Webology (ISSN: 1735-188X)
Volume 19, Number 2, 2022

Increasing The Efficiency Of Solar Energy Systems Using The Sun Tracking Method (Design And Implementation)

Manhal M. Basher Hasan Aga[1] & Sura Saad Basher[2] & luay abdulwahid shihab[3]

1.Northern Technical University, Mosul, Iraq.

2. Northern Technical University, Mosul, Iraq

3. Assist Prof. College of Nursing, University of Basrah, Basrah, Iraq.

Abstract:
Design and implementation of solar tracking system using Arduino Solar tracking system consists of solar panel, DC motor and Arduino control. The controller governs the motion of the tracking system, which is a special device moving with the direction of the sun to receive the greatest radiation energy from the sun and improve the efficiency of the collection energy. As such type of energy is renewable, intensive studies have been conducted on solar energy systems. As conclusion, studies showed that the use of solar energy tracking systems have increased productivity by about 22%, hence, augments the efficiency by 2%.

KeyWords Solar Energy System, Arduino, C++, Sun Tracking.

Introduction:

1.Solar Alternative
As an alternative continuous source of energy, solar energy still has a weak attention as a means of expanding the use of renewable energies. Using solar tracking system, once could ensure that larger amount of electricity is produced because the solar cell matrix remains aligned from the sun throughout its brightness. The project, initially invented at Cleveland State University, is designed to create a solar tracking system based on microcontrollers. The system and its practical components were fully processed and the design was theoretically assessed and explained in principle. Finally, the project discussed the problems we could face and some alternative solutions and improvements that could be made.
Renewable energy solutions are becoming widely popular and remarkably efficient over time. Solar cells are just an example.

Raising the value of solar cell output to a super value is needed in order to raise the yield of solar cells to a higher value. One way to get more radiation is to have solar cells always face the sun using a so-called Solar Tracking System. The solution is often much more economical than using more cells to get a higher output. It has been estimated that the power gained of solar cells can be increased up to 30 to 60% when we employ solar

tracking devices compared to that obtained when using fixed cells. This project addresses the design of one of these systems to get the greatest outcome.

The project starts with a background presentation on light sensors and linear motors that utilize in the project. The project proceeds by explaining a specific design methodology related to photovoltaic cells, actuators and their driving circuits, selection of microcontrollers, regulation of tension, physical structure, and explanation of the software work system used in the system. The project makes recommendations for developing this system into better future system benefits of solar energy. [1] [2]. the computer and find out local area networks has become a major tool to many companies and factories, universities, hospitals and standardization of data and security services that protect the data and means of communication [14].

2. Benefits of solar energy

Solar energy is defined as the sun's radiation, which produces heat, and is classified as renewable source of energy. Unlike energy produced from fossil fuel, solar energy is an endless source of supplying, clean and non-polluting source. Data obtained from survey concluded that the total amount of solar energy falling on the earth is much greater than the current and future energy demands. Therefore, if it is invested properly, it will meet all future energy needs. Although solar energy is a powerful source of energy, the amount of solar radiation reaching the Earth's atmosphere is a relatively low, due to the distance travelled of the sun light that results loss of solar radiation. Such losses involve atmosphere and clouds, which absorb or Dispersion of up to 54% of the sun's rays, which comprise approximately 50% of visible light, 45% of infrared radiation, as well as small amounts of ultraviolet radiation, and other types of electromagnetic radiation. [1] Energy can be invested in many fields using renewable energy technologies such as Alawa Solar cells. [2] Benefits of solar energy Electricity generation solar energy can be converted into electricity directly using photovoltaic (PV) technology. the electrons are released from their atomic bonds, resulting in current flow of electrons, which eventually produces an electric current when sunlight falls on photovoltaic modules, which are made of semi-conductive materials that are usually different forms of silicon. The highest production of PV at midday occurs when the sun is at the highest point in the sky. Concentrated solar energy can be stored for use as required in solar power plants concentrations, and applications on the production of electric power from solar energy is what follows. [3] [4] [5] .

3. Solar panels

The basic part of solar systems is the solar panels by which electricity is generated. These panels are cells made of semi-conductive materials which absorb sunlight such as silicon . An anti-reflection coating is applied to the cells in order to take advantage of the photons and prevent them from reflecting away from the cell. This is due to the fact that silicon is very bright in nature. In order to protect the silicone material from external factors and scratching ,a glass cover is placed on top of the solar panel. The panel is composed of a group of PV cells linked together in a single frame and connected between them

- Standard size 15.6 * 15.6 cm cells
- The 255-285 Watt panels contain 60 cells (6 * 10) and 99 * 1 . [6] [7] [8] .

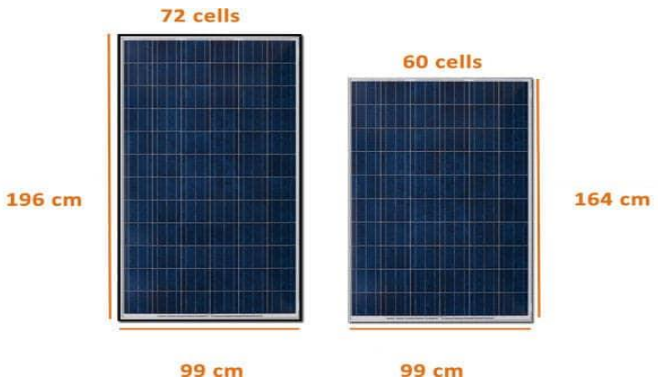

Figure.1.1 Mon crystalline Silicon

4. Types of solar panels:

There are available in the markets of three main types: [9] [10].

1. Mono crystalline Silicon

Mono crystalline panels have a symmetrical appearance that indicates the purity of silicon crystals. Mono blastic cells are strips of sliced silicon alloys . It is noted that the cell characters are not allied therefore the monochrome panels have a distinguished appearance as shown in the picture. [11]

Figure.1.2 Polycrystalline Silicon

2. Polycrystalline Silicon

The difference between the Polycrystalline and monocytes is obvious regarding their rectangular shape in the two pictures.

They are lower in price compared to monocytes. Its efficiency is about 16.9% and the default age is 25 years or more .The only drawback ignored to many is that its form is not as beautiful as the blue single solar panels [12].

Figure 1.3 Thin Film

Thin Film

This kind of solar panels takes the shape of the surface of installation and as shown in the image ,they are thin and efficient. For these reasons most researches depend on the development of these smooth and low weight panels.

Thin film panel is effective for many applications as in transport vehicles and boat surfaces . However, it possesses some disadvantages. Its efficiency may not exceed 12%.Therefore, it is the least efficient type. Its life span is less than its single and multiple counterparts and is only 15 years old. [13].

Characteristic of model cell

- Raped maximum power = 10 watt
- 36 cm x 24 cm in dimension
- Short circuit currint 0.62A
- Open circuit voltage 12.8 volt
- Nominal operating cell temperature +50 deg
- Current at P max. =0.57 A
- Voltage at P max. =17.8 v

Type of cell

The cells in the single panel are made from silicon alloys chopped to equally sliced pieces. One can clearly observe the separated boundary of each cell that gives each cell its unique appearance. Efficiency of this type of panels could touch 22.5%.

Type panel cell

Single panel

This type of system has one-degree-freedom ODF motion. Normally, the motion asymptotical moves to the north and south of the earth. The ODF allows the panel to curve from east to west to follow the sun when its shine tills its set.

The cost of ODF system is lower than the two-degree-freedom system. Besides, the ODF system has more reliability and life span because of limited motion of its parts. However, its efficiency to capture the solar energy is lower than the two-degree-freedom system.

Double panel

The two-degree-freedom systems have a curved motion from east to west and from north to south. Such flexibility in motion gives more options to optimize the system position faced to the sun during the year. Hence, higher energy is obtained. In return, the complexity of the system reduces its life span, increases its cost, and demands more maintenances shutdown.

Subjectively speaking, there is no winner as each type has drawbacks as well as advantages. Hence, the decision of selecting the type application is highly depend on assessing the factors such as location, cost, maintenance, reliability, and efficiency.

For this project, we select the ODF type since the sun angle does not exceed 15 during the entire year. Moreover, the system is durable in terms of its cost, complexity, and installation.

Power motor consumed

The DC motor operates on 12 V battery. Hence, it consider economical in terms of energy consumption. The maximum and minimum current consumed in the system are 0.7 A and 0.35 A, respectively. Average current consumed is around 0.55 A.

Type of Arduino

ON arduino are used in the project. For beginners, it is most commonly and easily used in building projects especially. It is used in the programming of microcontroller of the company ATmega328. This circuit offers ports to link electronic components such as sensors to the controller directly via 14 digital in / out. For PWM (pulse-width modulation) ,six of them can be used. The circuit also has a 16MHz Crystal Oscillator, plus a USB port for communication with the computer, and a discrete power input.

Software

Arduino program

The arduino are programed by C++

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
// Set the LCD address to 0x27 for a 16 chars and 2 line display
LiquidCrystal_I2C lcd(0x27, 16, 2);
int input wst=A0;          //variable to store the values from the analog pin 0
int inpu test=A1;
const int analogIn = A2;
const int analog Vin = A3;
const int in1 = 10;
const int in2 = 11;
```

```
const int in3 = 12;
const int in4 = 13;
int d=80;
int m Vper Amp = 66; // use 100 for 20A Module and 66 for 30A Module
int Raw Value= 0;
int AC Soffset = 2500;
double Voltage = 0;
double Amps = 0;
void setup() {
lcd. begin();
lcd. Backlight ();
Serial. Begin (9600);
Pin Mode (in1, OUTPUT);
Pin Mode (in2, OUTPUT);
Pin Mode (in3, OUTPUT);
Pin Mode (in4, OUTPUT);
Pin Mode (A3, INPUT);
}
void loop() {
RawValue = analog Read(analog In);
Voltage = (Raw Value / 1024.0) * 5000; // Gets you mV//
Amps = ((Voltage – ACS off set) / m Vper Amp);
Amps=Amps+0.52;
Serial. Print ("current= ");
Serial. Println (Amps);
//*************************************************************
int RawValue1 = analog Read(analog V in);
float Voltage1 = (RawValue1 / 1024.0) * 5.0;//
float volt=Voltage1*4.8;
Serial. Println (volt);
//*************************************************************************
float P=volt*Amps;
//*************************************************************
lcd.set Cursor(0, 0);
lcd.print ("POWER=");
lcd.prin t(P);
lcd.print("Watt");
lcd.set Cursor (0, 1);
lcd.prin t("I=");
lcd.print (Amps);
lcd.print ("A-");
lcd.print ("V=");
lcd.print (volt);
```

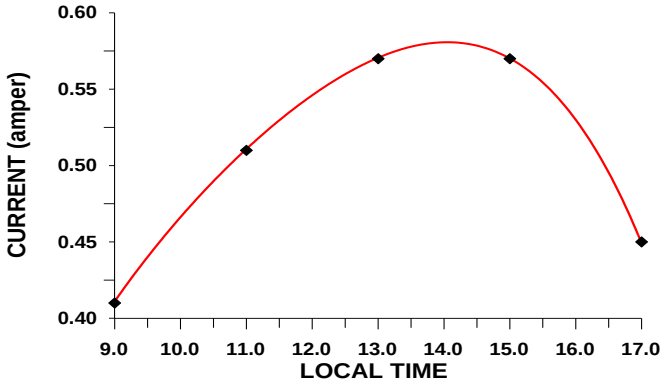

Fig (1)
local time vs currnt

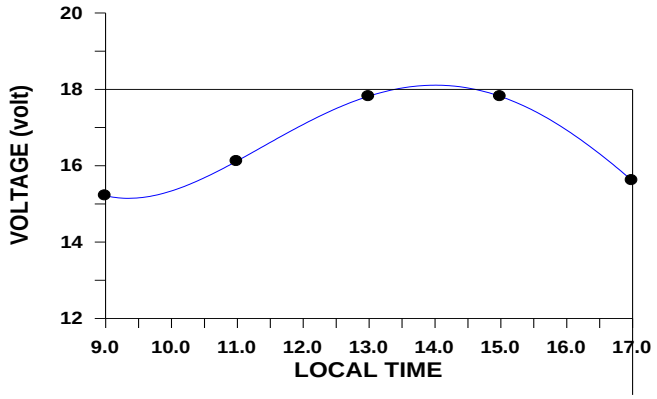

Fig (2)
local time vs voltag

```
lcd.print("v");
//**************************************
int valuewst =analog Read(input wst);   //reads the value from the right sensor
int values t=analog Read(inpu test);
Serial.print ("input wst= ");
Serial.println (value wst);
Serial.print ("inpu test= ");
Serial.print ln (value est);
int diff =(value wst-value est);
Serial.println (diff);
if(value wst>450 || value est<450){
  analog Write(in1, 0);
digital Write (in3, 0);

}
if(value wst>450 || value est>450){
  if(diff>=d){
  analog Write (in1, 255);
```

```
digital Write (in3, 1);
  }else if (diff<=-d){
   Analog Write (in1, 255);
Analog Write (in2, 255);
Digital Write (in3, 0);
Digital Write (in4, 0);
  }else{ analog Write(in1, 0);
Digital Write (in3, 0);
}
}
delay(1000);
}
```

Results and Discussion

The data recorded were for one day intended as a model. The output (current and voltage) and the power were measured five times during the daytime at two-hour intervals beginning from 9 am.

Measurement of Current shows the readings generated by the cell during the day, where we observe that the current intensifies with time until it reaches its maximum value at 14:00 hours, when the sun is perpendicular to the solar cell plate. This indicates that the use of the tracking system increases the efficiency of sunlight compared to when the solar cell is static. In addition, we notice that the intensity of the current is reduced after 14:00 hours, which is normal due to low solar radiation energy.

Measurement of Voltage It is known that the higher the solar radiation energy, the higher the voltages generated, as shown in the below diagram (Fig-1 and Fig-2). The largest volt generated was at 14:00 hours.

Reference

[1] Progress in photovoltaic: Research and Applications 14(5),393-411,2006
[2] MS Dresselhaus, IL Thomas Nature 414 (6861), 332, 2001
[3] Soteris A Kalogirou Energy conversion and management 45 (18-19), 3075-3092, 2004 a hysteresis curve to trigger the switching; iv) revision of the driver board, considering more carefully the design of the board in what it refers to the current carrying lines.

For future works, it is intended to: develop educational modules to show the inner working of each piece of the machine; develop prediction tools based on artificial and computational intelligence to infer results from measurements, like vibration and end effector’s drained power; development of modules for process efficiency analysis.

Reference

[1] GROOVER, Mikell. Automation, Production Systems, and Computer-

Integrated Manufacturing. 3 ed. Upper Saddle River: Prentice Hall, Inc., 2008;
[2] http://www.rogercom.com/, various programming languages implementations related to serial communication. Accessed at 06/02/2010;
[3] http://www.codeproject.com/KB/system/chaiyasit_t.aspx, source code of a serial communication program, developed in C++. Accessed at 06/02/2010;
[4] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/DeviceDoc/39632e.pdf, PIC18F2550 micro controllers' datasheet. Accessed at 05/25/2010;
[5] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/AppNotes/00956b.pdf, Application Note 956 – Migrating Applications to USB from RS-232 UART with Minimal Impact on PC Software. Accessed at 05/12/2010;
[6] http://www.usb.org/developers/docs/usb_20_052510.zip, full USB specification. Accessed at 25/05/2010;
[7] Rev 2.1 of the Inter-Integrated Circuit protocol, NxP (Philips), http://www.nxp.com/acrobat_download/literature/9398/39340011.pdf
[8] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/DeviceDoc/41262E.pdf, PIC18F677 micro controllers' datasheet. Accessed at 05/25/2010;
[9] www.st.com/stonline/books/pdf/docs/1773.pdf, L298 integrated circuit datasheet. Accessed at 06/04/2010;
[10] OPPENHEIM, Allan, SCHAFER, Ronald. Discrete-Time Signal Processing, 2 ed. Upper Saddle River: Prentice Hall, 1999;
[11] Digital Signal Processing lectur
a hysteresis curve to trigger the switching; iv) revision of the driver board, considering more carefully the design of the board in what it refers to the current carrying lines.
For future works, it is intended to: develop educational modules to show the inner working of each piece of the machine; develop prediction tools based on artificial and computational intelligence to infer results from measurements, like vibration and end effector's drained power; development of modules for process efficiency analysis.

Reference

[1] GROOVER, Mikell. Automation, Production Systems, and Computer-Integrated Manufacturing. 3 ed. Upper Saddle River: Prentice Hall, Inc., 2008;

[2] http://www.rogercom.com/, various programming languages implementations related to serial communication. Accessed at 06/02/2010;
[3] http://www.codeproject.com/KB/system/chaiyasit_t.aspx, source code of a serial communication program, developed in C++. Accessed at 06/02/2010;
[4] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/DeviceDoc/39632e.pdf, PIC18F2550 micro controllers' datasheet. Accessed at 05/25/2010;
[5] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/AppNotes/00956b.pdf, Application Note 956 – Migrating Applications to USB from RS-232 UART with Minimal Impact on PC Software. Accessed at 05/12/2010;
[6] http://www.usb.org/developers/docs/usb_20_052510.zip, full USB specification. Accessed at 25/05/2010;
[7] Rev 2.1 of the Inter-Integrated Circuit protocol, Nx P (Philips), http://www.nxp.com/acrobat_download/literature/9398/39340011.pdf
[8] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/DeviceDoc/41262E.pdf, PIC18F677 micro controllers' datasheet. Accessed at 05/25/2010;
[9] www.st.com/stonline/books/pdf/docs/1773.pdf, L298 integrated circuit datasheet. Accessed at 06/04/2010;
[10] OPPENHEIM, Allan, SCHAFER, Ronald. Discrete-Time Signal Processing, 2 ed. Upper Saddle River: Prentice Hall, 1999;
[11] Digital Signal Processing lectur
a hysteresis curve to trigger the switching; iv) revision of the driver board, considering more carefully the design of the board in what it refers to the current carrying lines.
For future works, it is intended to: develop educational modules to show the inner working of each piece of the machine; develop prediction tools based on artificial and computational intelligence to infer results from measurements, like vibration and end effector's drained power; development of modules for process efficiency analysis.

Reference

[1] GROOVER, Mikell. Automation, Production Systems, and Computer-Integrated Manufacturing. 3 ed. Upper Saddle River: Prentice Hall, Inc., 2008;
[2] http://www.rogercom.com/, various programming languages implementations related to serial communication. Accessed at

06/02/2010;
[3] http://www.codeproject.com/KB/system/chaiyasit_t.aspx, source code of a serial communication program, developed in C++. Accessed at 06/02/2010;
[4] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/DeviceDoc/39632e.pdf, PIC18F2550 micro controllers' datasheet. Accessed at 05/25/2010;
[5] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/AppNotes/00956b.pdf, Application Note 956 – Migrating Applications to USB from RS-232 UART with Minimal Impact on PC Software. Accessed at 05/12/2010;
[6] http://www.usb.org/developers/docs/usb_20_052510.zip, full USB specification. Accessed at 25/05/2010;
[7] Rev 2.1 of the Inter-Integrated Circuit protocol, NxP (Philips), http://www.nxp.com/acrobat_download/literature/9398/39340011.pdf
[8] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/DeviceDoc/41262E.pdf, PIC18F677 micro controllers' datasheet. Accessed at 05/25/2010;
[9] www.st.com/stonline/books/pdf/docs/1773.pdf, L298 integrated circuit datasheet. Accessed at 06/04/2010;
[10] OPPENHEIM, Allan, SCHAFER, Ronald. Discrete-Time Signal Processing, 2 ed. Upper Saddle River: Prentice Hall, 1999;
[11] Digital Signal Processing lectur
a hysteresis curve to trigger the switching; iv) revision of the driver board, considering more carefully the design of the board in what it refers to the current carrying lines.
For future works, it is intended to: develop educational modules to show the inner working of each piece of the machine; develop prediction tools based on artificial and computational intelligence to infer results from measurements, like vibration and end effector's drained power; development of modules for process efficiency analysis.

Reference

[1] GROOVER, Mikell. Automation, Production Systems, and Computer-Integrated Manufacturing. 3 ed. Upper Saddle River: Prentice Hall, Inc., 2008;
[2] http://www.rogercom.com/, various programming languages implementations related to serial communication. Accessed at 06/02/2010;
[3] http://www.codeproject.com/KB/system/chaiyasit_t.aspx, source code

of a serial communication program, developed in C++. Accessed at 06/02/2010;
[4] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/DeviceDoc/39632e.pdf, PIC18F2550 micro controllers' datasheet. Accessed at 05/25/2010;
[5] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/AppNotes/00956b.pdf, Application Note 956 – Migrating Applications to USB from RS-232 UART with Minimal Impact on PC Software. Accessed at 05/12/2010;
[6] http://www.usb.org/developers/docs/usb_20_052510.zip, full USB specification. Accessed at 25/05/2010;
[7] Rev 2.1 of the Inter-Integrated Circuit protocol, NxP (Philips), http://www.nxp.com/acrobat_download/literature/9398/39340011.pdf
[8] Microchip. U.S.A., 2009. Available at http://ww1.microchip.com/downloads/en/DeviceDoc/41262E.pdf, PIC18F677 micro controllers' datasheet. Accessed at 05/25/2010;
[9] www.st.com/stonline/books/pdf/docs/1773.pdf, L298 integrated circuit datasheet. Accessed at 06/04/2010;
[10] OPPENHEIM, Allan, SCHAFER, Ronald. Discrete-Time Signal Processing, 2 ed. Upper Saddle River: Prentice Hall, 1999;
[11] Digital Signal Processing lectur
GROOVER, Mikell. Automation, Production Systems, and Computer-Integrated Manufacturing. 3 ed. Upper Saddle River: Prentice Hall, Inc., 2008;
[4] Godfrey Boyle Renewable Energy, by Edited by Godfrey Boyle pp. 456.Oxford University press, May 2004. ISBN-10:0199261784. ISBN-13:9780199261789, 456, 2004
[5] Steven N Williams, Victoria Coverstone Journal of the Astronautical Sciences 45 (2), 143-159, 1997.
[6] Klaus Bogus, Tomas Markvart Chichester, New York. Wiley Press, 1994
[7] Muhamed Hugerat, Salman Ilyian, Zehava Toten, Fawzi Anabosi Journal of Science Education and Technology 12 (3), 309-315, 2003
[8] Joseph S Cantrell Jurnal of Chemical Education 55 (1), 41, 1978
[9] Donald A Kelly US Patent 4,119,863, 1978
[10] IEEE Journal of photovoltaics 4 (6), 1433-1435, 2014
[11] Appiled Physics Letters 37 (14), 1991-1993, 1998
[12] Solar energy materials and solar cells 34 (1-4), 219-225, 1994
[13] Progress in photovoltaics: research and Applications 11 (4), 225-230, 2003.
[14]. Luaay Abdulwahed Shihab. (2012). Wireless LAN Security and Management, International Journal of Engineering and Advanced Technology (IJEAT), 2(1).