An Example of Solar Tracking System & Hybrid Power Generation in Jordan

Mahmoud S. Awad, Khalaf Y. Al-Zyoud

Abstract— **This paper is designed to improve existing solar collection system to provide higher efficiency for lower cost. The existing system receives sun energy only for new hours, which is really not economical when compare the cost, which we are spending. Here the proposed system is designed to observe the sun light for the available maximum hours, for example 12 hours a day. This project operates a solar panel to constantly face sun at 90 degrees to produce maximum voltage. It will move the solar panel from east to west to correct for the durational movement of the Sun in the sky. The set of Light Intensify Sensors give the input to the and it operates Stepper motors with mechanism. The solar tracker is a device, which points a solar panel at the brightest part of the sky in order to achieve maximum power output from the solar panel. In Jordan the solar panel will move as per the sun movement to collect maximum possible light energy from Morning 6.00 AM to Evening 6.30 PM and in summer to 7 PM.**

Index Terms— **Solar, Tracking, Generation, Improve way, efficiency**

[redacted]INTRODUCTION

In today's climate growing energy needs and increasing environmental concern, alternatives to the use of non--renewable and polluting fossil fuels have to be investigated. One such alternative is solar energy. Solar energy is quite simply the energy produced by directly by the sun and collected elsewhere, normally the earth. The sun creates its energy throw a thermonuclear process that converts about 650, 000,000 tons of hydrogen to helium every second process creates heat and electromagnetic radiation. The heat remains in sun and is instrumental in maintaining the thermonuclear reaction. the electromagnetic radiation (including visible light, infrared-red light and ultraviolet radiation) streams out in to space in all directions. Only a very small fraction of the total radiation produced reaches the earth. The radiation that does reach the earth is the indirect source of nearly every type of 0energy used today. The exceptions are geothermal energy, and nuclear fission and fusion. Even fossil fuels owe their origins to the sun; they were once living plants and animals whose life was dependant up on the sun. Much of worlds required energy can be supplied directly by solar power. More still can be provided indirectly. The practicality of doing so will be examined as well as the benefits and drawbacks. In addition, the uses solar energy is currently applied to will be noted. Due to the nature of solar energy, two components are required to haw a fictional solar energy generator. These two components are collector and storage unit. The collector simply collects radiation that falls on it and converts fraction of it in to other forms of energy (either electricity and heat or heat alone). The storage unit is required because of the non-constant nature of solar energy; at a certain times only a very small amount of radiation will be received. At a night or during heavy cloud cover eg, the amount energy produced by the collector will be quite small. The storage unit can hold the excess energy produced during the period of maximum productivity, and reels it when the productivity drops. In practice, backup power supply is usually added, too, for the situation when the amount of energy required is greater than both what is being produced and what is soared in the container. Methods of collecting and solar energy vary depending on the uses planed for the solar generator. In general, there are three types of collectors and many forms of storage units. The three types of collectors are flat plate, focusing and passive collectors.

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1.1 Earth-Sun Geometry

Our paper is based on microcontroller system for solar tracking system. The major disadvantages of solar energy are the amount of sun light that arrives at the earth surface is not constant. It depends on location, time of day, time of year, and weather conditions. Because the sun does not deliver that much energy to any one place at any one time, a large surface area is required to collect the energy at a useful rate. We use solar panels to track the power from sun rays. Maximum power can get when sun is at 90 to panel. But this is not always possible because of earth rotation. The term earth rotation refers to the spinning of our planet on its axis. Because of rotation the earth's surface moves at the equator at a seed of about 467m per second. The ecliptic plane can be defined as two-dimensional flat surface that geometrically intersects the earth's orbital path around the sun. On this plane, the earth's axis is not right angles to this surface, but inclined at an angle of about 23.5 from the perpendicular

1.2. Photovoltaic energy

Photovoltaic energy is the conservation of sunlight into electricity. A photovoltaic cell, commonly called a solar cell or PV cell, is the technology used to convert solar energy directly into electrical energy. Structure of photovoltaic frame electron leave their positions, holes are formed. When many electrons each carrying a negative charge, travel towards the surface of the cell, the resulting imbalance of charge between the cells front and back surface create a voltage potential like negative and positive terminals of a battery. When the two surfaces are connected through an external load, electricity flows. The photovoltaic cell is the basic building block of a photovoltaic system. Individual cell can vary in size from about (1cm - 0.5 inches) to about (10 cm - 4inches) across. However, one cell only produces 1 or 2 watts which isn't enough power for most applications. To increase power output, cells are electrically connected into a package weather-tight module. Modules can be further connected to from an array. The term array refers to the entire generating plant, whether it is made up of one or several thousand modules. The number of modules connected together in an array depends on the amount of power output needed.

The performance of a photovoltaic array is dependent upon sunlight. Climate condition (e.g. could, fog) have a significant effect on the amount of solar energy received by a photovoltaic array and, in turn its performance. Most current technology photovoltaic modules are about 10 percent efficient in converting sunlight. Further research is being conducted to raise this efficiency to 20 percent. The photovoltaic effect is the electrical potential developed between two dissimilar materials when their common junction is illuminated with radiation of photons. The photovoltaic cell, thus, converts light directly into electricity. The PV effect was discovered in 1839 by French physicist Becquerel. Remained in the laboratory until 1954, when Bell Laboratories produced the first silicon solar cell. It soon found application in the U.S. space programs for its high power capacity per unit weight. Since then it has been an important source of power for satellites. Having developed maturity in the space applications, the PV technology is now spreading into the terrestrial applications ranging from powering remote sites to feeding the utility lines.

Some advantages of photovoltaic system are:

1) Conversion of sunlight to electricity is direct, so bulky mechanical generator systems are unnecessary.

2) PV array environmental impact is minimal, requiring no water for system cooling and generating no by-products.

Photovoltaic cell, like batteries, generates direct current (DC) which is generally used for small loads (electronic equipment). When DC from photovoltaic cells is used for commercial applications or sold to electric using the electric grid, it must be converted to alternating current (AC) using inverters, solid state devices that convert DC power in to AC. Historically; PV has been used at remote sites to provide electricity. In the future PV arrays may be located at sites that are also connected to the electrical grid enhancing the efficiency of photovoltaic (PV) arrays, and are essential for concentration PV system. The project discusses a light tracking servo model which

[redacted]GLOBAL ENERGY RESOURCES

Current global energy consumption is 4.1*1020J annually, which is equivalent to an instantaneous yearly-averaged consumption rate of 13*1012 W (13 trillion watts, or 13 terawatts TW). Projected population and economic growth will more than double this global energy consumption rate by the mid -21^{st} century and more than triple rate by 2100, even with aggressive conservation efforts. Hence to contribute significantly to global primary energy supply, a prospective resource has to be capable of providing at least 1-10 TW of power for an extended period of time. The threat of climate change imposes a second requirement on prospective energy resource. They must produce energy without the emission of additional greenhouse gases. Stabilization of atmospheric CO_2 level at even twice their pre anthropogenic value will require amounts of carbon-neutral energy by mid-century. The needed levels are in excess of 10 TW, increasing after 2050 to support economic growth for an expanding population.

The three prominent options to meet this demand for carbon-neutral energy are fossil fuel use in conjunction with carbon sequestration, nuclear power, and solar power. The challenge for carbon sequestration is finding secure storage for the 25 billion metric tons of CO_2 produced annually on earth. At atmospheric pressure, this yearly global emission of CO_2 would occupy 12500 km3, equal to the volume of lake superior, it is 600 times the amount of CO_2 injected every year into oil wells to super productions,100 times amount of natural gas the industry draws in and out of geologic storage in the united states each year to smooth seasonal demand, and 20,000 times the amount of CO_2 stored annually in Norway's sleipner reservoir. Beyond finding storage volume carbon sequestration also must prevent leakage. A 1%leak rate would nullified the sequestration effort in a century, far too short a time to have lasting impact on climate change. Although many scientists are optimistic, the success of carbon sequestration on the required scale for sufficiently long time has not yet been demonstrated. Nuclear power is a second conceptually viable option. Producing 10TW of nuclear power would required construction of a new 1 G-watt-electric nuclear fission plant somewhere in the world every other day for the next 50 year. Once that level of deployment was reached, the terrestrial uranium resource base would be exhausted in 10 years. The required fuel would have to be mined from sea water or else breeder reactor technology would have to be developed and disseminated to countries wishing to meet their additional demand in this way. The third option is to exploit renewable energy sources, of which solar energy is by far the most prominent. The remaining global practically exploitable hydroelectric sources is less than 0.5 TW. the cumulative energy in all the tides and ocean current in the world amounts to less than 2TW. The total geothermal energy at the surface of earth, integrated over all the land area of the continents, is 12 TW, of which only a small fraction could be practically extracted. the amount of globally extractable wind power has been estimated by the IPCC and others to be 2-4TWe.for comparison the solar constant at the top of the atmosphere is 170,000 TW, of which on average, 120,000 TW strikes the earth. It is clear that solar energy can be exploited on the needed scale to meet global energy demand in a carbon-neutral fashion without significantly affecting the solar resource.

Solar energy storage and distribution are critical to match demand. The amount of produced by covering 0.16% of the earth's land area with 10% efficient solar cell is equal to that produced by 20000 1-GWe nuclear fission plants.

2.1 .Diffuse and Direct Solar Radiation

As sunlight passes through the atmosphere, some of it is absorbed, scattered, and reflected by the following:

- Air molecules
- Water vapour
- Clouds
- Dust
- Pollutants
- Forest fires
- Volcanoes.

This is called diffuse solar radiation. The solar radiation that reaches the Earth's surface without being diffused is called direct beam solar radiation. The sum of the diffuse and direct solar radiation is called global solar radiation. Atmospheric conditions can reduce direct beam radiation by 10% on clear, dry days and by 100% during thick, cloudy days.

[redacted] WORKING OF PV CELLS

When light hits a surface, it may be reflected, transmitted, or absorbed. Absorption of light is simply the conversion of the energy contained in the incident photon to some other form of energy. Typically, this energy is in the form of heat; however, some absorbing materials such as photovoltaic (PV) cells convert the incident photons into electrical energy. A PV panel has one or more PV modules, which consist of connected PV cells. Figure 1 shows the schematic structure and operation of a PV cell.

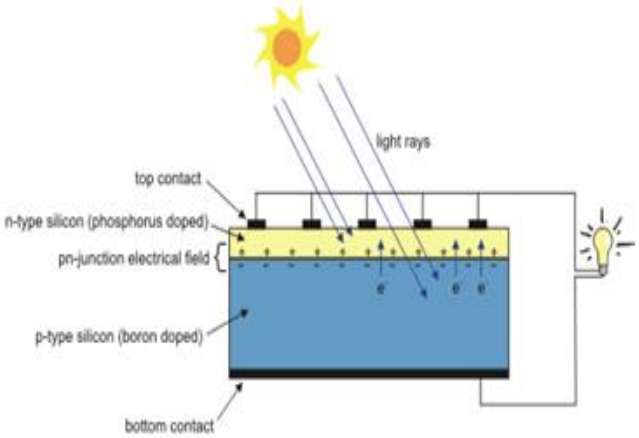

Fig.1. PV cell structure and operation schematic

Typically, a silicon PV cell contains two layers. The top layer consists of a thin sheet of phosphorus-doped (negatively charged or n-type) silicon. Underneath this sheet is a thicker layer of boron-doped (positively charged or p-type) silicon. A unique characteristic of these two layers is that a positive-negative (pn) junction is created when these two materials are in contact. A pn junction is actually an electric field that is capable of creating an electrical potential when sunlight shines on the PV cell. When sunlight hits the PV cell, some of the electrons in the p-type silicon layer will be stimulated to move across the pn junction to the n-type silicon layer, causing the p-type layer to have a higher voltage potential than the n-type layer. This creates an electric current flow when the PV cell is connected to a load. The voltage potential created by a typical silicon PV cell is about 0.5 to 0.6 volts dc under open-circuit, no-load conditions. The power of a PV cell depends on the intensity of the solar radiation, the surface area of the PV cell, and its overall efficiency (FSEC 2005). The efficiency of each individual PV cell directly determines the efficiency of the PV panel. PV cells can be categorized into different types according to their component materials and structural features. Efficiency of commercially available PV panels is typically 7-17% (Green et al. 2005).

3.1 Types of solar photovoltaic cells

PV cells can be divided in to three categories
1. Inorganic cells, based on solid-state inorganic semiconductors;
2. Organic cells , based on organic semiconductors;&
3. PEC cells, based on interfaces between semiconductors & molecules

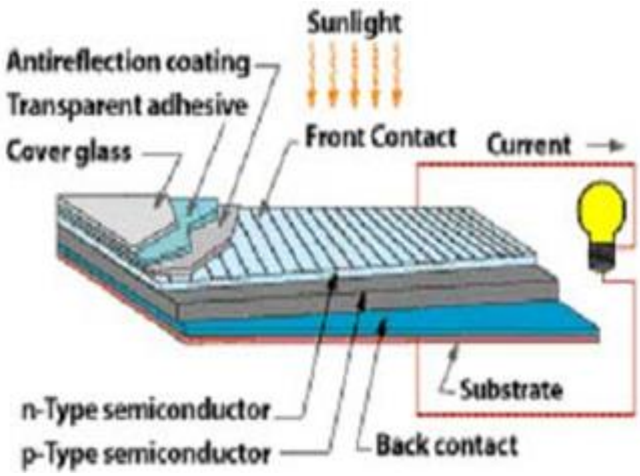

Fig. 2. Structure of solar cell

The figure 2-3 shows the structure of an inorganic solar cells based on the sandwich structure of two types of semiconductor material, one type has mobile free negative electrons (called an n type semiconductor) & the second type mobile free positive holes (called a p type semiconductor). The sandwich, called a p-n junction, allows the photo-generated electrons & holes to be separated. & transferred to external wires for electrical power production. PV cells have no moving parts & are silent.

3.2 Basic PV cell construction

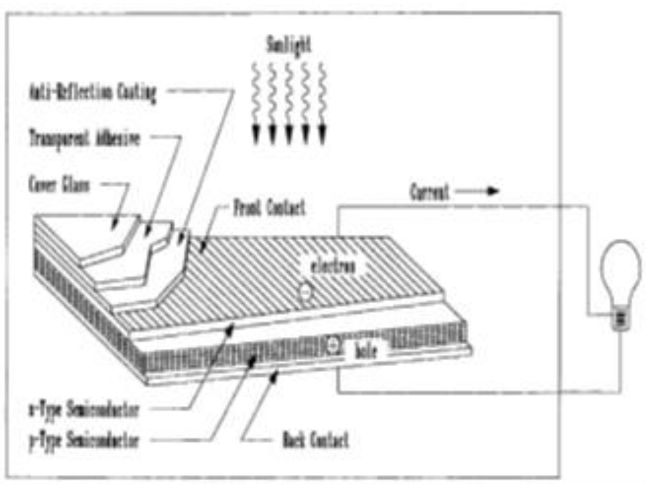

Fig. 3. Basic PV cell construction

OPEN CIRCUIT VOLTAGE AND SHORT CIRCUIT CURRENT

The two most important parameters widely used for describing the cell electrical performance is the open-circuit voltage Voc and the short-circuit current Isc. The short-circuit current is measured by shorting the output terminals, and measuring the terminal current under full illumination. Ignoring the small diode and the ground-leakage currents under zero-terminal voltage, the short-circuit current under this condition is the photocurrent IL. The maximum photo voltage is produced under the open-circuit voltage. Again, by ignoring the ground-leakage current, the open-circuit voltage as the following:

$$V_{oc} = \frac{AKT}{Q} Log_n\left(\frac{I_L}{I_D} + 1\right)$$

The constant KT/Q is the absolute temperature expressed in voltage (300°K = 0.026 volt). In practical photocells, the photocurrent is several orders of magnitude greater than the reverse saturation current. Therefore, the open-circuit voltage is many times the KT/Q value. Under condition of constant illumination, IL/ID is a sufficiently strong function of the cell temperature, and the solar cell ordinarily shows a negative temperature coefficient of the open-circuit voltage.

4.1 I-V Curve

The electrical characteristic of the PV cell is generally represented by the current versus voltage (I,V) curve. Figureshows the I-V characteristic of a PV module under two conditions, in sunlight and in dark. In the first quadrant, the top left of the I-V curve at zero voltage is called the short circuit current. This is the current we would measure with the output terminals shorted (zero voltage). The bottom right of the curve at zero current is called the open-circuit voltage. This is the voltage we would measure with the output terminals open (zero current). In the left shaded region, the cell works like a constant current source, generating voltage to match with the load resistance. In the shaded region on the right, the current drops rapidly with a small rise in voltage. In this region, the cell works like a constant voltage source with an internal resistance. Somewhere in the middle of the two shaded regions, the curve has a knee point.

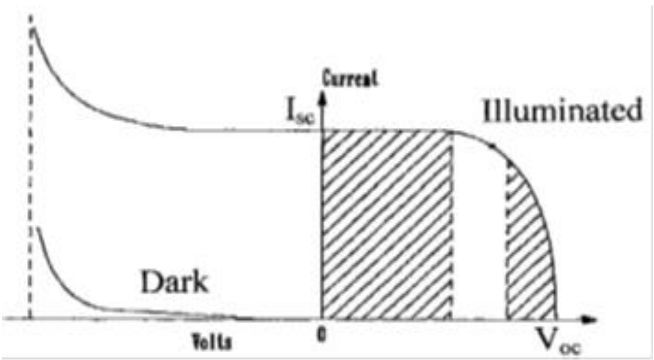

Fig. 4. Graph -Current versus voltage (i-v) characteristics of the pv module in sunlight and in dark.

If the voltage is externally applied in the reverse direction, say during a system fault transient, the current remains flat and the power is absorbed by the cell. However, beyond a certain negative voltage, the junction breaks down as in a diode and the current rises to a high value. In the dark, the current is zero for voltage up to the breakdown voltage which is the same as in the illuminated condition.

4.2 P-V Curve

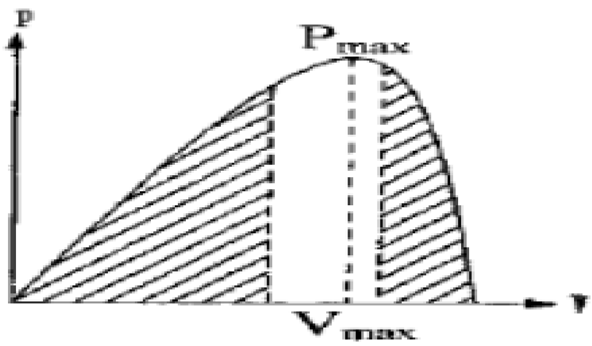

Fig.5. Graph -Power versus voltage (p-v) characteristics of the PV module in sunlight.

The power output of the panel is the product of the voltage and the current outputs. In Figure, the power is plotted against the voltage. Notice that the cell produces no power at zero voltage or zero current, and produces the maximum power at voltage corresponding to the knee point of the i-v curve. This is why PV power circuits are designed such that the modules operate closed to the knee point, slightly on the left hand side. The PV modules are modelled approximately as a constant current source in the electrical analysis of the system. The photo conversion efficiency of the PV cell is defined as the following:

$$\eta = \frac{\textit{electrical power output}}{\textit{solar power impinging the cell}}$$

Obviously, the higher the efficiency, the higher the output power we get under a given illumination.

SOLAR TRACKERS

A solar tracker is a generic term used to describe devices that orient various payloads toward the sun. Payloads can be photovoltaic panels, reflectors, lenses or other optical devices. In standard photovoltaic (PV) applications trackers are used to minimize the angle of incidence between the incoming light and a photovoltaic panel. This increases the amount of energy produced from a fixed amount of installed power generating capacity. In standard photovoltaic applications, it is estimated that trackers are used in at least 85% of commercial installations greater than 1MW from 2009 to 2014.

In concentrated photovoltaic (CPV) and concentrated solar thermal (CSP) applications trackers are used to enable the optical components in the CPV and CSP systems. The optics in concentrated solar applications accept the direct component of sunlight light and therefore must be oriented appropriately to collect energy. Tracking systems are found in all concentrator applications because such systems do not produce energy unless oriented closely toward the sun.

5.1. Sun Tracking System

From the various Electric Energy sources the solar now becoming more and more important for the human life. We can generate the solar energy from the sunlight by using solar panels which is becoming the individual energy generator with less resources and more useful. Currently the solar panels are fixed on the roof of the building, which collects the sunlight and generates the electric energy. But from sunrise to sunset the position of the sun is not fixed and therefore the generated solar energy varies with sunlight collected by the panel. Sun Tracking System is mainly designed to find out the actual position on sun at daytime. The system detects the ultimate position at which the maximum solar energy will be generated by the panel. As the system is a closed loop system, it keeps the track of the percentage of energy generation at various positions. The solar panel alignment to the maximum power generation is controlled by the means of stepper motor.

Photovoltaic trackers can be grouped into classes by the number and orientation of the tracker's axes. Compared to a fixed amount, a single axis tracker increases annual output by approximately 30% and a dual axis tracker an additional 6%. The selection of tracker type is dependent on many factors including installation size, electric rates, government incentives, land constraints, latitude, and local with 3.

[redacted]SYSTEM DEVELOPMENT

6.1. Block Diagram

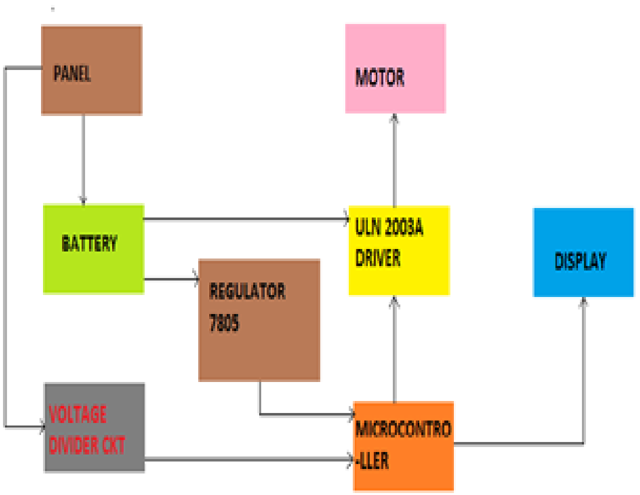

Fig.6. Fir-Tracking system of typical solar system

This is a solar tracking system which can be used as a power generating method from sunlight. This method of power generation is simple and is taken from natural resource. This needs only maximum sunlight to generate power. This project helps for power generation by setting the equipment to get maximum sunlight automatically. This system is tracking for maximum intensity of light. When there is decrease in intensity of light, this system automatically changes its direction to get maximum intensity of light.

Here we are using the micro-controller for tracking and generating power from sunlight. It will process the input voltage from the Battery and control the direction in which the motor has to be rotated so that it will receive maximum intensity of light from the sun.

6.2. Solar panel:

Solar cells convert light energy into electrical energy either indirectly (by first converting it into heat) or through a direct process known as the **photovoltaic effect**.

Fig7. Solar panel specifications: 20 Watt, 1.25A, 16V, Length 63.5 CM, Width 35.56 CM, Weight -3.2kg, Cell material –silicon crystal

The most common types of solar cells are based on the photovoltaic effect. This happens when light falls on a two-layer semiconductor material and results in a potential difference, or voltage, between the two layers. The voltage produced in the cell is capable of driving a current through an external electrical circuit that can be utilised to power electrical devices. Solar cells are usually made from silicon, which is treated to release electrons-thereby generating an electric current-when light strikes it.

6.3. **Liquid Crystal Displays (LCD)**

Fig.8. LCD Display Panel 2 Line 16 Character

An LCD is a small low cost display. It is easy to interface with a micro-controller because of an embedded controller. This controller is standard across many displays which means many micro-controller have libraries that make displaying messages as easy as a single line of code. LCD Display Panel 2 Line 16 Character Wide Viewing Angle

Specifications:

Number of Characters: 16 characters x 2 lines
Module Dimension: 85(W) x 30(H) x 13.2(T)mm
Viewing Display Area: 65(W) x 16(H)mm
Character Size: 2.78(W) x 4.89(H)mm
Other Mechanical Data: Yellow Green, 1/16 Duty, 12 o'clock

Supply Voltage for Logic: VDD-VSS Min 4.5V, Typ: 5.0V, Max: 5.5V.

6.4. Stepper motor

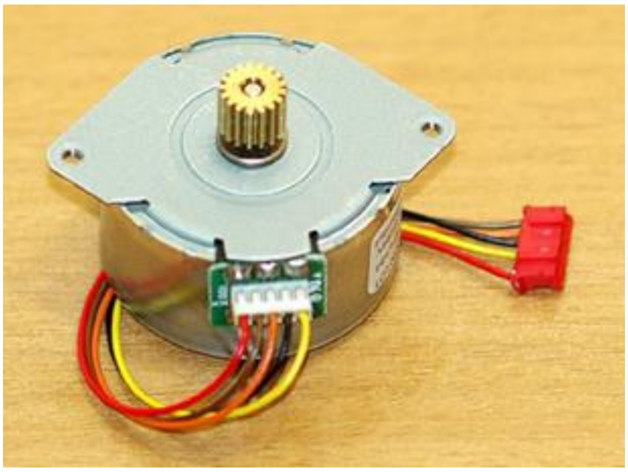

Fig.9. Stepper motorspecifications: Input: 12 V, 0.5 A, Torque: 2 kg, Half step: 0.9deg, Full step: 1.8deg

A bi-polar stepper motor is being used for rotation in both directions. The stepper motor covers an full step angle1.8 degree per step and half step angle 0.9 degree. The output of the microcontroller is given to this motor through motor driver circuit and hence the motor is rotated accordingly, pointing in the direction of maximum intensity of sunlight.

6.5. *Working of stepper motor*

The stepping motor is an electromagnetic device which converts digital pulses into discrete mechanical rotational movements. In rotary step motor, the output shaft of motor rotates in equal increments, in response to a train of input pulses. We are used gear system for the purpose of movement of the solar panel from East to west and vice versa. The gear G1 is fitted on the shaft of the stepper motor. No of teeth's of G1 are 10. The gear G2 is fitted on the shaft of the solar panel. No of teeth's of G2 are 100.

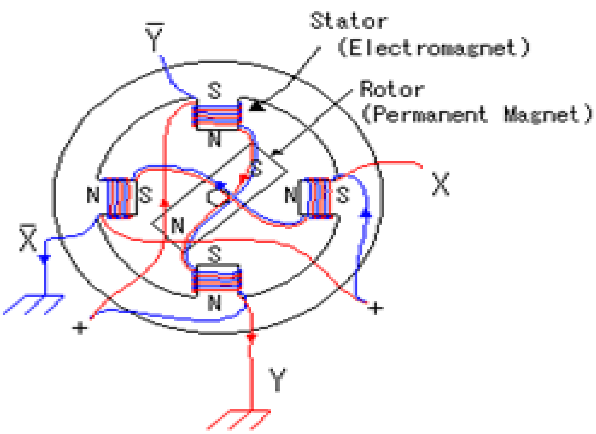

Fig.10. Working of stepper motor

***6.6. Microcontroller*:**

This is the heart of the circuit which performs all commanding and controlling operations. Microcontroller now days are becoming more popular because of several advantages over microprocessor. As it reduces the requirement of additional interfacing IC those are needed in microprocessor, the data which has to be read and controlled is directly fed to microcontroller and the software is designed in accordance with the requirement for controlling the circuit and action is taken by proper output device.

• High-performance, Low-power ,8-bit Microcontroller
• Advanced Architecture

– 130 Powerful Instructions – Most Single-clock Cycle Execution
– 32 x 8 General Purpose Working Registers
– Fully Static Operation
– On-chip 2-cycle Multiplier
• Non-volatile Program and Data Memories
– 8K Bytes of In-System Self-Programmable Flash
In-System Programming by On-chip Boot Program
True Read-While-Write Operation
– 512 Bytes EPROM
– 1K Byte Internal SRAM
– Programming Lock for Software Security

• Peripheral Features
– Two 8-bit Timer/Counters with Separate Prescaler, one Compare Mode
– One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
– Real Time Counter with Separate Oscillator
– Three PWM Channels
– 8 channel ADC , Eight Channels 10-bit Accuracy
– 6 channel ADC in PDIP package
– Byte-oriented Two-wire Serial Interface
– Programmable Serial USART
– Master/Slave SPI Serial Interface
– Programmable Watchdog Timer with Separate On-chip Oscillator
– On-chip analog Comparator
• Special Microcontroller Features
– Power-on Reset and Programmable Brown-out Detection
– Internal Calibrated RC Oscillator
– External and Internal Interrupt Sources
– Five Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, And Standby
• I/O and Packages
– 23 Programmable I/O Lines
– 28-lead PDIP, 32-lead TQFP, and 32-pad QFN/MLF
• Operating Voltages
– 2.7 - 5.5V (ATmega8L)
– 4.5 - 5.5V (ATmega8)
• Speed Grades
– 0 - 8 MHz (ATmega8L)
– 0 - 16 MHz (ATmega8)
• Power Consumption at 4 MHZ, 3V, 25°C
– Active: 3.6 mA
– Idle Mode: 1.0 mA
– Power-down Mode: 0.5 µA

6.7. Pin Configuration

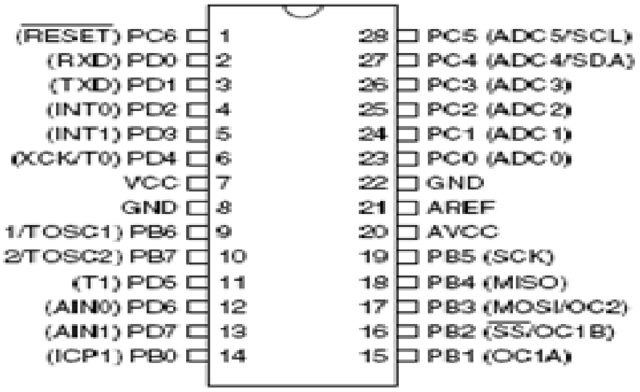

Fig11. Pin Configurations of Atmega8, VCC Digital supply voltage, GND Ground, Port B (PB7.PB0)

PERFORMANCE ANALYSIS

7.1. System Operation

The main theme of our project is hybrid power generation and it is nothing but the combination of wind mill and solar tracker, using this concept we can obtain maximum power. We give high priority to renewable energy sources and then authorized power system. So authorized power supply used as option.

Fig.12. Solar tracking system

7.2. Results at various stages compared with various inputs

Panel position	Time	Voltage output (Volts)
Towards East	7.00am	Enough good
Towards East	8.00am	Enough good
Towards East	9.00am	Enough good
Towards East	10.00am	Enough good
Towards East	11.00am	Enough good
Towards East	12.00pm	Enough good
In east-west plane	13.00pm	Enough good
In east-west plane	14.00pm	Enough good
Towards west	15.00pm	Enough good
Towards west	16.00pm	Enough good
Towards west	17.00pm	Enough good
Towards west	18.00pm	Enough good
Towards west	19.00pm	Enough good

The model was analysed from 7.00am to19.00pm for one day. The result obtained is tabulated in the above table.

7.3. (Comparison with fixed panel system)

Panel position	Time [Hrs]	Voltage output [Volts]
In east-west plane	7.00am	Enough good
In east-west plane	8.00am	Enough good
In east-west plane	9.00am	Enough good
In east-west plane	10.00am	Enough good
In east-west plane	11.00am	Enough good
In east-west plane	12.00pm	Enough good
In east-west plane	13.00pm	Enough good
In east-west plane	14.00pm	Enough good
In east-west plane	15.00pm	Enough good
In east-west plane	16.00pm	Enough good
In east-west plane	17.00pm	Enough good
In east-west plane	18.00pm	Enough good
In east-west plane	19.00pm	Enough good

7.4. Comparison of above results by at least two methods (justification for the differences or error)

Time [Hrs]	Solar tracking system	Fixed position system
7.00am	11.2 volts	4.0volts
8.00am	12.6 volts	6.5 volts
9.00am	13.5 volts	9.5 volts
10.00am	14.0 volts	12.2 volts
11.00am	15.1 volts	14.7 volts
12.00pm	16.7 volts	16.7 volts
13.00pm	16.8 volts	16.7 volts
14.00pm	16.8 volts	16.3 volts
15.00pm	16.2 volts	14.2 volts
16.00pm	15.9 volts	12.2 volts
17.00pm	13.8 volts	10.5 volts
18.00pm	10.8 volts	7.9 volts
19.00pm	8.1volts	3.6 volts

It is clear that output of solar tracking system is more than fixed panel system. So solar tracking system is better as compared to normal system.

CALCULATION FOR EFFICIENCY

Wind power = $0.5*\rho*A*V^3*Cp$

Here,

ρ = air density in kg/m^3

A = area sweft by rotor in m^2

V = velocity of wind in m/s

Cp = air coefficient

Wind power = $0.5*1.125*3.14*1.5^2*5^3*.59$ = 293.08Actual output = 7.6*12 = 91.2

So, % efficiency = (91.2/293 08)*100 = 31.11

8.1. Tariff calculation:

Per hour wind mill output = 110W Average hours per day = 10 hours So total output per day =10*110 = 1100W Per hour solar tracking output = 20W Average hour per day = 10hours So total output per day = 200W.

Total power obtained per day = 1100+200 = 1300W = 1.3unit So if 1 unit = 3.50Rs Total cost per day =1.3*3.50 = 4.55Rs So total cost per month =30*4.55 = 136.5Rs Per year cost=136.5*12 = 1638Rs

[redacted]CONCLUSIONS

To investigate the PV output power for tracking mode and fixed mode an experimental study is done under local climate. Designed simplicity, Low cost and material availability will make the designed tracking system more effective and acceptable in the market. This tracking system is more compact and easier than any other tracking system with minimum cost. This device does not need auxiliary power and may adjust automatically depending on the direction of the sun. With the designed Sun tracker, it is possible to get substantially more power from each PV panel and this increase in power results in lower cost per watt.

From the result of the performance test of designed system the following conclusion can be drawn.

• The designed solar tracker automatically controlled and follows the sun path preciously;

• The efficiency of the tracking solar panel with respect to fixed panel was 23% at average intensity 1100 W/m2;

• The use of software outside the mechanical part makes the tracker flexible for future development. The experiments done were implemented during three month. It is necessary to test during other months and The future development of the tracker should include a new case containing the method and all moving parts with electronics circuit, allowing continuous operation under local conditions. Although ASTS is a prototype towards a real system, but still its software and hardware can be used to drive a real and very huge solar panel. A small portable battery can drive its control circuitry. Therefore by just replacing the sensing instrument, its algorithm and control system can be used in RADAR and moveable Dish Antennas. The original purpose of this paper is the power generation by setting the equipment to get maximum sunlight automatically. Although due to resources constraints we just accomplished the tracking part of the system.

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