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MINI SOLAR POWER PLANT WITH WEATHER DETECTION SYSTEM

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Abstract: According to market economy, the increasing worldwide demand for energy, forces a continuous rise on the price of fossil combustibles[1]. In fact it is expected in the near future, that the demand for energy will grow faster than the finding out of new available fossil resources[2]. In this context we have assisted, in the last decades, to a concentrated focus on renewable energy research. Among these renewable energetic sources, the international scientific community has devoted intense efforts to wind, solar photovoltaic and biomass. The solar energy is a clean, freely and abundantly available alternative energy source in nature. Capturing solar energy from nature is an advantageous task for power generation[3]. Conversion of sun energy into another form is a highly complex phenomenon. For this purpose, Photo-Voltaic (PV) panels are used which convert Sun energy to Direct Current (DC) electricalenergy. Conventional fixed type PV panels extract maximum energy only during 12 noon to 2 PM which results in less efficiency. Therefore, building of an automatic solar tracking system is the need of an hour. PV panels have to be perpendicular with the sun for maximum energy extraction which can be fulfilled by automatic tracking. This project includes the design and development of microcontroller based automatic solar tracking system.

***Index Terms* – Photo Voltaic,PV cell,Renewable systems, MPPT**

I. INTRODUCTION

Solar cells or Photovoltaic cells converts the energy of light directly into electricity by thephotovoltaic effect, which is a physical and chemicalenomenon. It is a form of photoelectric cell, defined as adevice whose electrical characteristics, such as current, voltageor resistance vary when exposed to light. Individual solar celldevices can be combined to form modules, otherwise known assolar panels. The common single junction silicon solar cell canproduce a maximum open circuit voltage of approximately 0.5to 0.6 volt DC under no load and open circuit condition. Thepower ratting of PV cell mainly depends on its efficiency, size (surface area) & is proportional to the intensity of light strikingthe surface of cell. For example, under peak sunlight conditions, a typical commercial PV panel of surface area 160 cm^2 (25inch^2) will produce about 1.2 watts. So intensity adds a lot to efficiency[3]. Extensive research shows that output of a PV cellcan be increased by two methods: fabrication and passivedevices. Passive devices are use widely to enhance the efficiency as fabrication is expensive one.

II. MATHEMATICAL MODELLING OF PV CELL

Modeling is the basis for computer simulation of a real system. It is usually based on a theoretical analysis of the various physical processes occurring in the system and of all factors influencing these processes

The I-V characteristics equation of solar cell [4]

$$I = I_L - I_0[\exp(\frac{qV}{nkT}) - 1]\ldots(1)$$

I_L is a light generated current or photo current (representing the current source), I_O is the saturation current (representing the diode), , k (= 1.38 ×10^{-23} W/m^{2}K) is Boltzmann's constant, q (=1.6×10^{-19}C) is the magnitude of charge on an electron and T is

working cell temperature. Photo current or light generated current, mainly depends on the solar insolation and cell working temperature, which is described as:

$$\boldsymbol{I_L = G[I_{SC} + K_I(T - T_{ref})]\ldots \quad (2)}$$

III. BLOCK DIAGRAM AND EXPLANATION

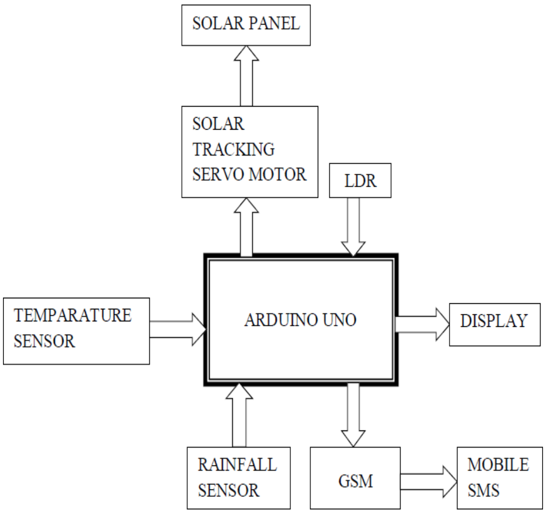

Fig.1: Block diagram

The proposed system consists of a weather detection system to predict the environmental conditions. There will be continuous monitoring of temperature sensor and rainfall sensor. Any changes in the values of rainfall and temperature sensor from the predefined threshold values will trigger Arduino to send SMS via GSM to the user mobile, with the prediction of solar output power. There is a tracking system also integrated with the proposed system to track solar energy efficiently. The whole tracking system is based on the output of LDR. Based on the output of LDR, the Arduino will send signal to change the direction of the servo motor tracking system. A display is also integrated to show the status of solar output.

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.

A Light Dependent Resistor (LDR) is also called a photo resistor or a cadmium sulfide (CdS) cell. It is also called a photoconductor. It is basically a photocell that works on the principle of photoconductivity**.** A **servo motor** is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through **servo mechanism**. If motor is used is DC powered then it is calledDC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight packages. Doe to these features they are being used in many applications like toy car, RC helicopters and planes, Robotics, Machine etc

IV. CONNECTION DIAGRAM AND EXPLANATION

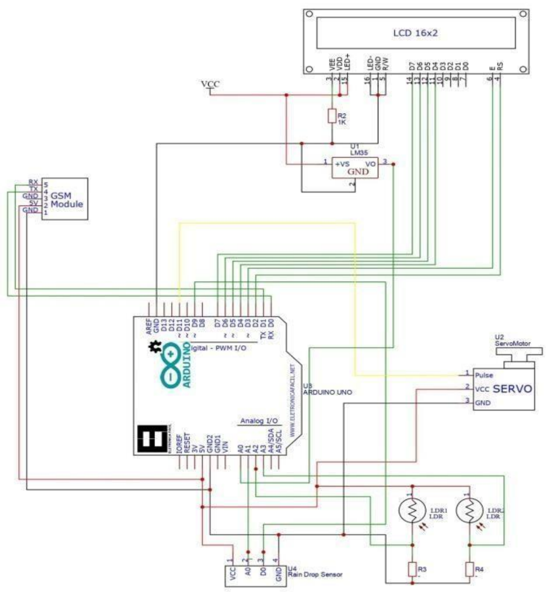

Fig.2. Connection diagram

Interfacing LCD Display with Arduino

- Insert LCD screen into breadboard vertically such that each pin has its own separate line on the board.
- Insert potentiometer in the same way.
- Connect 5v and GND from Arduino to the + / - rails on breadboard. This will ground Backlight and LCD.
- Connect Pins 1 and 16 from the LCD screen to the negative power rail. This will power Backlight and LCD.
- Connect Pins 2 and 15 from the LCD to the positive power rail. This will power Backlight and LCD.
- Connect Pin 3 to the center pin of potentiometer, this will control the contrast.
- Connect the top and bottom pins on potentiometer to GND and 5v rails. As we twist this potentiometer we can control contrast.
- Connect Pin 4 of the LCD to pin 2 on Arduino. This will be the register select pin we output to from the Arduino later.
- Connect Pin 5 of the LCD to ground.
- Connect Pin 6 of the LCD to pin 3 on Arduino. This is the data enable pin that we will use later.
- We will be using data pins 4,5,6,7 for our LCD screen. Thisrepresents 4 bits of data, known as a nibble. The LCD screen has the capability for 8-bit parallel communication but 4 bit will be adequate for our project.
- Connect those pins to 4 pins on your Arduino, we use 4,5,6,7 respectively.

INTERFACING SIM900A GSM MODULE WITH ARDUINO

- Insert your SIM card to GSM module and lock it.
- Power up your GSM by connecting it to Arduino's 5V and GND
- Connect Rx & Tx of GSM correspondingly to Tx & Rx of Arduino for serial communication between Arduino & SIM900A module
- Connect the Antenna
- Now wait for some time (say 1 minute) and see the blinkingrate of 'status LED' or 'network LED' GSM module will take some time to establish connection with mobile networkOnce the connection is established successfully, the status/network LED will blink continuously every 3 seconds.

INTERFACING LM35 TEMPERATURE SENSOR WITH ARDUINO

- Connect +Vs pin to +5 Vcc of Arduino
- Connect GND pin to any Ground pin of Arduino
- Connect Vo to any analogue pin in Arduino (Here A0)

INTERFACING RAIN DROP SENSOR WITH ARDUINO

- Connect Vcc to +5V Vcc of Arduino
- Connect A0 to Analogue I/O pin A1 of arduino & Do todigital I/O pin D9 of Arduino
- Connect GND to any Ground pin of Arduino

INTERFACING SERVO MOTOR WITH ARDUINO

- The servo motor has a female connector with three pins. The darkest or even black one is usually the ground. Connect this to the Arduino GND.
- Connect the power cable that in all standards should be red to 5V on the Arduino.
- Connect the remaining line on the servo connector to a digital pin on the Arduino.

INTERFACING LDR WITH ARDUINO

- Connect +5V of the Arduino to one pin of the LDR (LDR pins can be swapped, so no worries about polarity here).
- Connect the other pin of the LDR to analog pin of the Arduino and one pin of the 100KΩ resistor.
- Connect the other pin of the 100KΩ resistor to GND of the Arduino.

CONCLUSION

The proposed system consists of a "MINI SOLAR POWER PLANT" in which three solar panels are arranged along with LDR module and servo motor for the purpose of "Automatic Sun Tracking". In this project, the sun tracking system is developed based on microcontroller. The microcontroller based circuit is used in this system with a minimum number of components and the use of DC servo motors enables accurate tracking of the sun. The whole tracking system is based on the output of LDR . Based on the output of LDR, the Arduino will send signal to change the direction of the servo motor tracking system. Since the sun tracking systems can collect maximum energy than a fixed panel system and high efficiency is achieved through this tracker, it can be said that the proposed sun tracking system is a feasible method of maximizing the light energy received from sun. This is an efficient tracking system for solar energy collection. The method implemented in this project is simple, easy to maintain and requires no technical attention for its operation.

The system also consists of a "WEATHER DETECTION SYSTEM" in which temperature sensor and rainfall sensor is integrated with Arduino Uno in order to predict environmental conditions. There will be continuous monitoring of temperature sensor and rainfall sensor. Any changes in the values of rainfall and temperature sensor from the predefined threshold values will trigger Arduino to send SMS via GSM to the user mobile, with the prediction of solar output power which provides better communication with the user. This weather detection system can be very helpful to the users to find alternative energy sources in caseof adverse atmospheric conditions.

ADVANTAGES

- The solar module with tracking system achieves about 21% efficiency improvement over the static solar module. Hence implementation of this technique in building solar systems will greatly improve utility satisfaction.
- Faster and accurate tracking using LDR and servomotor integrated with Arduino Uno.
- Weather prediction using temperature and rainfall sensor can be helpful to the user to find alternative source of energy.
- Real time and better communication with the user through GSM module.
- The Arduino Uno used is differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.
- Arduino Uno used is an open source platform where anyone can modify and optimize the board based on the number of instructions and task they want to achieve.
- By using LM35 temperature sensor we can measure temperature more accurately than using a thermistor and it generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.
- LDR's used are cheap and are readily available in many sizes and shapes and they need very small power and voltages for their operation.

DISADVANTAGES

- Dual axis sun tracking will be more efficient than the proposed system.
- A smart weather prediction with battery charging can be implemented to use solar energy efficiently
- Although solar energy can still be collected during cloudy and rainy days, the efficiency of the solar system drops hence it is weather dependant.
- LDR's may be inaccurate with a response time of abouttens or hundreds of milliseconds.
- The rain sensor based system may function when waterfalls on the sensor directly hence false detection of rain may occur.

FUTURE SCOPE

1. Drone charging platform and wireless power transfercharging
2. Solar tree as electric and hybrid vehicle chargingplatform
3. Panels on high mast lights**.**

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