# Experimental and Fabrication of Solar Panel Tracking Using the Real Time Clock

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*Abstract*— The growth or energy demand in response to industrialization, urbanization and social affluence has led to an extremely uneven global distribution of primary energy consumption. The Sun, Wind, Waves and geothermal heat are renewable energy sources that will never run out. They are self- renewal. The rate of consumption does not exceed rate of renewability. The cost of generating electricity from wind and solar power has decreased by 90% over the past 20 years. Maximizing power output from a solar system is desirable to increase the efficiency of a solar tracing system. To maximize the power output from solar panels, we need to keep the panels aligned with the sun. In this project, the design of an efficient solar tracking system based on Real Time Clock (RTC) using microcontroller. The proposed tracking system is a low cost, high accurate, more efficient with low power consumption. The IC RTC is able to regulate the movement of solar panel about 15 degree per hour. The updating position of solar panel is constantly changed, but the approach is enough for capturing sunlight energy for generation of power by the solar panel.

***Key words:*** Real Time Clock, Microcontroller, Solar Powered, Automatic Tracking

## I. INTRODUCTION

The regeneration energy also called the green energy, has gained much importance nowadays. Green energy can be recycled, much like solar energy, water power, wind power, biomass energy, terrestrial heat, temperature difference of sea, sea waves, morning and evening tides, etc. Among the non-conventional, renewable energy sources, solar energy affords great potential for conversion into electric power, able to ensure an important part of the electrical energy needs of the planet. The conversion principle of solar light into Electricity is called Photo-Voltaic (PV) conversion. It is not very new, but the efficiency improvement of the PV conversion equipment is still one of top priorities for many academic and industrial research groups all over the world. Among the proposed solutions for improving the efficiency of PV conversion, we can mention solar tracking, the optimization of solar cell configuration and geometry, new materials and technologies, etc. The topic proposed in this project refers to the design of a single axis solar tracker system that automatically adjusts the optimum PV panel position with respect to the sun by means of a DC motor controlled by an intelligent controller unit that equipped with a positioning algorithm to mathematically solve the optimum tracker position for any time of the day using RTC. A practical measurement of the sun position with respect to the natural time relational table is implemented as an algorithm to track the sun position to achieve maximum energy. Finally, a comparison between the tracking system and the fixed system is made. From the experimental results, the proposed tracking system is verified more efficiently in generating energy than the fixed system.

### A. *Project Objective*

The main objective of done this project is to develop an automatic system for solar panel deviation and produce more amount of power for consumption and specific objectives of this project are listed as followed:

1) Will automatically changes the direction of the solar panel based on the time based on which the calculation is made to rotate the solar panel using the dc motor. This project is done by developing the circuit of Light Real time clock which is could detect the time and circuit of microcontroller to run the setup. Programming the controller to control the motor to rotate the solar panel using the dc motor based on the time.
2) The time in hours is calculated for which the sun would be in particular position and the solar panel to be placed in that angle for particular amount of time. Basically the angle solar panel to be deviated is 15* for every one hour of time.
3) This project will produce more power output than the standard solar panel and it is automatic process where the solar panel deviation is controlled by the microcontroller. The project will display the program codded to the microcontroller and the position of sun based on time.

## II. LITERATURE REVIEW

This literature review explains about relevant past research and project development which is used the almost similar system for this project.

### A. *Automatic Solar Panel Deviation*

Several MPPT techniques together with their implementation are reported in the literature. Researchers always feel confused while selecting an MPPT technique for a particular application. Unfortunately, only a few techniques were available in this field including Curve fitting, Fractional Short Circuit Current, Fractional Open Circuit Voltage, Look Up Table, One Cycle Control, Perturb and Observe, Incremental Conductance and Feedback techniques earlier that includes discussions on MPPT techniques until 2007. But many new MPPT techniques such as Fuzzy logic, Artificial Neural Network, Adaptive Perturbation and Observation, Estimated perturb and perturb, Genetic Algorithm, Adaptive Neuro fuzzy and particle swarm optimization based MPPT, etc., have been reported since then illustrated in other papers.

It is necessary to prepare a review that includes all the efficient and effective MPPT techniques proposed before 2007 and after that until 2013. A review, comparison of the MPPT techniques on the basis of their

advantages, disadvantages, control variables involved, types of circuitry, complexity of algorithm, complexity level on hardware implementation, and types of scientific and commercial application is described. Among all the MPPT methods, Perturb & Observe (P&O) and Incremental Conductance (IC) are most commonly used because of their simple implementation and lesser time to track the maximum power point and also other economic reasons Under suddenly changing weather conditions (irradiation level) as MPP changes continuously, P&O takes it as a change in MPP due to perturbation rather than that of irradiation and sometimes ends up in calculating wrong MPP. However this problem is eliminated in Incremental Conductance method as the algorithm takes two samples of voltage and current to compute MPP [19]. However, instead of more efficiency the complexity of the algorithm is very high compared to the former one and hence the cost of execution increases.

*B. Solar Tracker by Sensor*

Solar tracking system project had been widely employed by the other giant company like BP Solar, Yingli Green Energy, Kyocera, Q-Cells, Sanyo, Sharp Solar, Solar World, Sun Power, and Sun-tech. Now, many people use solar energy or photovoltaic energy as an alternative power because it's free and renewable. As we can see now, the payment charge for an electricity had been risen rapidly because the increasing of gas price. Many researchers have tried to find the alternative energy to replace the gas. One of the alternative energy that we can use is photovoltaic energy. Photovoltaic energy is the most promising and popular form of solar energy. In solar photovoltaic, sunlight is actually converted into electricity. This is very different from a conventional understanding of solar power as only a way of heating water. Photovoltaic, now the biggest usage of solar energy around the world, is briefly explained below:

Sunlight is made of photons, small particles of energy. These photons are absorbed by and pass through the material of a solar cell or solar photovoltaic panel. The photons agitate the electrons found in the material of the photovoltaic cell. As they begin to move or are dislodged, these are routed into a current. This, technically, is electricity - the movement of electrons along a path. Solar panels made of silicon to convert sunlight into electricity. Solar photovoltaic are used in a number of ways, primarily to power homes that are inter-tied or interconnected with the grid.

Wire conducts these electrons, either to batteries or to the regular electrical system of the house, to be used by appliances and other household electrical items. In many solar energy systems, the battery stores energy for later use. This is especially true when the sun is shining strongly.

*C. Closed Loop Sun Tracker*

Closed-loop types of sun tracking systems are based on feedback control principles. In these systems, a number of inputs are transferred to a controller from sensors which detect relevant parameters induced by the sun, manipulated in the controller and then yield outputs (i.e. sensor-based). In 1986, Ahmed yaroveta first increased the output power of a solar photoelectric station in Kazakhstan from 357 W to 500 W by integrating the station with an automatic sun tracking system. Several years later, Maish developed a control system called Solar Track to provide sun tracking, night and emergency storage, communication, and manual drive control functions for one- and two axis solar trackers in a low-cost, user-friendly package. The control algorithm used a six-degree self-alignment routine and a self-adjusting motor actuation time in order to improve both the pointing accuracy and the system reliability. The experimental results showed that the control system enabled a full-day pointing accuracy of better than +0.1o to be achieved. In 1992, Agarwal presented a two axis tracking system consisting of worm gear drives and four bar-type kinematic linkages to facilitate the accurate focusing of the reflectors in a solar concentrator system. In the same year, Enslin applied the principles of maximum power point tracking (MPPT) to realize a power electronic converter for transforming the output voltage of a solar panel to the required DC battery bus voltage.

The first LDR detected the focus state of the collector, while the second and third LDRs were designed to establish the presence (or absence) of cloud cover and to discriminate between day and night, respectively. The output signals from the three LDRs were fed to an electronic control system which actuated a low-speed 12 - V DC motor in such a way as to rotate the collector such that it remained pointed toward the sun .In 1997, Stone and Sutherland presented a multiple tracking measurement system comprising more than 100 heliostats for tracking the sun's position on an hourly basis from early morning to late evening. Hua and Shen compared the solar tracking efficiencies of various MPPT algorithms and implemented a simple control method which combined a discrete time control scheme and a proportional-integral (PI) controller to track the maximum power points (MPPs) of a solar array.

The goal of an MPPT system is to provide a fixed input voltage and/or current, such that the solar panel is held at the maximum power point, while allowing the output to match the battery voltage. In the converter was controlled to track the maximum power point of the input source under varying input and output parameters and was shown to provide a minimum input source saving of 15% for 3-5 kWh/day systems.

*D. Open Type Sun Tracker*

An open-loop type of controller computes its input into a system using only the current state and the algorithm of the system and without using feedback to determine if its input has achieved the desired goal i.e. algorithm-based. The system is simpler and cheaper than the closed-loop type of sun tracking systems. It does not observe the output of the processes that it is controlling. Consequently, an open-loop system cannot correct any errors so that it could make and may not compensate for disturbances in the system.

Open-loop control algorithms of sun tracking systems utilize some form of solar irradiation geometry model. In 1983, Al-Naima and Yaghobian developed a solar tracking system featuring a two-axis equatorial

mount and a microprocessor, in which the tracking operation was performed on the basis of the astronomical coordinates of the sun. The experimental results demonstrated that the proposed system yielded a significantly better tracking performance than that obtained by a conventional sensor controlled system. Several years later, Lorenz proposed a set of design guidelines for a window glazing which rejected solar radiation during the summer, but accepted it during the winter. The design featured a purely passive control algorithm based on seasonal changes in the incident angle of the solar rays.

Advances in the algorithms of sun tracking systems have enabled the development of many solar thermal and photovoltaic systems for a diverse variety of applications in recent years. Compared to their traditional fixed-position counterparts, solar systems which track the changes in the sun's trajectory over the course of the day collect a far greater amount of solar energy, and therefore generate a significantly higher output power. This paper has presented a review of the major algorithms for sun tracking systems developed over the past 20 years.

Having reviewed existing solar vector prediction algorithms, the authors developed a new algorithm for predicting the solar vector given a knowledge of the time given as the date and the Universal Time and the location given as the longitude and latitude of the observer in degrees. The performance of the proposed was verified by evaluating the direction of the sun vector for 447,048 reference values of the true horizontal coordinates of the sun over the period 1999 to 2015. It was shown that the algorithm enabled the direction of the solar vector to be determined with an error of less than 0.5 minutes of arc. It compares the sun vectors generated by the proposed algorithm with those computed using the algorithm proposed by Michalsky in 1988.

### *E. Calculation of the Angle*

The particular interest regarding to the determination of angle movement of solar tracker is the daily pattern of sun movement. The sun rises in the east, then reaches solar noon before set somewhere in the west. The solar noon is the highest elevation of sun in the sky, which depends on the local latitude of location (L) and solar declination. The solar noon angle or altitude angle maximum can be calculated as follows:

Where the solar declination angle is the line latitude where the sunlight arrives on certain location in particular day of the year. Therefore, the solar declination is depending on the day number (n), for example n= 1 is for January 1, and n = 365 is for December 31. The equation can be expressed as in figure.

Equation implies that the solar declination varies sinusoidal between ±23.5o on the day number 81. In the calendar, the day number of 81 is the spring equinox, March 21 where the sun is exactly over the equator. In the Northern hemisphere, the highest point of solar noon on the summer solstice; while the highest point of solar noon on the winter solstice.

In this study, we are designing solar tracker for PV application in equator region. The local latitude of our city, Makassar, South Sulawesi of Indonesia is located the maximum solar noon can be shown. It can be seen that the solar noon deviates not too far away from the equator. It means that the quality of sunlight intensity can be guaranteed good annually. Therefore, we do not have such kind of summer or winter solstice in equatorial region. The only need for operating the solar tracker in this region is to manually adjust the module either facing North or South, which can be done every six months.

In addition, it is important to determine how much the angle of designed solar tracker is required to drive the PV module for perpendicular to the direction of sunlight. If we assume the solar noon at 12 p.m. and the initial angle at 8 a.m. is 30*, then every hour the angle of solar tracker should be updated every 15*. After the module reaches the position at 4 p.m., control mechanism is applied to reset the solar tracker to the position similar to 8 a.m. It means that the angle of PV module turns back to 30* and waits for the next day operation.

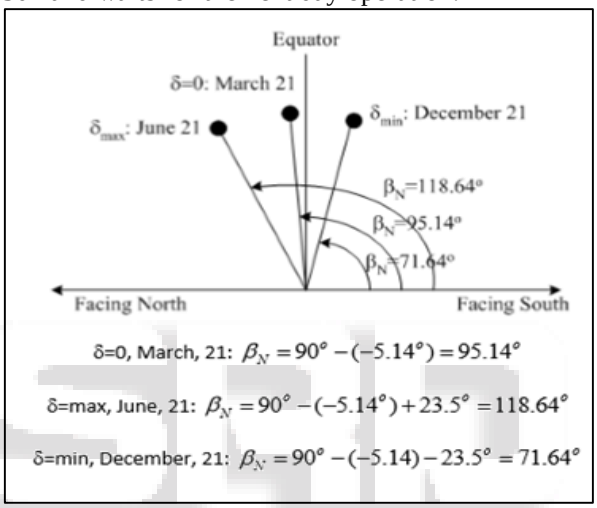



Fig. 1: Angle of Sun

Solar tracker is successfully performed to rotate the PV module based on the targeted design. Now, we need to know how much the increasing in power of PV module achieved using this solar tracker in compared to the system without solar tracker. The PV system with solar tracker will be rotated automatically every 15 degree per hour from 8 a.m. to 4 p.m. based on the initial assumption of apparent movement of sunlight in equator region. As a result, the PV module will be perpendicular continuously to the direction of sunlight with simple actuator device. If the angle is arbitrarily changed, for instance 10 degree every hour, then the hardware needs to be modified. If the time interval movement is changed, then the microcontroller program is updated and so the hardware. In comparison to steady PV module (without solar tracker), the angle of module is constant of 45, 90 and 135 degrees to represent the sunlight position, such as just after sunrise, noon and before sunset respectively.

## III. FACTORS DETERMINING THE CHOICE OF MATERIALS

The various factors which determine the choice of material are discussed below.

### *A. Properties*

The material selected must possess the necessary properties for the proposed application. The various requirements to be satisfied can be weight, surface finish, rigidity, ability to

withstand environmental attack from chemicals, service life, reliability etc.

The following four types of principle properties of materials decisively affect their selection

1) Physical
2) Mechanical
3) From manufacturing point of view
4) Chemical

The various physical properties concerned are melting point, thermal Conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic purposes etc.

The various Mechanical Properties Concerned are strength in tensile, Compressive shear, bending, torsional and buckling load, fatigue resistance, impact resistance, elastic limit, endurance limit, and modulus of elasticity, hardness, wear resistance and sliding properties.

The various properties concerned from the manufacturing point of view are,

1) Cast ability
2) Weld ability
3) Surface properties
4) Shrinkage
5) Deep drawing etc.

### *B. Manufacturing Case*

Sometimes the demand for lowest possible manufacturing cost or surface qualities obtainable by the application of suitable coating substances may demand the use of special materials.

### *C. Quality Required*

This generally affects the manufacturing process and ultimately the material. For example, it would never be desirable to go casting of a less number of components which can be fabricated much more economically by welding or hand forging the steel.

### *D. Availability of Material*

Some materials may be scarce or in short supply, it then becomes obligatory for the designer to use some other material which though may not be a perfect substitute for the material designed. The delivery of materials and the delivery date of product should also be kept in mind.

### *E. Space Consideration*

Sometimes high strength materials have to be selected because the forces involved are high and space limitations are there.

### *F. Cost*

As in any other problem, in selection of material the cost of material plays an important part and should not be ignored.

Sometimes factors like scrap utilization, appearance, and non-maintenance of the designed part are involved in the selection of proper materials.

## IV. COMPONENTS

### *A. Microcontroller*

LPC2148 development board with built in ADC and RS232 features. A 6V, 300mA solar panel is fixed to the rotor of the DC motor. Communication between controller and Personal Computer (PC) is established through serial communication using RS232 to record the output voltage. The recorded output voltage from the panel is stored in the data base for analyses. The DC motor control input signals are connected to the controller and the output of the panel was connected to a load that would dissipate 9W that would match the panel's rating 9W at 12V corresponds to a current of 0.75A, so by Ohm's law; a load resistance was calculated as being 16Ω. A 15Ω, 50W resistor was the closest value found and was connected to the panel. The tracking device still requires power, but a 12V battery that is connected in a charging arrangement with the solar panel supplies it. The voltage across and current through the load was monitored using ADC channels of the controller, and was recorded every half hour on a clear day into a data base. The readings were taken on a span of days that possessed similar conditions including no cloud cover.

### *B. Electric Motor*

An electric motor is an electrical machine that converts electrical energy into mechanical energy. The reverse of this is the conversion of mechanical energy into electrical energy and is done by an electric generator.

In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy.

### *C. Solar Panel*

A solar panel is a device that collects and converts solar energy into electricity or heat. It known as Photovoltaic panels, used to generate electricity directly from sunlight Solar thermal energy collection systems, used to generate electricity through a system of mirrors and fluid-filled tubes solar thermal collector, used to generate heat solar hot water panel, used to heat water. It is energy portal. A solar power technology uses solar cells or solar photovoltaic arrays to convert light from the sun directly into electricity.

Photovoltaic, is in which light is converted into electrical power. It is best known as a method for generating solar power by using solar cells packaged in photovoltaic modules, often electrically connected in multiples as solar photovoltaic arrays to convert energy from the sun into electricity. The photovoltaic solar panel is photons from sunlight knock electrons into a higher state of energy, creating electricity.

Solar cells produce direct current electricity from light, which can be used to power equipment or to recharge a battery. A less common form of the technologies is thermos photovoltaic, in which the thermal radiation from some hot body other than the sun is utilized. Photovoltaic devices are also used to produce electricity in optical wireless power transmission.

### *D. Real Time Clock*

Real Time Clock is basically correlated with time output from seconds to hours and from date to year. Another function is the IC RTC can be used to store permanent data in the internal RAM RTC, because the data cannot be loosed

although the power supply is disconnected. It is due to the battery embedded in the IC system to power the clock all the time. Beside this, the IC RTC also can be used as the timer and alarm. For time output calculation, this device is valid up to 2100 year with mode selection either 12 or 24 hour clock with a.m. and p.m. in 12 hour mode. Electronically, the IC RTC DS1307 utilizes I2C technique with capability of 2 paths of transferring serial data in compared with 3 paths in SPI and Micro Wire techniques.

All techniques have basically one path for clock. The remaining 1 path in I2C has the capability of bidirectional data transfer, while the 2 paths of SPI and Micro Wire have only capable in single directional of input-output data transfer. The protocol communication of I2C in RTC DS1307 is similar to the access EEPROM serial type of 24C04. The mechanism is sending start-bit, address of RTC (0xC0) with bit R/W low then the register number is willing to be accessed.

### *E. Relay*

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called protective relays.

### *F. Limit Switches*

Limit switches are used in a variety of applications and environments because of their ruggedness, ease of installation, and reliability of operation. They can determine the presence or absence, passing, positioning, and end of travel of an object. They were first used to define the limit of travel of an object; hence the name Limit Switch.

### *G. Worm Gear*

A gearbox designed using a worm and worm-wheel is considerably smaller than one made from plain spur gears, and has its drive axes at 90° to each other. With a *single start* worm, for each 360° turn of the worm, the worm-gear advances only one tooth of the gear. Therefore, regardless of the worm's size sensible engineering limits notwithstanding, the gear ratio is the size of the worm gear to 1. Given a single start worm, a 20 tooth worm gear reduces the speed by the ratio of 20:1. With spur gears, a gear of 12 teeth must match with a 240 tooth gear to achieve the same 20:1 ratio. Therefore, if the diametrical pitch (DP) of each gear is the same, then, in terms of the physical size of the 240 tooth gear to that of the 20 tooth gear, the worm arrangement is considerably smaller in volume.

Unlike with ordinary gear trains, the direction of transmission input shaft verses output shaft is not reversible when using large reduction ratios, due to the greater friction involved between the worm and worm-wheel, when usually a single start one spiral worm is used. This can be an advantage when it is desired to eliminate any possibility of the output driving the input. If a multi-start worm multiple spirals is used then the ratio reduces accordingly and the *braking effect* of a worm and worm-gear may need to be discounted, as the gear may be able to drive the worm.

### *H. Battery*

In our project, we are using secondary type battery. It is rechargeable type. A battery is one or more electrochemical cells, which store chemical energy and make it available as electric current. There are two types of batteries, primary (disposable) and secondary (rechargeable), both of which convert chemical energy to electrical energy. Primary batteries can only be used once because they use up their chemicals in an irreversible reaction. Secondary batteries can be recharged because the chemical reactions they use are reversible; they are recharged by running a charging current through the battery, but in the opposite direction of the discharge current. Secondary, also called rechargeable batteries can be charged and discharged many times before wearing out. After wearing out some batteries can be recycled.

Batteries have gained popularity as they became portable and useful for many purposes. The use of batteries has created many environmental concerns, such as toxic metal pollution. A battery is a device that converts chemical energy directly to electrical energy it consists of one or more voltaic cells. Each voltaic cell consists of two half cells connected in series by a conductive electrolyte.

One half-cell is the positive electrode, and the other is the negative electrode. The electrodes do not touch each other but are electrically connected by the electrolyte, which can be either solid or liquid. A battery can be simply modelled as a perfect voltage source which has its own resistance, the resulting voltage across the load depends on the ratio of the battery's internal resistance to the resistance of the load.

When the battery is fresh, its internal resistance is low, so the voltage across the load is almost equal to that of the battery's internal voltage source. As the battery runs down and its internal resistance increases, the voltage drop across its internal resistance increases, so the voltage at its terminals decreases, and the battery's ability to deliver power to the load decreases.

### *I. Control Unit*

The Control Unit is digital circuitry contained within the processor that coordinates the sequence of data movements into, out of, and between a processor's many sub-units. The result of these routed data movements through various digital circuits within the processor produces the manipulated data expected by a software instruction loaded earlier, likely from memory. In a way, the CU is the brain within the brain, as it controls conducts data flow inside the processor and additionally provides several external control

signals to the rest of the computer to further direct data and instructions to/from processor external destinations

Microcontrollers are destined to play an increasingly important role in revolutionizing various industries and influencing our day to day life more strongly than one can imagine.

Since its emergence in the early 1980's the microcontroller has been recognized as a general-purpose building block for intelligent digital systems. It is finding using diverse area, starting from simple children's toys to highly complex spacecraft.

Because of its versatility and many advantages, the application domain has spread in all conceivable directions, making it ubiquitous. Microprocessor system is implemented with a single chip microcontroller. This could be called microcomputer, as all the major parts are in the IC. Most frequently they are called microcontroller because they are used they are used to perform control functions.

A microcontroller is a Computer on a Chip, or, if you prefer, a single-chip computer. Micro suggests that the device is small, and controller tells you that the device might be used to control objects, processes, or events. Another term to describe a microcontroller is embedded controller, because the microcontroller and its support circuits are often built into, or embedded in, the devices they control.

### *J. Working*

The power supply is given to the tracking system from external battery.7805 voltage regulator converts this incoming power supply into 5 volts in order to provide supply to other components in the system. The program to the AT89S52 micro controller is given through ISP pins. Based on RTC, the number of tilts of the panel will be set manually using four switches that are fed as an inputs to the 74LS21 AND gate and its output as an interrupt to the controller. Real Time, Tilt time settings are displayed on LCD which is connected to Port 1 of the micro controller. In this project, we use 4 tilts for tracking purpose and 5th tilt for bringing the panel back to the initial position. The RTC continuously runs and sends a high output to the microcontroller at our prescribed tilt time. Then microcontroller sends a high output to the motor driver which drives the DC motors connected to the panel. Flow chart of the RTC based solar tracking system. The controller will continuously reads the Real Time Clock (RTC) and compares with the tabular values stored, if it matches with those values the corresponding positional values will be send to the controller which will make the motor to operate to rotate solar panel to sun shine.

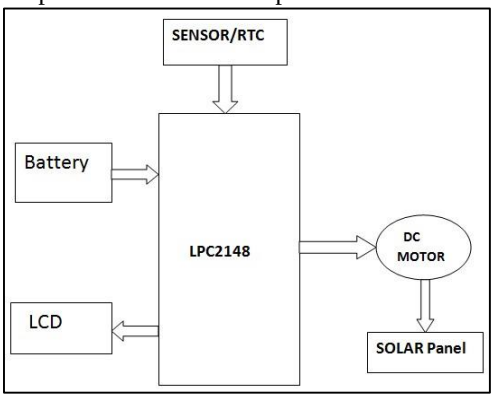
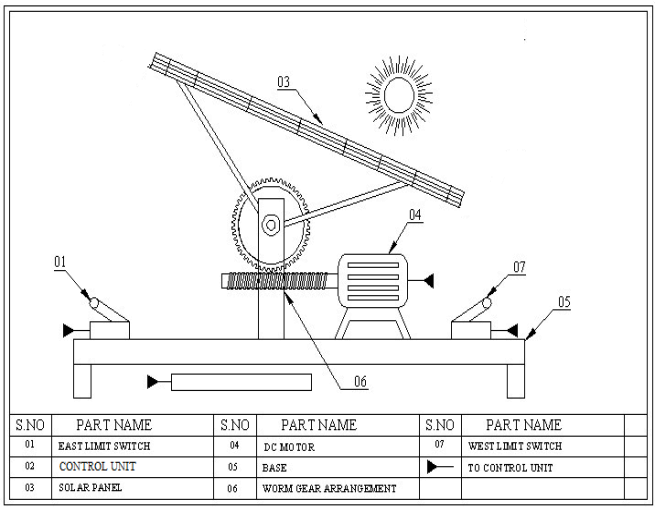



Fig. 2: Block Diagram




| S.NO | PART NAME | S.NO | PART NAME | S.NO | PART NAME |
|---|---|---|---|---|---|
| 01 | EAST LIMIT SWITCH | 04 | DC MOTOR | 07 | WEST LIMIT SWITCH |
| 02 | CONTROL UNIT | 05 | BASE | ▶— | TO CONTROL UNIT |
| 03 | SOLAR PANEL | 06 | WORM GEAR ARRANGEMENT | | |

Fig. 3: Assembly Drawing

The panel rotation or tilt angles will be initially fixed in the program that is given to the microcontroller. The output of solar panel is connected to Op Amp which amplifies the signal and gives it to the ADC which is connected to the port 1 of the microcontroller. Voltage generated by the panel as per the individual tilt time is displayed on LCD. It has motor driver development board with built in ADC and RS232 features. A 6V, 300mA solar panel is fixed to the rotor of the DC motor. The DC motor control input signals are connected to the controller and the output of the panel was connected to a load that would dissipate 9W that would match the panel's rating. 9W at 12V corresponds to a current of 0.75A, so by Ohm's law a load resistance was calculated as being 16Ω. A 15Ω, 50W resistor was the closest value found and was connected to the panel. The tracking device still requires power, but a 12V battery that is connected in a charging arrangement with the solar panel supplies it. The voltage across and current through the load was monitored using ADC channels of the controller, and was recorded every half hour on a clear day into a data base. The readings were taken on a span of days that possessed similar conditions including no cloud cover.

## V. CONCLUSION

The design of microcontroller based an efficient solar tracking system with real time clock is developed and described. The proposed system provides a variable indication of their relative angle to the sun by comparing with pre-defined measured readings. By using this method, the solar tracker was successfully maintained a solar array at a sufficiently perpendicular angle to the Sun. The power increase gained over a fixed horizontal array was in excess of 40%. The proposed design is achieved with low power consumption, high accuracy and low cost.

We provide automatic feature reset after 4 p.m. to pull back the PV module to the position of 8 a.m. and waiting the next day operation. This feature increases the efficiency operation of system. The materials and components can be easily found in the market with low price and constructed without having special knowledge for design.

Advances in the algorithms of sun tracking systems have enabled the development of many solar thermal and

photovoltaic systems for a diverse variety of applications in recent years. Compared to their traditional fixed-position counterparts, solar systems which track the changes in the sun's trajectory over the course of the day collect a far greater amount of solar energy, and therefore generate a significantly higher output power.

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