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Energy Efficient Solar Powered Automatic Irrigation System

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ABSTRACT

Irrigation is one of the major requirements of agriculture which requires abundant electric power. Indian farmers are facing a massive problem due to frequent power failures. Solar powered automatic irrigation system can be a suitable alternative for farmers in the present state of energy crisis. This paper proposes an automatic smart irrigation system which uses solar power for irrigation. Solar powered water pump operates automatically based on different soil parameters like Moisture and Temperature. Hence ensures efficient irrigation as it uses solar energy simultaneously whenever a power failure occurs.

Keywords-- Agricultural Soil Parameters, Automatic Irrigation System, Power Switching, GSM based irrigation

I. INTRODUCTION

The projected population of India being 1500 million by 2050 and agriculture remaining as the primary source of livelihood in rural areas, the focus should be on the increase of productivity[1].The motivation of this project has come from the countries where economy is based on agriculture and the climatic conditions lead to insufficient rainfall and scarcity of water. The increasing demand of the food supplies requires a rapid improvement in food production technology. In many countries where agriculture plays an important part in shaping up the economy and climatic conditions are isotropic, but still we are not able to make much benefit out of agricultural resources.

One of the main reasons is the lack of rains and scarcity of land reservoir water. Extraction of water at regular intervals from the earth is reducing the water level and as a result of which the zones of un-irrigated lands are gradually increasing. The farmers working in the farm lands are solely dependent on the rains and bore wells for irrigation of the land. Even if the farm land has a water pump, manual intervention by farmers is required to turn the pump on/off whenever needed. In general the farmers have been using irrigation technique through the manual control in which the farmers irrigate the land at regular intervals by turning the water pump on/off when required[4]. Also, the unplanned use of water inadvertently results in wastage of water.

This process sometimes consumes more water and sometimes the water supply to the land is delayed due to which the crops dry out. Water deficiency deteriorates plants growth before visible wilting occurs. In addition to this slowed growth rate, lighter weight fruit follows water deficiency. This problem can be perfectly rectified if we use automated irrigation system in which the irrigation will take place only when there will be intense requirement of water, as suggested by the moisture in the soil. The most significant advantage of an automated irrigation system is that water is supplied only when the moisture in soil is identified low. This can save lot of water.

Solar energy is the most abundant source of energy in the world. Solar power is not only an answer to today's energy crisis but also an environmental friendly form of energy. Photovoltaic generation is an efficient approach for using the solar energy. Solar panels (an array of photovoltaic cells) are now-a-days extensively used for running street lights, for powering water heaters and to meet domestic loads. The cost of solar panels has been constantly decreasing which encourages its usage in various sectors. One of the applications of this technology is used in irrigation systems for farming. Solar powered irrigation system can be a suitable alternative for farmers in the present state of energy crisis in India. This green way for energy production which provides free energy once an initial investment is made [2].

II. SOLAR POWER GENERATION

We propose an automatic irrigation system using solar power which drives water pumps to pump water from reservoir to field and it is automatically controlled by using microcontroller and moisture sensor to control the flow rate of water from the tank to the irrigation field which optimizes the use of water. Generally total setup works on the AC supply which is received from the power grid. But

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when the power failure occurs, the total setup works on solar power which it is stored in the battery. An inverter is used to supply continuous AC power to the total setup even in the case of power failure.

The objective of the system is to

- Conserve energy & water resources
- Manual and automatic irrigation system
- Efficient power utilization
- Enhance crop productivity

Solar power is the cleanest, most reliable form of renewable energy available, and it can be used in several forms to help power your home or farm. Solar-powered photovoltaic (PV) panels convert the sun rays into electricity as given in figure1. Low -carbon technology has assured harmless solar power generation [3].

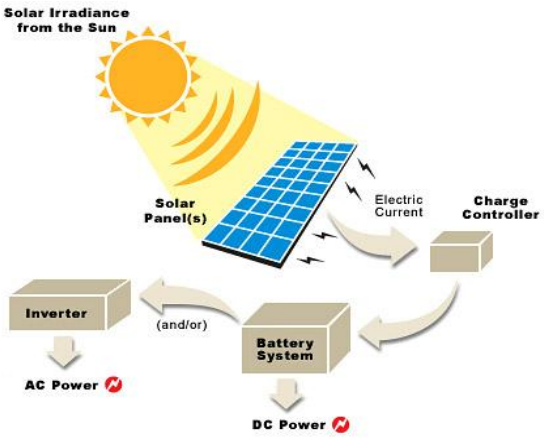

Figure1 .solar power generation

III. EXISTING MICRO IRRIGATION METHODS

The two main micro irrigation systems are shown in figure2&3 .

A) Drip Irrigation

B) Sprinkler Irrigation

Micro irrigation methods are precision methods which have high water efficiency. In many parts of the country there is decline of irrigation water and conventional methods uses large quantity of water. A micro irrigation method reduces water wastage and increases the crop productivity [2].

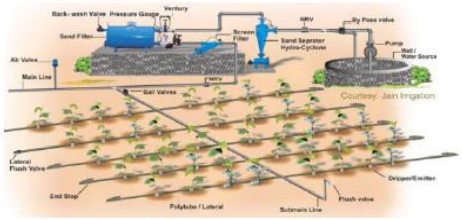

Figure2. Layout of drip irrigation

Figure3. Sprinkler Irrigation

IV. SWITCHING BETWEEN GRID POWER AND THE SOLAR POWER

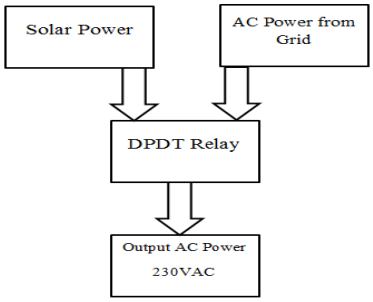

Figure4. Block diagram of power switching

The block diagram of power switching is given in figure4 that shows the technique of switching between two power sources using a DPDT (double pole double throw) relay [6].

AUTOMATIC IRRIGATION SYSTEM

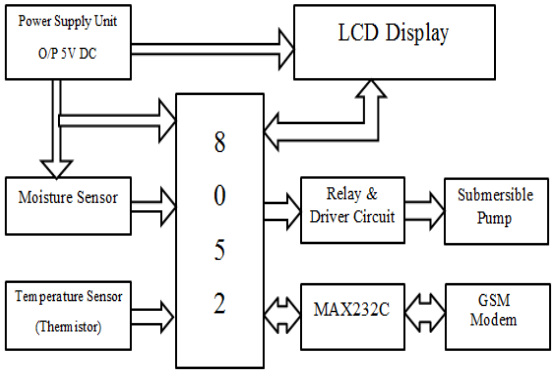

Figure5. Block diagram of automatic irrigation system

The automatic irrigation system shown in figure5 uses Atmel AT89C52 which is a powerful microcomputer that provides a highly-flexible and cost-effective solution to many embedded control applications. The major inputs to the system are moisture of the soil and temperature. Based on the input conditions the controller will drive a submersible pump through a relay and driver circuit. Based

on cost comparison of AC and DC loads it indicate that, for renewable energy powered small scale irrigation systems, AC pumps leads to uneconomic results and excess generation. On other hand, DC pumps prove to be economic and reliable.[5]

A GSM module is used to send the information to the former via SMS. GSM/GPRS RS232 Modem is built with SIMCOM Make SIM900 Quad-band GSM/GPRS engine, works on frequencies 850 MHz, 900 MHz, 1800 MHz and 1900 MHz it is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with RS232 Level converter circuitry, which allows you to directly interface PC Serial port .The baud rate can be configurable from 9600-115200 through AT command. Initially Modem is in Auto baud mode. This GSM/GPRS RS232 Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS as well as DATA transfer application in M2M interface.

A two line X 16 character general purpose alpha numeric LCD display is used to display the information. The 8-bit data pins, D0-D7, are used to send information to the LCD or read the contents of the LCD's internal registers. To display letters and numbers, we must send ASCII codes for the letters A-Z, and number 0 -9 to these pins while making RS=1 [9].The Power Supply is a Primary requirement for the project. The required DC power supply for the base unit as well as for the recharging unit is derived from the mains line. For this purpose center tapped secondary of 12V-012V transformer is used. From this transformer 5V DC is extracted. Output is further regulated using 7805 positive voltage regulator. This is a 3 Pin voltage regulator that can deliver current up to 800 mille Amperes.

MOISTURE SENSOR

The health of the crop is influenced by many factors; Vegetation and crops always depend on the moisture available at root level than on precipitation occurrence. Grid-like resistance type sensors shown in figure6 are used to sense the moisture on vegetation from 0% (dry) to 100% (wet) [7]. The sensor is placed in the soil as given in figure9. The total setup of automatic irrigation system is given in figure 8.

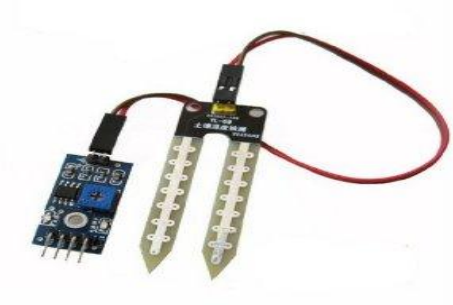

Figure6. Soil Moisture Sensor

TEMPERATURE SENSOR

Temperature of the field is sensed by a Thermistor shown in figure7. Thermistors typically achieve a greater precision within a limited temperature range, typically −90 °C to 130 °C.

Figure7. Thermistor type Temperature sensor

SETUP OF SOLAR POWERED AUTOMATIC IRRIGATION SYSTEM

Figure8. Setup of Solar powered automatic irrigation system

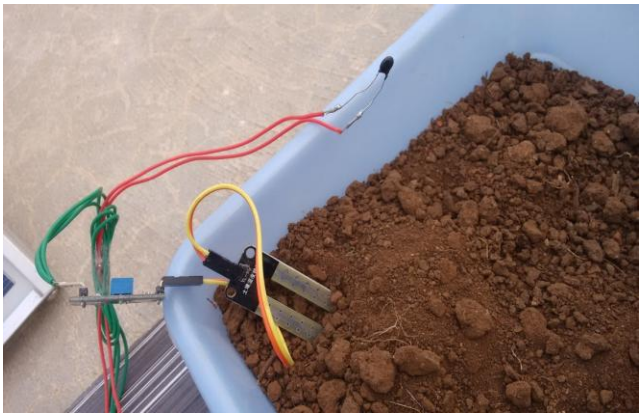

Figure9. Soil moisture and temperature sensors

V. RESULTS AND COST ANALYSIS

Component	Unit Cost in Rs/-	Quantity	Total Cost in Rs/-
Solar Panel(300Watts)	10000	8	80000
Battery 24V,100Ah	8250	1	8250
Controller and Inverter	19700	1	19700
Automatic Irrigation Module	2000	1	2000
		Overall Cost	1,09,950/-

Table1. Cost analysis of the solar powered automatic irrigation system

With over nine hundred thousand tube wells being used in every state of India, around Rs.18 Million of energy is used for pumping water for irrigation. This amount of money used for electricity can be saved with the help of solar water pump. Annually the cost of nearly five million kilo watt hour of energy can be spared. That is around Rs.27 Million per annum can be redeemed which comes around 40% of the total amount of investment. Even though the initial investment is high, it can be earned back in two and a half years of time. If we assume the cost of power is Rs.1.5 Million per kilo watt hour, Rs.18 Million is used for pumping water alone in a year. By using the solar water pump, we can save up to 4.8 million KWh of energy annually which saves a lot of energy. The excess energy can also be given to the grid with small modifications and investments in the circuit, which can add to the revenue of the farmer. The cost analysis of the solar powered automatic irrigation system is given in Table1.

VI. CONCLUSION

By implementing the proposed system there are various benefits to both the government and the farmers. This can be a solution for the government in the present state of energy crisis. By using the automatic irrigation system one can optimizes the usage of water by reducing wastage and reduces the human intervention. The excess energy produced using solar panels can also be given to the grid with small modifications in the circuit, which can be a source of the revenue of the farmer, thus encouraging farming in India and same time giving a solution for energy crisis. Proposed system is easy to implement and environment friendly solution for irrigating fields. The system was found to be successful when implemented for bore holes as they pump over the whole day. Solar pumps also offer clean solutions with no danger of borehole contamination. The system requires minimal maintenance and attention as they are self-starting. GSM Modem is also implemented to get status of motor to the former by an SMS. Even though there is a high capital investment required for this system to be implemented, the overall benefits are high and in long run this system is economical.

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