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Automated Solar Powered Green House Irrigation System Using Single Axis Solar Tracking

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Abstract **- The proposed irrigation system is powered with solar panel integrated with sun tracker. As these solar trackers generate more electricity than the traditional fixed solar panel [5] due to increased direct exposure to solar rays at every instant of day, its power efficiency can be improved to a maximum of 45% depending on the geographic location of the tracking system. The utilization of photovoltaic (PV) off grid solar system could be the solution for pumping and irrigation system. The amount of power generated by the solar tracking system was compared with the power generated by fixed solar panels. The experimental results indicate that compared to the power generated by fixed solar panels, the solar tracking system generated about 20% to 25% more Power. Solar Tracking System is the flow of electricity. The electrical power generated by solar panel depends on the intensity of the solar isolation.**

Keywords: Solar panels, Automation irrigation, Microcontroller, Renewable energy, Sensor, Greenhouse.

I. INTRODUCTION

The system is an automatic irrigation system where the irrigation pump is operated from solar energy. It became tedious to manually operate the irrigation system and keep monitoring the water level of the soil. Hence the system uses solar power by using photovoltaic cells instead of commercial electricity. In agricultural sector, it is very common to use diesel or hydropower energy for Agricultural operations. On the other hand, increasing costs of this kind of energy has been decreasing the profit of agricultural Products and this situation moved farmers toward to find both cheap and renewable Energy sources.

The proposed system aims at providing an automatic irrigation system by monitoring the field, crop and weather conditions. The system is powered up by a solar tracker which in turn reduces the cost of electrical power consumption. The system also provides real time updates to the farmer, using which he can manually control the system over web whenever needed.

Soil moisture sensor base irrigation system ensures proper moisture level in the soil for growing plants in all season. In this system, sensor is sensing the moisture content of soil and accordingly switches the pump motor on or off. Soil moisture sensor is finding the soil condition whether the soil is wet or dry. If soil is dry the pump motor will pump the water till the field is wet which is continuously monitored by the microcontroller. The main advantage of soil moisture sensor is to ensure accurate measurements and farmer doesn't have to visit his farm to operate the pump. Same time, using GSM technique microcontroller is sending message on farmers mobile about pump status.

In this paper, we are proposing an automatic irrigation system which monitors the soil moisture levels and the weather conditions periodically thereby automatically switch on the water pump when the soil moisture is below a preset threshold and if the weather reports no rain. The proposed system can be configured as either automatic or semi-automatic. In the automatic mode, the system would automatically switch on the water pump when the soil moisture is below a threshold, which varies with type of crop and the age of the crop. When the soil moisture is above the threshold level, the motor gets switched off. In the semiautomatic mode, the farmer would receive an email alert about the field conditions. The farmer can then switch on the motor using a web interface. The motor will automatically turn off when the soil moisture reaches the threshold level. The system also provides real time updates to the farmer about the weather and crop conditions so that the farmer can maintain an efficient future watering schedule.

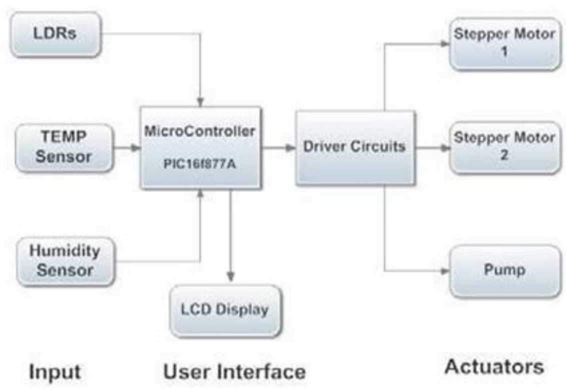

Figure 1: Block diagram of automatic irrigation system PV tracking system

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II. SYSTEM AND SIMULATION

The complete system has been simulated by using Proteus ISIS professional package in order to verify the validity of the control algorithm of the irrigation system before its construction. The simulation includes the microcontroller PIC 16F877A, LDR sensors, temperature sensor LM35, humidity sensor, LEDs, relays, UNL2003 ICs, L298 ICs and stepper motors all connected as the block diagram in figure 2 [8]. Different situations have been simulated with very good results for solar tracking and for the pump function.

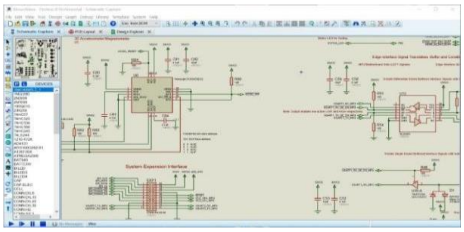

Figure 2: Simulation diagram

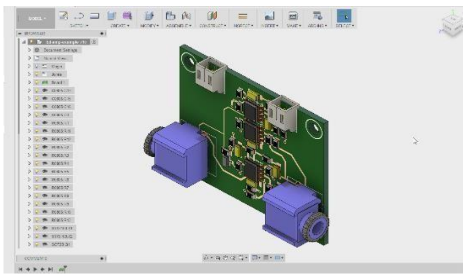

Figure 3: The constructed System

III. CIRCIUTS AND COMPONENTS

Single-axis solar tracking systems follow the solar by moving in a single axis (vertical or horizontal). Generally, the inclination angle is adjusted manually at certain intervals during the year and automatic movement is provided in the east–west direction. Single axis systems are more cost-effective than two-axis systems but have lower yields in terms of efficiency.

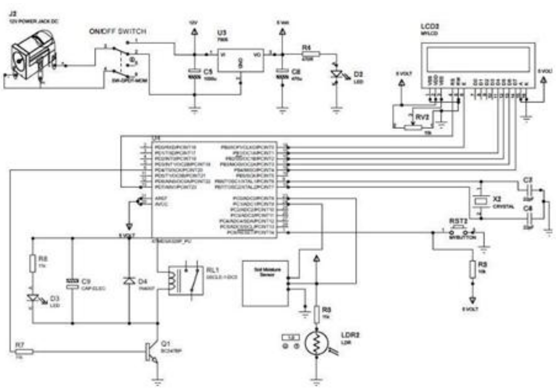

Figure 4: Circuit diagram of Solar Tracking System

Single-axis solar tracking systems are moved on the vertical or horizontal axis depending on the solar trajectory and the weather condition.

Components

3.1 Solar Panel

Figure 5: Solar Panel

Solar panels are a cumulative orientation of photovoltaic cells. The PV cells are arranged in a solar panel or a PV array such that is serves the purpose of exciting the electron of the material consisting inside the solar cells using photons. The average amount of sunlight received by solar panels particular depends on the position of the sun. Polycrystalline solar panels: Often called multi-crystalline, solar panels made with Polycrystalline cells are a little less expensive & slightly less efficient than Monocrystalline cells because the cells are not grown in single crystals but in a large block of many crystals. This is what gives them that striking shattered glass appearance. Like Monocrystalline cells, they are also then sliced into wafers to produce the individual cells that make up the solar panel. Amorphous solar panels: These are not really crystals, but a thin layer of silicon deposited on a base material such as metal or glass to create the solar panel. These Amorphous solar panels are much cheaper, but their energy efficiency is also much less so more square footage is required to produce the same amount of power as the Monocrystalline or Polycrystalline type of solar panel. Amorphous solar panels can even be made into long sheets of roofing material to cover large areas of a south facing roof surface.

3.2 AVE Microcontroller

Figure 6: AVE Microcontroller

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ATmega328 is an Advanced Virtual RISC (AVR) microcontroller. It supports 8-bit data processing. ATmega328 has 32KB internal flash memory.ATmega328 has 1KB Electrically Erasable Programmable Read-Only Memory (EEPROM). This property shows if the electric supply supplied to the micro-controller is removed, even then it can store the data and can provide results after providing it with the electric supply. Moreover, ATmega-328 has 2KB Static Random Access Memory (SRAM). Other characteristics will be explained later. ATmega 328 has several different features which make it the most popular device in today's market. These features consist of advanced RISC architecture, good performance, low power consumption, real timer counter having separate oscillator, 6 PWM pins, programmable Serial USART, programming lock for software security, throughput up to 20 MIPS etc. Further details about ATmega 328 will be given later in this section.

3.3 Temperature Sensor

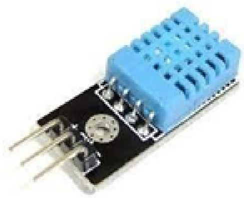

Figure 7: Temperature Sensor

The digital temperature sensor like DS18B20 follows single wire protocol and it can be used to measure temperature in the range of -67oF to +257oF or -55oC to +125oC with +5% accuracy. The range of received data from the 1-wire can range from 9-bit to 12- bit. Because, this sensor follows the single wire protocol, and the controlling of this can be done through an only pin of Microcontroller. This is an advanced level protocol, where each sensor can be set with a 64-bit serial code which aids to control numerous sensors using a single pin of the microcontroller. This article discusses an overview of a DS18B20 temperature sensor.

3.4 Relay

Figure 8: Relay

The rating of the relays is 5V. Relay is sensing device which senses the fault and sends a trip signal to circuit breaker to isolate the faulty section. A relay is an automatic device by means of which an electrical circuit is indirectly controlled and is governed by change in the same or another electrical circuit. There are various types of relay: Numerical relay, Static relay and electromagnetic relay. Relays are housed in panel in the control room. Here three mini power relays are used each for one of the three phases. The relays periodically scan the three phases and send the signal to the AT Mega16 Microcontroller controller.

3.5 Battery

The lead acid battery is made up of plates, lead, and lead oxide (various other elements are used to change density, hardness, porosity, etc.), with a 35% sulfuric acid and 65% water solution. This solution is called electrolyte, which causes a chemical reaction that produces electrons.

Figure 9: Battery

When you test a battery with a hydrometer, you are measuring the amount of sulfuric acid in the electrolyte. If your reading is low, that means the chemistry that makes electrons is lacking. So where did the sulfur go? It's resting on the battery plates so that when you recharge the battery, the sulfur returns to the electrolyte.

IV. FLOWCHART

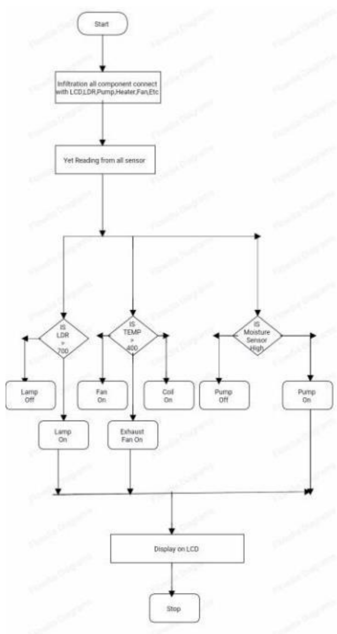

Figure 10: Flow chart

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V. RESULTS AND OBSERVATIONS

Different size of PV modules produce different amount of power. Data about the energy (Wp) produced by the PV panels and radiation (w/m2) were recorded into a data logger. The pump we used run by 0.37 kW the discharge of it was 3.33 L/s. The fixed panel start producing an energy of 150 Wp at almost 5.00 a.m. and continued to produce same amount of energy until 21.00 p.m. (fig.7). It means we can run this pump to irrigate our plants from 5 a.m. to almost 21 p.m. without using a battery or batteries. By using this energy (151 Wp) it is possible to pump the discharge of 432 L/h by the pump. If we produced 377 Wp by only one panel, we would have pumped the discharge of 1080 L/h.

	Using solar tracker Static solar panel			Using solar tracker Static solar panel		
Hour	Voltage (V)	Current (mA)	Power (mW)	Voltage (V)	Current (mA)	Power (mW)
0800	16.8	1.23	20.664	18.3	3.41	62.403
0900	17.0	2.34	39.780	18.9	3.57	67.473
1000	17.6	2.51	44.176	19.4	3.98	77.212
1100	19.4	3.64	70.616	19.7	4.76	93.772
1200	19.8	4.45	88.110	20.4	5.40	110.430
1300	20.5	5.12	104.960	21.6	6.35	137.160
1400	21.1	5.94	125.334	21.4	6.11	130.754
1500	19.4	5.43	105.342	20.5	5.87	120.335
1600	17.2	5.01	86.172	19.6	5.26	103.096
1700	16.5	4.28	70.620	18.5	4.86	89.910
1800	16.2	2.87	46.494	17.5	3.75	65.625

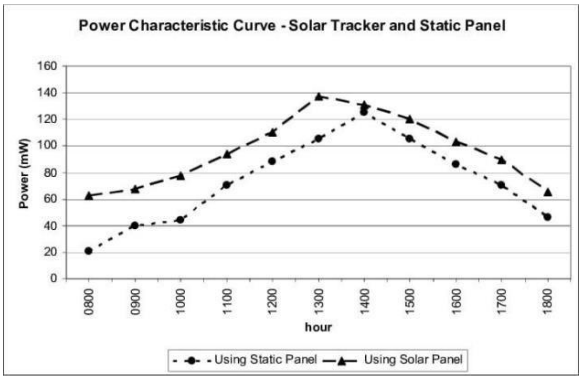

Figure 11: Result Analysis

Hardware Prototype

Figure 12: Hardware Prototype

VI. CONCLUSION

The proposed solar tracker assisted automatic irrigation system for agricultural fields is successfully constructed and tested in real time. Additional simulator scripts are created to check the system response for a specific soil moisture value. It is observed that the water wastage is reduced considerably. The farmer can remotely monitor the field and crop conditions, thereby planning for an efficient future watering schedule. By relying on weather forecast information, the ground water level also can be maintained. The energy consumption is also handled effectively using our solar tracker. This system will be of prominent use in drought areas or the areas with water scarcity. The system can be improved further by adding pH sensors. By monitoring the pH values, fertilizer usage can also be reduced. The energy efficiency of the system can be further improved by putting the system in sleep mode during the night. Smart irrigation system occupies an exact amount of water at the correct location. It saves time of operation and decreases hard work. This whole system is operated with renewable energy, where this energy will store in the lead-acid battery using fast charging & solar charge controller and it will take only 6 to 8 h to fully recharge. So, this simplest and lowest-cost technology will also help farmers to adapt to the scarcity of irrigation water. It also makes a country self-sufficient in food section.

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