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Automatic Solar Submersible Pump Control for Irrigation

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Abstract

Electrical energy and water are two major things whose demands are very high globally. In order to meet these demands, the production of electrical energy has now been shifted more towards renewable sources of energy like solar, wind, tidal etc. The crisis of water has also become a global concern. In this modern era where everything is getting automated, agriculture is an area where both electricity and water are very essential. In order to use electricity and water effectively and efficiently, an automated solar powered agricultural pumping system can be fruitful. Cost effective solar power can be the answer for all our energy needs. Solar powered smart irrigation system is an answer to the needs of farmers. This system would control the flow of water all across the field, from water reservoir to the crops. It is the proposed solution for the present situation of agriculture. This system conserves electricity by reducing the usage of grid power and conserves water by reducing water losses. This paper discusses about solar panels, battery, charge controller, voltage regulator, inverter, submersible pump, water level controller, microcontroller, moisture sensor, humidity and temperature sensor and GSM. The goal is to design such a system which is capable of using water and electricity as per the requirements and providing an easy solution to the existing issues.

Keywords: *Automation, Controller, Sensors, Pumps*

1. Introduction

The system consists of electrical part and mechanical part. The electrical part consists of photovoltaic solar panels, which is meant to generate electrical power and the power is stored in the rechargeable battery.

The power is utilized to operate the pumps. The mechanical part consists of pumps which will maintain the flow of water. The parameters in this work are soil humidity condition, water level condition and the position of the Sun. The solar panels are used to generate electrical energy which is supplied to the entire system and it is much cheaper than the grid electricity. It is suitable to the rural area that is why the solar system is used as a power supplier to replace DC motor electricity source. The initial cost of solar installation is higher than use of DC electrical motor but the solar system has no bill compared to grid electricity which has a bill to pay every month. It is a versatile source of renewable energy that can be used in any application. The system consists of hardware and software. The integration of the two parts makes the system which provides the results. The hardware system consists of the sensors, and drivers. In hardware design, we need all the components that are necessary to accomplish the project, and these components are solar panel, water pump motor, sensors, some controller circuits, driving circuits and some minor components like tank and reservoir.

2. Methodology

The figure demonstrates the methodology of the system. The purpose of this system is to automatically maintain the water flow throughout the

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field.The solar panels will

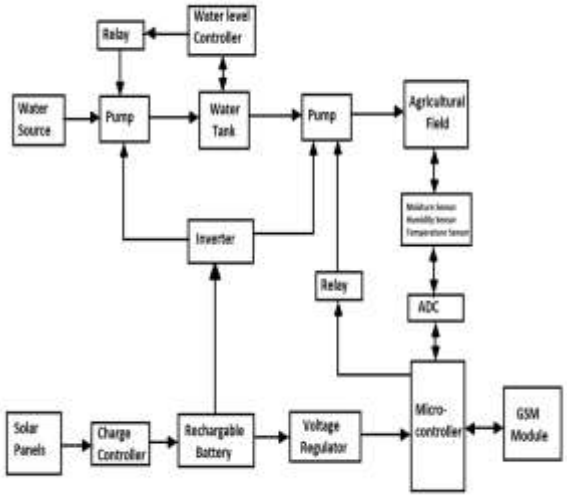

Fig. 1 Block Diagram

generate electrical energy which will power the entire system. The excess energy will be stored in rechargeable battery. A charge controller will maintain the charging limit of the battery and provide protection from overcharging and overheating of the battery. The soil moisture sensors along with humidity and temperature sensors are placed in the field near the crops which will provide feedback to the microcontroller. A voltage regulator is used to supply constant power to the microcontroller. The microcontroller will control the switching of the pump which will supply water to the crops as per their requirements. The water level in overhead water tank is maintained by a water level controller which will operate the pump and the pump will supply water from the water reservoir. AC pumps are used in this system as they are economical and efficient as well. The pumps require ac supply whereas the solar panels provide dc power. So an inverter is used to convert this dc supply to ac supply. Also, a GSM module is used in this system. This enables the live updates of the field via SMS. The moisture level of the soil, humidity and temperature in the field, status of the pumps will be sent to the user via SMS. The pumps can be manually operated via SMS. The user can send SMS to the system to switch ON or switch OFF the pump.

3. Materials and Methods

- Solar panel rating – 5W /17V
- Output Voltage –Variable (5V – 14V)
- Maximum output current – 0.29 Amps.
- Drop out voltage- 2- 2.75V.
- Voltage regulation: +/- 100mV
- LM317 voltage regulator
- Diode – 1n4007
- Capacitor – 0.1uF
- Schottky diode – 3A,50V
- Resistors – 220
- 680 ohms
- Pot – 2K
- Connecting wires

3. Algorithm

- Start
- Initialize variables R (Received SMS), A0 (Soil Moisture Sensor Output), A1 (Temperature) and A2 (Humidity).
- Check if R='A' then Pump = ON.
- Check if R='B' then Pump = OFF,
- Check A0, A1 and A2.
- If A0<adcValue, Pump = OFF, send SMS and Go-To Step 2.
- Else, Pump = ON, send SMS and Go-To Step 2.

4. Flowchart

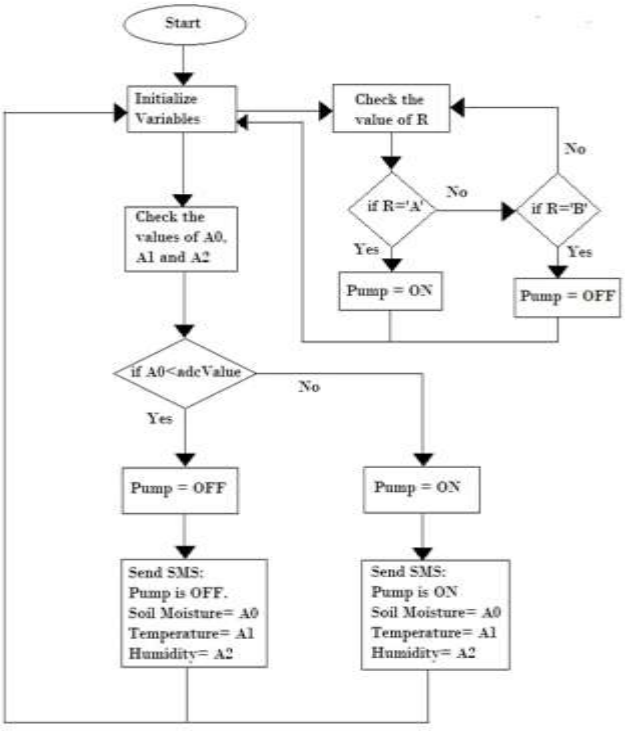

Fig. 2 Flowchart

4. Sensors

Two Sensors have been used in this paper:

4.1 Soil Moisture Sensor

The soil moisture sensor or the hygrometer is usually used to detect the humidity of the soil. So, it is perfect to build an automatic watering system or to monitor the soil moisture of your plants. The sensor is set up by two pieces: the electronic board (at the right), and the probe with two pads, that detects the water content (at the left). The sensor has a built-in potentiometer for sensitivity adjustment of the digital output (D0), a power LED and a digital output LED.

4.2 Humidity and Temperature Sensor

The DHT11 humidity and temperature sensor makes it really easy to add humidity and temperature data. It's perfect for remote weather stations, home environmental control systems, and farm or garden monitoring systems. The DHT11 measures relative humidity. Relative humidity is the amount of water vapor in air vs. the saturation point of water vapor in air. At the saturation point, water vapor starts to condense and accumulate on surfaces forming dew. The saturation point changes with air temperature. Cold air can hold less water vapor before it becomes saturated, and hot air can hold more water vapor before it becomes saturated.

5.Pump Technologies

There are three main pumps used in rural water pumping applications: centrifugal, helical rotor and diaphragm. Each of these pump technologies has different pumping characteristics which means they are suitable for different applications A centrifugal pump can deliver higher flow at a lower head. These pumps are most efficient when run at their rated operating voltage. A helical rotor pump can deliver lower flow at a higher head. This type of pump is efficient at a range of operating voltages, making it a pump type well suited to solar PV-powered pumping.

A diaphragm pump can deliver lower flow at a lower head. These pumps are generally not damaged by solids or by dry running. Pumps are most efficient when run at their rated operating voltage. A helical rotor pump can deliver lower flow at a higher head. This type of pump flows at a range of operating voltages, making it a pump type well suited to solar PV-powered pumping. A diaphragm pump can deliver lower flow at a lower head. These pumps are generally not damaged by solids or by dry running.

6.Conclusions

The proposed system is beneficial to the farmers when this system is implemented. And also useful to the government with solar panel energy, helping in tackling solution for energy crisis is problem. When the soil needs water, it is indicated by the sensor by this automatic irrigation system which is implemented. According to the sensors and GSM feature and commands by farmer, the irrigation system detects the moisture level of the crop. For example, Wheat, Paddy, Sugarcane crops moisture content of soil is detected and irrigated automatically. Automatic irrigation system is used to optimize the usage of water by reducing wastage and reduces the human work. The energy needed to the water pump and controlling system is given by solar panel. Solar panels which are small grid that can produce excess energy. By using solar energy, it reduces the energy crisis problem. The system requires minimal maintenance and attention because they are self-starting. To further enhance the daily pumping rates, tracking arrays can be implemented. This system demonstrates the feasibility and application of using solar PV to provide energy for the pumping requirements for sprinkler irrigation. Even though this system requires more investment but it solves more irrigation problem after long run of this system.

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