasons such as clouds in winter and temperature scattering in summer in addition to the Suns changing altitude. But nevertheless in such cases, it is desirable that the average yearly collection ofenergy is maximized (i.e. the angle position of the collector or module is adjusted to receive maximum energy). A Sun-tracking mechanism increases the amount of solar energy that can be received by the solar collectors or photovoltaic modules consequently this would result in a higherdaily and annual output power harnessed. The use of a tracking system is more expensive and more complex than fixed mounts: however they can become cost-effective in many cases because they provide more power output throughout the year and in many cases this increase exceeds 25% [1]. Commercially, tracking systems are available eitheras a single-axis or a dual-axis design. The single-axis tracker follows the Suns apparent east-to-west movement across the sky, while the dual-axis tracker, in addition to east–west tracking, tilts the solar collector or module to follow the Sun's changing altitude angle. To investigate the improvement in the daily output power of a photo-voltaic module, a single-axis Sun-tracking system is designed based on a programmable logic controlling unit. A suitable controlling program is also developed to accomplish the control operation with the possibility of implementing this arrangement as a data-acquisition system for solar radiation values during daytime.

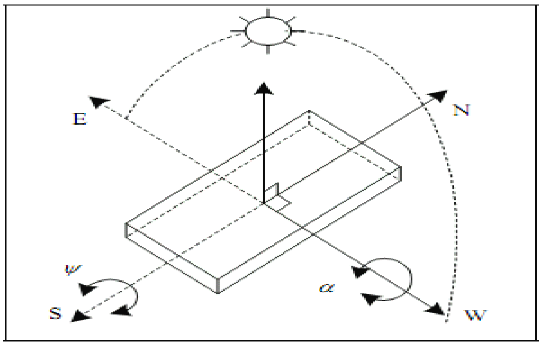


Figure 1: Two axis position control of the solar Panel

Efficient collection of maximum solar irradiation on a flat panel requires adjustments of two parameters of the energy collecting surface namely the angle of azimuth, ψ and the angle of tilt, α, of the surface to be illuminated in Figure 1.

II. THE ORIENTATION PRINCIPLE OF THEPHOTOVOLTAIC PANELS

The orientation principle of the PV panels is based on the input data referring to the position of the sun on the sky dome (fig. 2). For the highest conversion efficiency, the sunrays have to fall normal on the receiver surface so the system must periodically modify its position in order to maintain this relation between the sunrays and the panel. The positions of the Sun on its path along the year represent input data for the design process of the tracking systems.

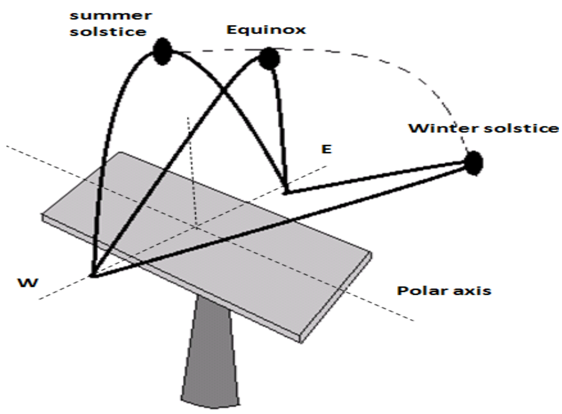


Figure 2: Position of the sun on the sky dome

The Earth describes along the year a rotational motion following an elliptical path around the sun. During one day, the Earth also spins around its own axis describing a complete rotation, which generates the sunrises and the sunsets. The variation of the altitude of the sun on the celestial sphere during one year is determined by the precession motion, responsible for a declination of the Earth axis in consideration with the plane of the elliptic yearly path. In these conditions, for the design process of the tracking systems, there are taken into consideration two rotational motions: the daily motion, and the yearly precession motion. Consequently, there are two basic types of tracking systems: single-axis tracking systems, and dual-axis tracking systems. The single-axis trackers pivot on their axis to track the sun, facing east in the morning and west in the afternoon. The tilt angle of this axis equals the latitude angle of the loco because this axis has to be always parallel with the polar axis. In consequence for this type of single axis tracker is necessary a seasonal tilt angle adjustment. The two-axis trackers follow combine two rotational motions, so that they are able to follow very precisely the sun path along the period of one year. Depending on the relative position of the revolute axes, there are two basic types of dual-axis tracking systems (fig. 2): azimuthally (a), and polar (b). For the polar tracking systems, there are two independent motions, because the daily motionis made by rotating the panel around the polar axis. For the azimuthally trackers, the daily motion is made by rotating the panel around the vertical axis, so that it is necessary to continuously combine the vertical rotation with an elevation motion around the horizontal axis; obviously, this solution increases the complexity of the controlling process.Determining the real behavior of the tracking systems is a priority in the design stage since the emergence of the computer simulation. Important publications reveal a growing interest on analysis methods for multi body systems (MBS) that may facilitate the self-formulating algorithms [4, 6, and 8]. In the last decade, a new type of studies is defined through the utilization of the MBS products: Virtual Prototyping; this technique consists in conceiving a detailed model and using itin a virtual experiment, in a similar way with the real case.

III. SUN TRACKING SYSTEM

This system consists of the following main part

A. Microcontroller Unit

A microcontroller type 16F877 is using in this study. This unit is considered to be the heart of the sun tracker system. The unit is reading the incoming signals from the sensors (Light Dependent Resistors (LDR) and the limit switches of the east and west directions) and sending the signals to the driver for rotated in the east to west. Fig. 1 represents the diagram of input/output of the microcontroller unit.

B. Sensors and Signal Processing Unit

Two symmetric photo-resistors used to track the sun's position. The photo-resistors positioned on the same holder of the double-pass thermoelectric solar air collector, and separated by a solid barrier to provide shadowingfor one of the resistors. The physical values of the resistors decrease when the sunlight is incident on their surfaces. When the solar radiation intensity increases, the resistivity of the photo-resistor decreases, and consequently the Voltage drop across this resistor decreases. As a result, the voltage drop across the variable resistor (100 k) increases. This will produce a direct relationship between the incident solar radiation intensity and the corresponding voltage-drop across the resistor. The two output signals of this unit are connected directly to the analog inputs of the microcontroller, which in turn compares the two signals and produces a proper output signal to activate an electromechanical sun-tracking movement.

C. System Power Supply

A switching-mode power supply is used for the sun tracking system. Implementation of the switching-mode technology resulted in a power supply unit with high efficiency and low losses. The unit is based solely on the switching regulator which provide a voltage output of 5 V and a driving current output of 10 A for driving a motor and a voltage output of 12 V and a current output of 1 A for driving the relays of all electronic units.

D. Maximum power point tracker

A MPPT, or is maximum power point tracker an electronic DC to DC converter that optimizes the match between the solar array (PV panels), and the battery bank or utility grid. To put it simply, they convert a higher voltage DC output from solar panels (and a few wind generators) down to the lower voltage needed to charge batteries.

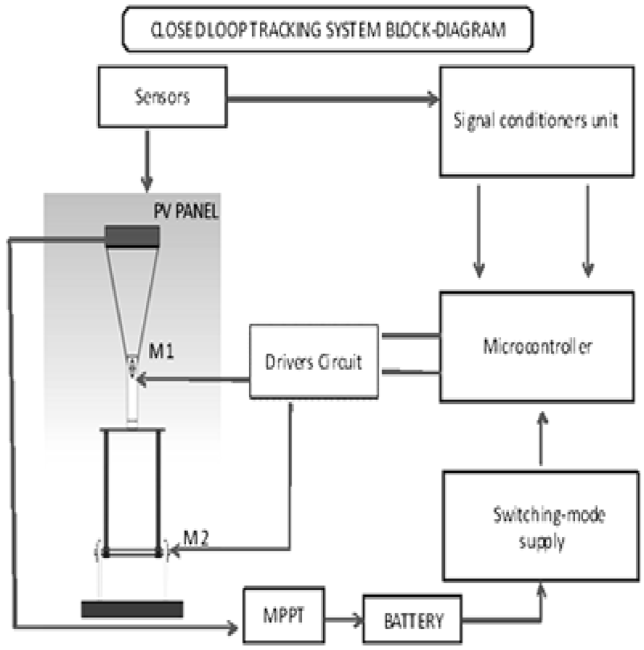


Figure 3: Block diagram of closed loop tracking system

IV. SOLAR TRACKING SYSTEM

Solar energy is the oldest primary source of energy. It is clean, renewable and abundant in every part of the world. Almost all energies are derived from solar energy. However it is possible to convert solar energy into mechanical or electrical energy with adequate efficiency. Sun tracking systems are designed in a way to track the solar azimuth angle on a single axis or to track the solar azimuth and zenith angles on two axes. For the purpose of clarity, the eastwest of the tracker will be called the "horizontal tracking" while the angular height tracker will be referred to as "vertical tracking". In the literature based on the previous studies, it is observed that sun tracking systems provided a significant increase in the amount of energy produced

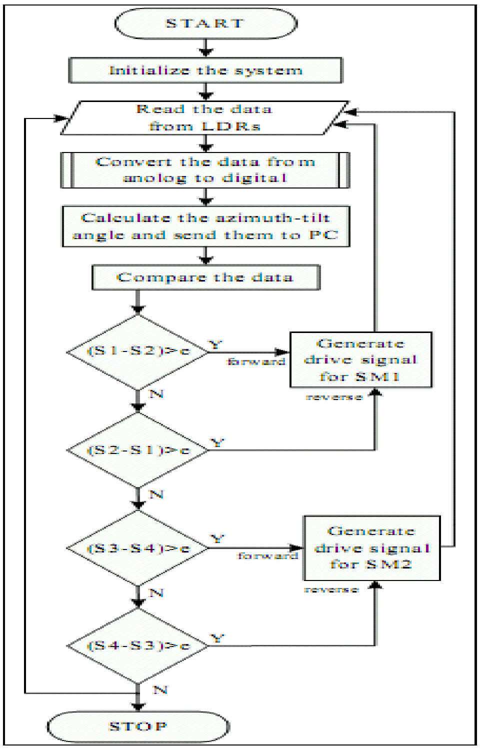


Figure 4: flow chat for tilt angle calculation

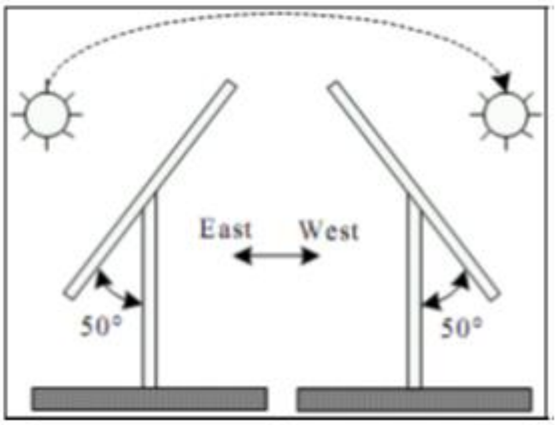


Figure 5: Limits for movement of the solar panel

V. PROTEUSSIMULATION

A. Introduction

These programs are the backbone of the microprocessor and microcontroller based systems; since using Micro Basic we can build the software of the project using Basic, and then we can simulate the project virtually using PROTEUS, finally we can download the program on the microcontroller and see the results practically using programmer. So this experiment includes all the knowledge the student will need to get started to the programs.

a. micro Basic Program

Micro Basic is a Windows-based Integrated Development Environment, and is much more than just Basic compiler for PIC MCUs. With micro Basic, you can:

1. Create Basic source code using the built-in Code Editor
2. Compile and link your source code
3. Inspect program flow and debug executable logic with Debugger
4. Monitor variables in Watch Window
5. Get error reports
6. Get detailed statistics (how compiled code utilizes PIC MCU memory, hex map, charts and more...)

B. PROTEUS Program

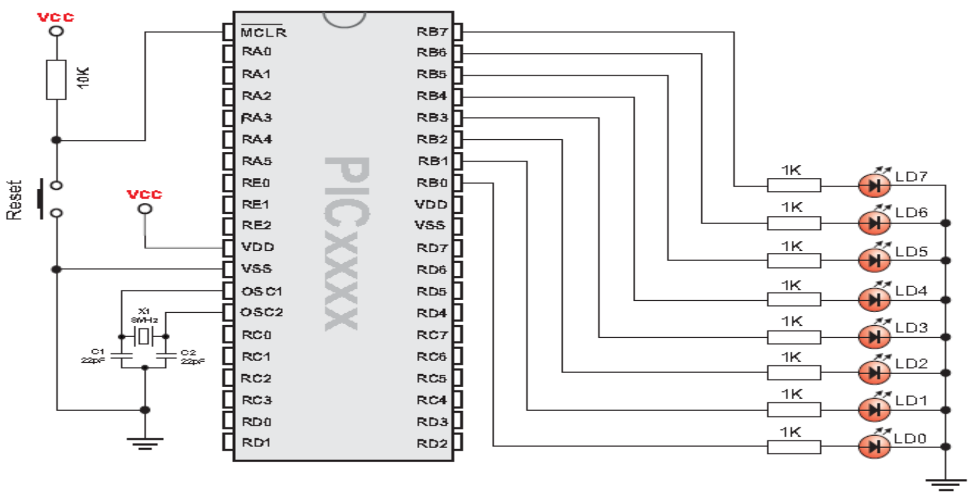
Proteus contains everything you need to develop; test and virtually prototype your embedded system designs based around the Microchip Technologies™ PIC18 series of microcontrollers. The unique nature of schematic based microcontroller simulation with Proteus facilitates rapid, flexible and parallel development of both the system hardware and the system firmware. This design synergy allows engineers to evolve their projects more quickly, empowering them with the flexibility to make hardware or firmware changes at will and reducing the time to market. Proteus VSM models will fundamentally work with the exact same HEX file as you would program the physical device with, binary files (i.e. Intel or Motorola Hex files) produced birany assembler or compiler.

C. Part 1: Create Program for Microcontroller

a. Creating First Project in micro Basic for PIC

In this section, we will create a new project , write some code and compile it in micro basic for PIC and test the result. Out project will make LED diodes blink, so it can easily tested on PIC microcontrollers.

The following diagram show the connection scheme you'll need to test the code for the micro controller , we have used common chop in our experiments. LED diodes are connected to PORTB, but you can use any other available port.



Step 1: Install the compiler

Install the mikroBasic for PIC compiler. Desktop shortcut and start menu shortcuts will be created.

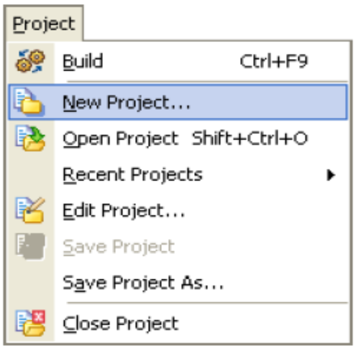
Step 2: Run the compiler

Run the mikroBasic for PIC compiler. mikroBasic IDE (Integrated Development Environment) will appear.

Step 3: Start the Wizard

Click the New Project icon or select **Project** > **New Project** from the drop-down menu:

New Project.



Led blinking for mikroBasic for PIC:

Here is the code that will make LED's on PORTB blink every second. Type it in the Code Editor (if there is any default code you can over write it):

File: ProjName.pbas
Page: 1 od 1

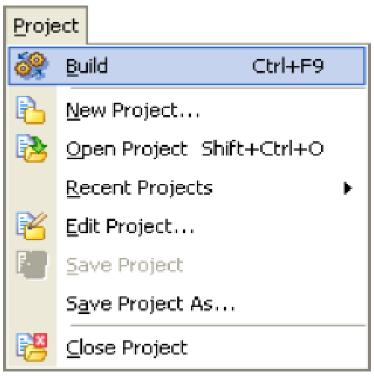
```
program Led_blinking
main:
  while TRUE                  ' Endless loop
    TRISB = 0                 ' Configure pins of PORTB as output
    PORTB = %11111111         ' Turn ON diodes on PORTB
    while true
      PORTB = not PORTB       ' Toggle diodes on portb
      delay_ms(1000)
    wend
  wend
end.
```

Note: If you want to try another port, just replace each instance of PORTB and TRISB in code with your port, e.g. PORTC/TRISC.

Step 6: Build!

Now it's time to build our project. First, save your file by clicking on the Save Icon, or click Ctrl+S. Select **Project** > **Build** from the drop-down menu, or click the Build Icon. You can also use the short-cut Ctrl+F9.

Build.



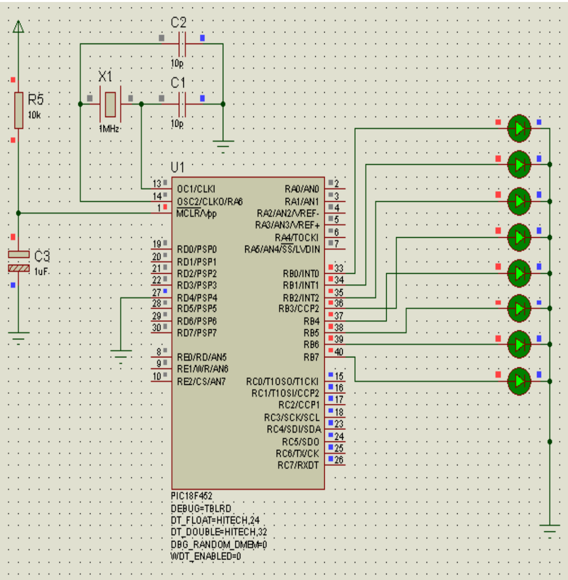
Compiler will generate output files in the project folder. There should be 4 new files: ProjectName.asm, ProjectName.lst, ProjectName.mcl, and ProjectName.hex. The last one will be used to program the microcontroller directly.

Step 7: Real World test

To "burn" the PIC you can use the compiler's integrated (PICflash) programmer (default shortcut is F11) or any other programmer for selected microcontroller. As a result, LED's connected to PORTB of programmed microcontroller should blink indefinitely.

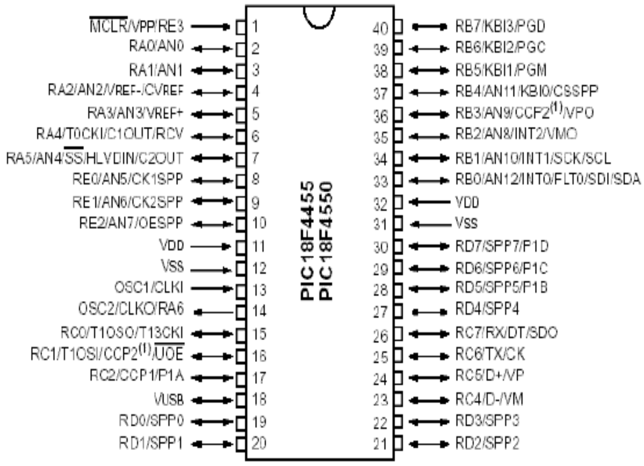
D. Part 2: Simulation in PROTEUS Program

1. Run the PROTEUS Program
   1. From start menu chose the PROTEUS, and then chose ISIS (blue).
   2. To get a part click on Devices (P).
   3. Write the name of the PIC18F452.
   4. To get LED write led then choose yellow led.
   5. To get a resistor write 1k and choose the first part.
2. Connect the circuit shown in the Figure1 below on Proteus ISIS program.
3. Load the (.hex) file to PIC18F452 microcontroller.
4. Configure PIC18F452 parameters needed for the simulation by putting Processor clock frequency 8MHz.
5. Simulate the circuit using Proteus ISIS program.
6. Figure 5 shows the simulation module of PIC18F452 using LED blinking.



Figures 5

PIN Diagram



The **Proteus Design Suite** is an Electronic Design Automation (EDA) tool including schematic capture, simulation and PCB Layout modules. It is developed in Yorkshire, England by **Labcenter Electronics** Ltd with offices in North America and several overseas sales channels.By using Proteus software the hardware circuits combined by two parts, Arduino Uno microcontroller and the H-Bridge IC which is used to control the motor. The process started with the input signal by the sensor which is the light intensity (LUX used in the software) going into the microcontroller. For Arduino, the analog-to-digital converter (ADC) already exists on the input pins. Therefore, the LDR can be directly connected into it. Inside microcontroller a comparison between the voltages outputs from each LDR occur. There are 5 cases are made by using "if else" statement. The first case is when LDR sensor 1 received the highest light intensity. Therefore the output voltage V1 is higher than the other sensor. Case number 2, 3 and 4 is the same as case number 1 but at this time with different LDR sensor receives the highest light intensity. Case number 5 is when all the LDR sensors received the same light intensity, thus producing the same value of output voltage. And also proteus simulation module is shown in fig.6

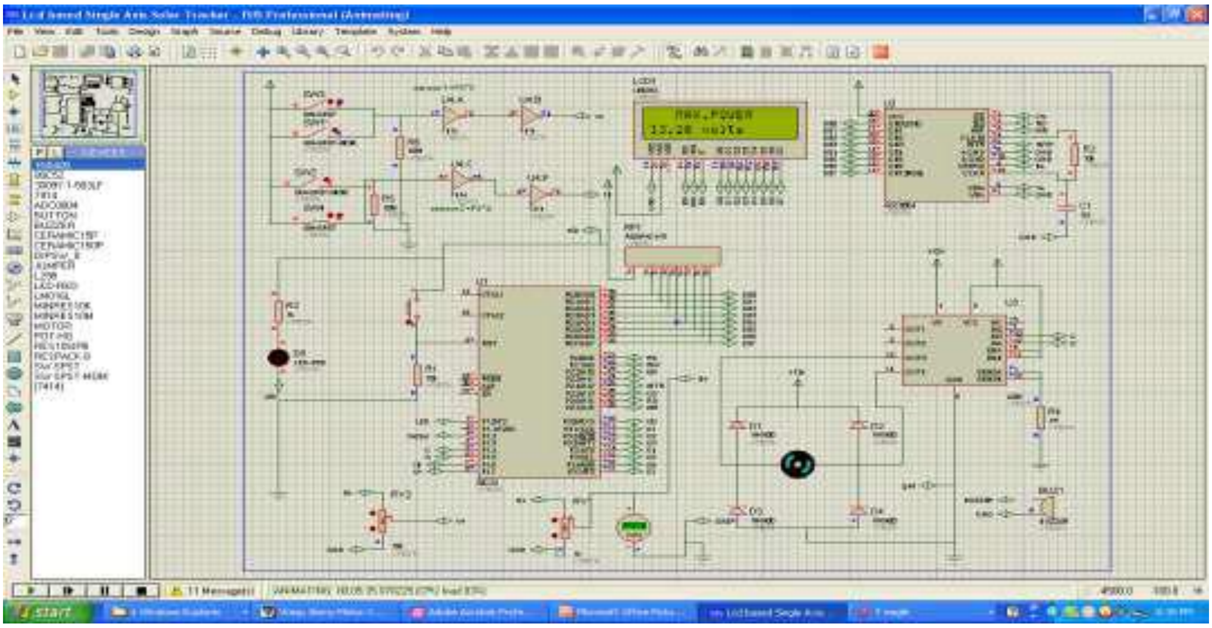


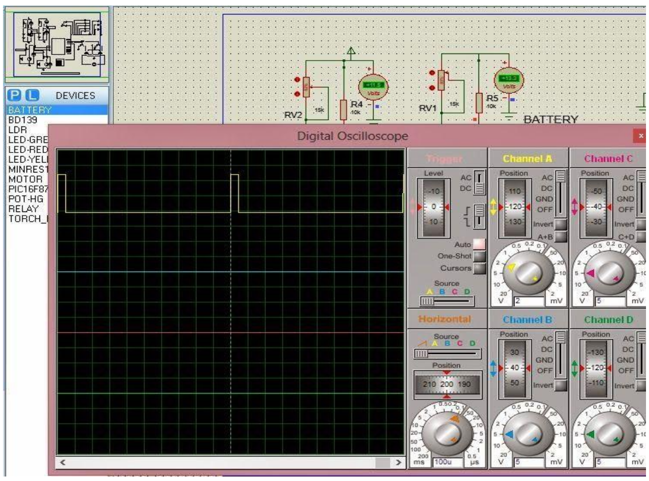
Fig.6 Sun tracking system implemented with proteus design

CONCLUSION

In order to collect the greatest amount of energy from the sun, solar panels must be aligned orthogonally to the sun. For this purpose, a new solar tracking technique based on microcontroller implemented and tested in this study. The tracking system presented has the following advantages: The tracking system is not constrained by the geographical location of installation of the solar panel since it is designed for searching the maximum solar irradiance in the whole azimuth and tilt angle (except hardware limitations) during day times; namely, the angle of elevation does not need to be adjusted periodically. The operator interference is minimal because of not needing to be adjusted. The tracker provides also PC based system monitoring facility. Since the tracking system is controlled completely by MCU; the PC, used for monitoring the panel only, may not be employed. A drawback of the tracker is being affected by temporal variations in the atmospheric refractions caused by rain, cloud, fog, etc. Thus, the system may give an erroneous detection in the direction of the sun, and lead to wrong positioning of the solar panel.

RESULTS AND DISCUSSION

The performance of the sun's tracking system has been tested using proteus design software and is found to operate well. The movement of the Photo voltaic panel following the sun's incident radiation is smooth and without any time-lag. The process starts when a shadow is developed on one of the two resistors causing a resistivity difference. This difference is converted to a voltage applied directly to the analog inputs of the microcontroller. The tracker scans an angle of about 120 east-west every day, and it stops tracking and returns to its starting point automatically at the time when the value of the incident solar radiation decreases to a very small value at sunset. At every half hour, the voltage, current and power values received from the thermoelectric solar collector measure for both positions. The comparison of the values acquired from the fixed position and the values obtained from the sun-tracking system as the result of the experiment is shown in Fig. 7. We found that the difference in output power produced by the photovoltaic panel in the tracking and fixed modes of operation is 21.7%.



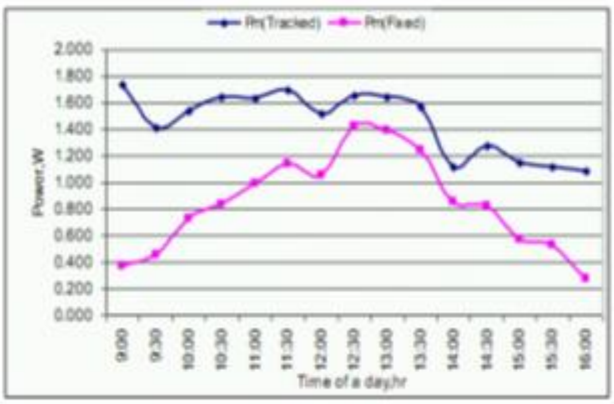


Figure 7: Power value curve of the panel according to fixed position and sun tracking

References

[1] Hegazy, A. A. (2000) Comparative study of the performance of four photovoltaic/thermal solar air collectors, Energy Conversion and Management, 41, pp. 861-881.

[2] Lertsatitthanakorn, C., Khasee N., Atthajariyakul, S., Soponronnarit S., Therdyothin A. and Ryosuke O. S. (2008) Performance analysis of a double-pass thermoelectric solar air collector, Solar Energy Materials and Solar Cells, 92, pp. 1105-1109.

[3] Al-Mohamad, A. (2004) Efficiency improvements of photovoltaic panels using a Sun-tracking system, Applied Energy, 79, pp. 345-354.

[4] Abdallah, S. (2004) The effect of using sun tracking systems on the voltage-current characteristics and power generation of flat plate photovoltaics, Energy Conversion and Management, 45, pp. 1671-1679.

[5] Sungur, C. (2009) Multi-axes sun-tracking system with PLC control for photovoltaic panels in Turkey, Renewable Energy, 34, pp. 1119-1125.

[6] Huang, B.J. and Sun, F.S. (2007) Feasibility study of one axis three positions tracking solar PV with low concentration ratio reflector, Energy Conversion and Management, 48, pp. 1273- 1280.

[7] Y. Goswami, F. Kreith and J. Kreder, Principles of solar engineering, Taylor & Francis, Philadelphia (1999).

[8] S. Abdallah and S. Nijmeh, "Two-axis sun tracking with PLC control", Energy Conversion and Management, Vol. 45, No. 12, pp. 1931-1939, 2004.

[9] A. Canova, L. Giaccone and F. Spertino, "Sun tracking for capture improvement", in Proc. UPVSEC'2007, Milano, pp. 3053- 3058.

[10] H.D. Mohring, F. Klotz and H. Gabler, "Energy yield of PV tracking systems", in Proc. EUPVSEC'2006, Dresden, pp. 2691- 2694.

[11] S. Odeh, "Design of a single-axis tracking collector", in Proc. EUROSUN'2004, Freiburg, pp. 527-532.

[12] P. Roth, A. Georgiev and H. Boudinov, "Design and construction of a sun-tracking system", Renewable Energy, Vol. 29, No. 3, pp. 393-402, 2004. [7] J. Garcia de Jalón and E. Bayo, Kinematic and dynamic simulation of multibody systems, Springer - Verlag, New York (1994).

[13] J.A. Chojnacki, "Application of fuzzy logic neural network controllers in photovoltaic systems", in Proc. EUPVSEC'2005, Barcelona, pp. 2269-2272.

[14] M. Comşiţ and I. Vişa, "Design of the linkages-type tracking mechanisms by using MBS method", in Proc. IFToMM'2007, Besançon, pp. 582-587.