Solar Panel Tracking System for GSM Based Agriculture System

Aruna.D.Mane, Sirkazi Mohd Arif, Shaikh Sehzad, Shaikh Sohail

Abstract: Solar modules are devices that cleanly convert sunlight into electricity and offer a practical solution to the problem of power generation in remote areas. This project involves the development of an Automatic Solar radiation tracker that could be further used for agriculture purpose, making use of a GSM Module as the control system. Fossil fuels are a relatively short-term energy source consequently; the uses of alternative sources such as solar energy are becoming more wide spread.

To make solar energy more viable, the efficiency of solar array systems must be maximized. A feasible approach to maximizing the efficiency of solar array systems is sun tracking. Proposed in this paper is a system that controls the movement of a solar array so that it is constantly aligned towards the direction of the sun. The solar tracker designed and constructed in this paper offers a reliable and affordable method of aligning a solar module with the sun in order to maximize its energy output.

Automatic Sun Tracking System is a hybrid hardware/software prototype, which automatically provides best alignment of solar panel with the sun, to get maximum output (electricity). The system will be implemented for irrigation purpose wherein the irrigation system will be controlled using a GSM technology.

Keywords : GSM, Solar Panel, Microcontroller.

I. INTRODUCTION

The system discussed over here is based on natural and clean solar power. This is a whole automated system with self decision making capability. The decision making part will be carried out by the Microcontroller. The solar tracking system will help in capturing maximum sunlight from the sun. This energy will be stored in a DC Battery. The stored power will be used to drive the irrigation pump. Here the system will be a sensor based one where the pump will start only when there is the need of water to the land. The control of the irrigation pump will be made through a mobile phone from any remote location. In this section some related works are connected to the monitoring system using GSM services. However [1] developed a water meter reading using GSM system which is suitable for remote places to monitor the water meter reading before any billing process. In [2], this system is used to control home appliances tenuously and offer security when the owner is away from the place.

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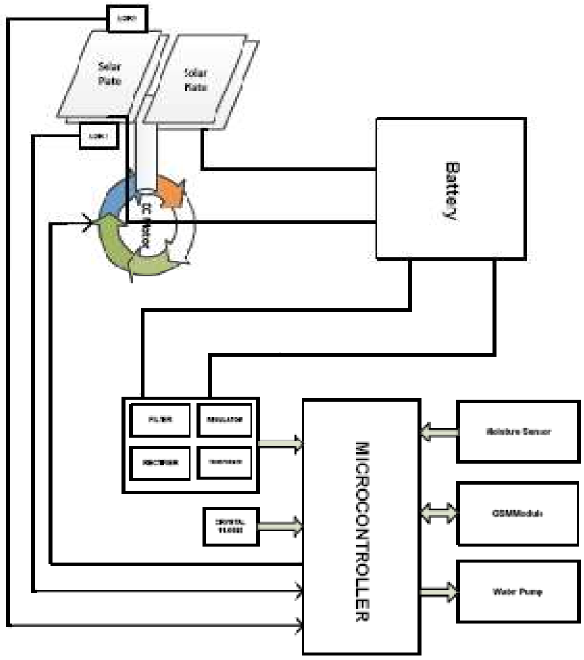
II. BLOCK DIAGRAM

The block diagram of solar tracking system for GSM based Agriculture system is shown in figure1. It comprises power supply section (solar panels,battery…), Microcontroller, Max 232 driver , relay driver , sensors & GSM modem. The GSM board has a valid SIM card with sufficient recharge amount to make outgoing calls.



III. SYSTEM ARCHITECTURE & IMPLEMENTATION

3.1 Microcontroller:

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

Some microcontrollers may use four-bit words and operate at clock rate frequencies as low as 4 kHz, for low power consumption (milliwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption.

3.2 Solar Cell Panel:

The solar cells that we see are also called photovoltaic (PV) cells, which as the name implies (photo meaning "light" and voltaic meaning "electricity"), convert sunlight directly into electricity. A module is a group of cells connected electrically and packaged into a frame (more commonly known as a solar panel), which can then be grouped into larger solar arrays.

Photovoltaic cells are made of special materials called semiconductors such as silicon, which is currently used most commonly. Basically, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely. PV cells also all have one or more electric field that acts to force electrons freed by light absorption to flow in a certain direction. This flow of electrons is a current, and by placing metal contacts on the top and bottom of the PV cell, we can draw that current off for external use, say, to power a calculator. This current, together with the cell's voltage (which is a result of its built-in electric field or fields), defines the power (or wattage) that the solar cell can produce.

That's the basic process, but there's really much more to it. Silicon has some special chemical properties, especially in its crystalline form. An atom of silicon has 14 electrons, arranged in three different shells. The first two shells -- which hold two and eight electrons respectively -- are completely full. The outer shell, however, is only half full with just four electrons. A silicon atom will always look for ways to fill up its last shell, and to do this, it will share electrons with four nearby atoms. It's like each atom holds hands with its neighbors, except that in this case, each atom has four hands joined to four neighbors. That's what forms the **crystalline structure**, and that structure turns out to be important to this type of PV cell.

The only problem is that pure crystalline silicon is a poor conductor of electricity because none of its electrons are free to move about, unlike the electrons in more optimum conductors like copper. To address this issue, the silicon in a solar cell has **impurities** -- other atoms purposefully mixed in with the silicon atoms -- which changes the way things work a bit. We usually think of impurities as something undesirable, but in this case, our cell wouldn't work without them. Consider silicon with an atom of phosphorous here and there, maybe one for every million silicon atoms. Phosphorous has five electrons in its outer shell, not four. It still bonds with its silicon neighbor atoms, but in a sense, the phosphorous has one electron that doesn't have anyone to hold hands with. It doesn't form part of a bond, but there is a positive proton in the phosphorous nucleus holding it in place.

When energy is added to pure silicon, in the form of heat for example, it can cause a few electrons to break free of their bonds and leave their atoms. A hole is left behind in each case. These electrons, called free carriers, then wander randomly around the crystalline lattice looking for another hole to fall into and carrying an electrical current. However, there are so few of them in pure silicon, that they aren't very useful.

But our impure silicon with phosphorous atoms mixed in is a different story. It takes a lot less energy to knock loose one of our "extra" phosphorous electrons because they aren't tied up in a bond with any neighboring atoms. As a result, most of these electrons do break free, and we have a lot more free carriers than we would have in pure silicon. The process of adding impurities on purpose is called **doping**, and when doped with phosphorous, the resulting silicon is called **N-type** ("n" for negative) because of the prevalence of free electrons. N-type doped silicon is a much better conductor than pure silicon. The other part of a typical solar cell is doped with the element boron, which has only three electrons in its outer shell instead of four, to become P-type silicon. Instead of having free electrons, **P-type** ("p" for positive) has free openings and carries the opposite (positive) charge.

3.3 Moisture sensor:

The terms humidity and moisture are not interchangeable. Humidity refers to the water content in gases such as in the atmosphere. Moisture is the water content in any solid or liquid. Other important, related quantities are dew point temperature absolute humidity and relative humidity. These are defined as follows:

Relative humidity is the ratio of the water vapor pressure of the gas (usually air) to the maximum saturation water vapor pressure in the same gas at the same temperature.

Saturation is that water vapor pressure at which droplets forms. The atmospheric pressure is the sum of the water vapor pressure and the dry air pressure.

Relative humidity is not used above the boiling point of water (100°C) since the maximum saturation above that temperature changes with temperature. Dew-point temperature is the temperature at which relative humidity is 100%. This is the temperature at which air can hold maximum amount of moisture. Cooling below it creates fog (water droplets), dew or frost. Absolute humidity is defined as the mass of water vapor per unit volume of wet gas in grams/cubic meter [g/m3]. The simplest moisture sensor is capacitive sensor It relies on the change in permittivity due to moisture. The permittivity of water is rather high (80°c at low frequencies). Humidity of course is different than liquid water and hence the permittivity of humid air is either given in tables as a function of relative humidity or may be calculated from the following empirical relation:

$$\varepsilon = 1 + \frac{211}{T}\left(P + \frac{48P_s}{T}H\right)10^{-6}\varepsilon_0$$

e0 is permittivity of vacuum,

T is the absolute temperature [°K],

P is the pressure of moist air [mm Hg],

H is the relative humidity [%]

Ps is the pressure of saturated water vapor at the temperature T [mm Hg]

The capacitance of a parallel plate capacitor is C=εA/d

This establishes a relation between capacitance and relative humidity:

C0 is the capacitance of the capacitor in vacuum (C0=ε0A/d).

This relation is linear at any given pressure and temperature

In more practical designs, means of increasing this capacitance are used.

Use a hygroscopic material between the plates both to increase the capacitance at no humidity and to absorb the water vapor. (hygroscopic polymer films.

The metal plates are made of gold. In a device of this type the capacitance is approximated as:

$C = C_o + C_o \alpha_h H$

Where α_h is a moisture coefficient

- Method assumes that the moisture content in the hygroscopic polymer is directly proportional to relative humidity and that
- As the humidity changes, the moisture content changes (that is, the film does not retain water).
- Under these conditions the sensing is continuous but, as expected, changes are slow and
- A sensor of this type can sense relative humidity from about 5% to 90% at an accuracy of 2-3%.
- In a parallel plate capacitor the film must be thin
- Moisture can only penetrate from the sides.

It is therefore slow to respond to changes in moisture because of the time it takes for moisture to penetrate throughout the film.

3.4 GSM MODEM:

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone.

When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities.

For the purpose of this document, the term GSM modem is used as a generic term to refer to any modem that supports one or more of the protocols in the GSM evolutionary family, including the 2.5G technologies GPRS and EDGE, as well as the 3G technologies WCDMA, UMTS, HSDPA and HSUPA.

A GSM modem exposes an interface that allows applications such as SMS to send and receive messages over the modem interface. The mobile operator charges for this message sending and receiving as if it was performed directly on a mobile phone. To perform these tasks, a GSM modem must support an "extended AT command set" for sending/receiving SMS messages, as defined in the **ETSI GSM 07.05** and **3GPP TS 27.005** specifications.

3.5 Water pump:

A DC voltage based water pump will also be used in order to supply the water in the field. Since we are dealing with the stored DC power, hence we are going to use a DC power water pump.

3.6 DC motor:

A DC motor is designed to run on DC electric power. The Most Common DC Motors are the brushed and brushless types which use internal and externally. Brushless DC motors are commonly used where precise speed control is necessary. DC brushless motors range in power from a fraction of a watt to many kilowatts. Larger brushless motors up to about 100 kw rating are used in electric machines. They also find significant use in high performance servo controlled systems in Industrial automation.

3.7 : 12 V DC Battery:

A 12 V DC battery is used to store the charge or power that is generated by the Solar Cell Panel. This stored energy will be further used to power the irrigation system. The same stored energy is also used to control the entire system implemented in this project. That means the same stored energy will be used to power up the Microcontroller unit that is used to control the entire system. Also the same energy is used to move the Solar Cell Panel according to the position of the sun.

IV. WORKING PRINCIPLE:

The basic idea of developing this paper is to obtain maximum sunlight from the sun throughout the day, by tracking the movement of the sun. Here the Solar Cell Panel is moved according to the position of the sun. By tracking the movement of the sun ,maximum sunlight is obtained, further this energy will be stored in a 12 V DC Battery.The solar cell panel will be mount on a rotating structure. This structure will have DC motors that will help the structure to rotate. Here we are going to implement the LDR for detection of the sunlight. The LDR will be detecting the sunlight and send the data to the microcontroller. We are going to use two LDRs in the project. One at each direction East and West. As long as the sunlight is in the perimeter of the 1st LDR the solar panel will remain in the same direction. Once the sunlight is out of the perimeter of the 1st LDR, it will stop sending data to the microcontroller. But at the same time the sunlight will be in the perimeter of the 2nd LDR, as we have installed the LDRs in such a pattern. Now the 2nd LDR will start sending the data to the microcontroller. Upon getting the data from the 2nd LDR the microcontroller will send a command to the DC motor. After receiving the command from the microcontroller now the DC motor will get started and the panel will move to the corresponding direction. This is how we are going to track the sunlight and adjust the solar panel in a position where it will receive maximum sunlight.

Now moving to the second part of the project, the energy generated through the solar panel will be sent to a DC battery. The battery will store the energy for further applications. Now we are connecting a water pump to the battery so that the motor should run on the power generated by the solar panel. We are making the irrigation system an intelligent one. In this system the water supply will be an automated one that means the pump will supply the water only when the land needs it. And the water pump will be controlled by a cellular phone from any remote location.

In order to achieve this task we are making use of a moisture sensor and a GSM Module or device. The moisture sensor will be placed in the field, and it will be connected to the microcontroller. The moisture sensor will be continuously sending the amount of moisture to the microcontroller, where it will be compared with a predefined value. Now whenever the moisture level becomes less than the predefined level, the microcontroller will activate the GSM Module, which will send a message to the user, stating that the moisture level of the land has dropped.

Now upon receiving the message the user can activate or switch on the water pump by just sending an sms. After receiving the sms the GSM module will send the data to the microcontroller and the microcontroller will send a command to activate the water pump.

After the motor gets started and starts supplying water to the field, simultaneously the moisture sensor will be sending the moisture level to the microcontroller. Since the field is getting water supply now the moisture level of the field will start increasing, this increase in the moisture will again be compared with a predefined moisture level by the microcontroller. Once if it reaches the maximum level again the microcontroller will activate the GSM module which will again send a message to the user about the increase in the moisture level. Now if the user wants he/she can switch off the water pump by sending an sms.

This is how the system will become an automated system also .we are drawing maximum power through the sunlight. The user is free to take a decision whether to supply the water or not from any remote location as long as there is cellular phone network.

V. HARDWARE AND SOFTWARE

5.1 : Hardware used:

- Solar Cell Panel.
- Light Dependent Resistor.
- DC Battery
- Microcontroller AT89C52.
- Moisture Sensor.
- GSM Module.
- Water Pump.
- Power supply 5V. (Through Battery)

5.2 :Software used:

- The software program can be written in C or assembly language & complied using keil software .After compiler operation the hex code is generated & stored in the computer .the hex code of the program is burnt into the AT89C52.by using Top win Universal programmer.
- Kiel IDE.
- Embedded C.

VI. CONCLUSION

In this paper the use of solar panel increases the efficiency & provides maximum output voltage during sunny days. This system can be implemented for efficient use & for future work of this paper external supply can be used to get the work done in all seasons.

VII. FUTURE DEVELOPMENT:

This can be used for all the time by including external supply in case of emergency such as rainy season & bad weather conditions. Solar panel tracking can be used for other applications such as industrial parameter control, home automation , and many more applications with slight modifications in the block diagram.

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