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Review Paper

Solar powered smart irrigation system-an innovative concept

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Abstract

Irrigation is one of the important process in agricultural system. Generally it is dependent on rain but after introduction of pressurized irrigation system the dependency of rain is decreased day by day. The pressurized irrigation system is controlled manually by the farmers. Manually operated system requires extra manpower for supervising therefore it decreases the field efficiency. Sometimes this irrigation leads to over irrigation than the actual plant requirement and under irrigation when plants required more water in their peak periods. Which result slow crop growth rate, late flowering and reduction of the yield are the major concern due to water deficiency. Moreover, excess irrigation in the root zones leads to ill health of the root zones and vegetation, additional cost for farmer, wastage of time and water. Also salinity of the land can be increased by unbroken stretch supply of more than enough water. On the other hand electricity supply is the major concern in remote areas. Farmers are not getting regular supply of electricity for agriculture operations. Hence this paper introduces a new approach for solar powered smart irrigation system (SIS) in agricultural management using soil moisture sensor. Based on the sensed data, system automatically decided about the necessary action for irrigation and also notifies the user. The system also focused on the use of solar energy utilization by the sensors during communication. The paper discussed the working mechanism and component details of system.

Keywords: Solar energy, Soil moisture sensor, Irrigation system, Microcontroller.

Introduction

A proper technique is to be required for the irrigation process because of uncertainty of rain and scarcity of water in land. The water level of the soil always influences agriculture. The production of agriculture produce is directly proportional to the water level and quality of soil. Moisture level of soil is reducing day by day because of continuous withdrawal of water from soil to avoid this problem there is a need to planned proper irrigation system. Inappropriate use of water leads to wastage of large amount of water. On the other hand energy is also a major concern in India. It is reported that total annual energy consumption is 168913 Giga Watt Hours (GWh) in agriculture sector in 2014-15 which is 17.81% of total electricity consumption[1]. It is required to develop a SIS using moisture sensor and solar energy which provide the accurate amount of water according to the requirement of field. The proposed system is operated by using sunlight through photovoltaic cells. This system consists of soil moisture sensors which are installed under the soil to detect the moisture whether the soil is dry or wet. A microcontroller is a heart of the unit which controls the whole system. The relay unit is connected to the motor and received signal from the soil moisture sensor when the moisture level in the soil goes down. The motor will ON automatically in dry state and switch off when the soil is under wet state. The moisture level of soil is detected by the sensor installed under the soil which sends signal to electronic decision making unit microcontroller whether agriculture field needs water or not. The signal from the sensor received through the output of the comparator and it is preceded with instruction from the program stored in the microcontroller[2]. When the soil is in dry state motor gets ON automatically and in wet state motor is OF when moisture reached at its preset value. This condition of motor ON and OFF is displayed on a LCD. The whole system is totally using the renewable source of energy by using solar photovoltaic cells. This cells coverts sunlight into electricity which can be used directly of can be stored in battery. The electricity is used to run electric devices.

There are two major components one is soil moisture sensor and other is solar energy, maintained the irrigation in the field. If the required level of water is not provided then the plant will die and results in low production[3]. Hence there is a need to provide exact amount of water to the right place. This can be achieved by soil moisture sensor. The moisture sensor is used to provide proper irrigation according to crop requirement. By the use of soil moisture farmer can provide optimum water to their crop which increase production as well as quality of crop.

Existing System

In India, agriculture field is irrigated by manually in most of the cases. This system is time consuming and required lots of labor

for observing the health and productivity of crop. This system is much more costly than automatic system when considering the labor's salary. The farmer himself has to check the wet level of the land and has to make a Judgment whether the field has need of water or not. This way of carefully looking at the wet level is not accurate and this drawback can be eliminated by using soil moisture sensor which is been used in our architecture.

Working of System

The proposed system having two working units: one is solar pumping unit and other is smart irrigation unit. The solar pumping unit is utilizing the solar energy to operate the pump. The solar energy is converted into electric energy with photovoltaic cells which are installed near the pump set. A controller circuit is designed for controlling the batteries.

On the other hand smart irrigation unit is equipped with electronically controlled solenoid valve. This valve regulated by soil moisture sensing unit and used to control the flow of water. The sensors indicate moisture in terms of voltage. This voltage signal is send to sensing unit and is compared to the reference voltage which can be set by the farmer according to the crop requirement. The difference of these voltages is directly proportional to the water requirement. Then the sensing unit is given signal to the motor whose revolving angle is dependent to the difference in voltage. The motor controls the flow rate of water through solenoid valves. Hence, the moisture difference is proportional to the amount of water flowing in the field. The microcontroller is further connected to Global System for Mobile Communication (GSMC) which is used to send SMS to the user for real time monitoring from remote location[4].

If the moisture value is less than the preset value then the system will automatically open the solenoid valves. The solenoid valves in the pipe will open for prescribed time and then automatically closed. As the entire system will be triggered for every 1 hour, it is more sufficient for a plant to maintain the moisture required for it.

Likewise the water level sensor in the tank will screen the water level inside the tank and in the event that it is lower than the fundamental parameter, the system will begin the motor to pump the water from the well. For every one of the occasions, the data about the status of the water level, motor on/off, moisture level is communicated to the client through SMS. Since all the nodes are powered by solar energy from the solar panel, the system will reduce the energy supply problem also.

The flowchart will explain the complete process of the system. The system is designed in such a way to minimize the cost of communication between sensors (Figure-3).

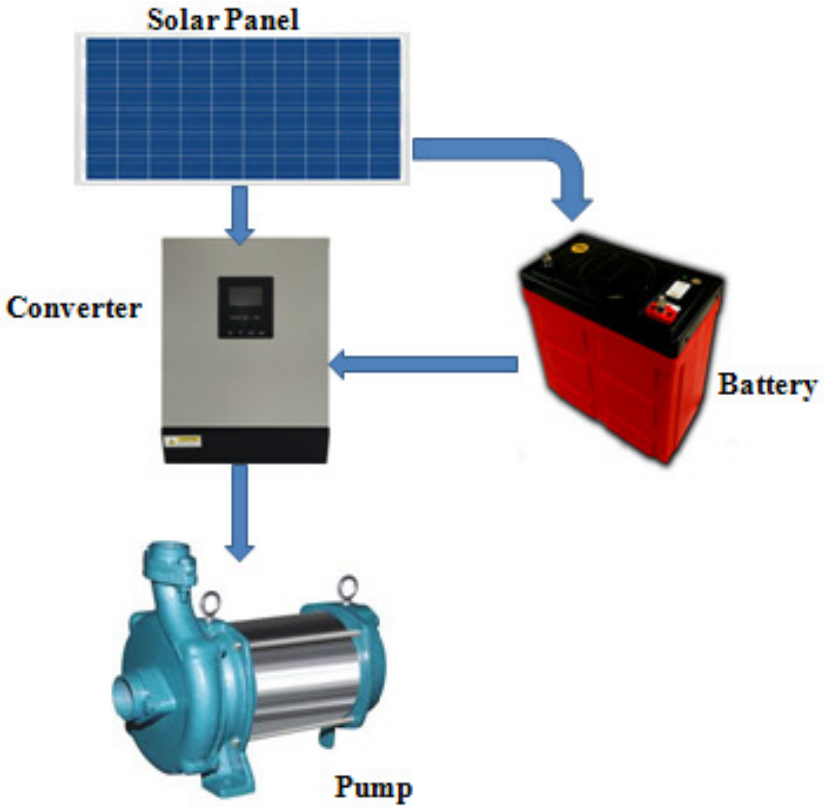

Figure-1: Layout of solar pumping unit.

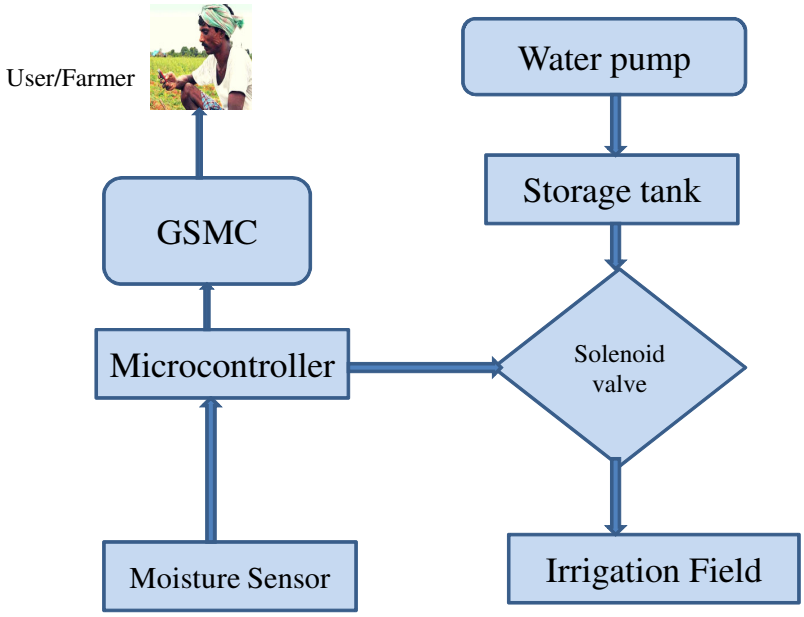

Figure-2: Layout of Smart irrigation unit.

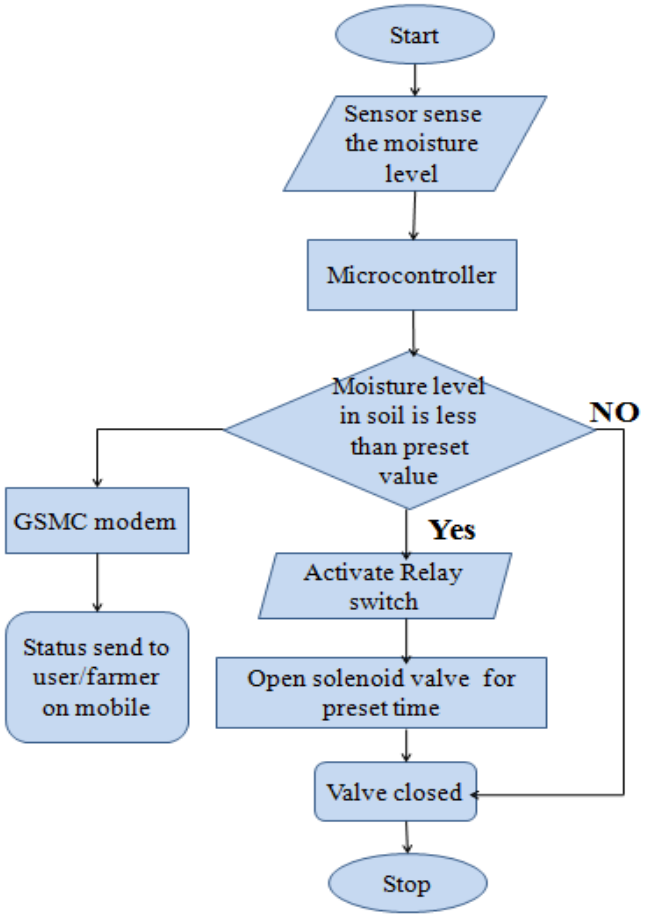

Figure-3: Flow diagram of the proposed system.

Components

Solar photovoltaic panel: Solar panel is an assembly of photovoltaic (PV) cells electrically connected and mounted on a supporting structure. Photovoltaic (PV) cells are made of uncommon materials called semiconductors for example silicon. Fundamentally, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. The electricity generated by the semiconductor is called direct current (DC) and can be used immediately or stored in a battery.

Battery: Electrical batteries are blend of one or more electrochemical cells, used to transfer chemical energy into electrical energy. In this proposed system, batteries are used for storage of electricity produced by solar panels. The stored energy further used for operation of the irrigation system.

GSMC (Global System for Mobile Communication): The GSMC is used for sending a SMS about pump status to farmer / user. Global system for mobile communication (GSMC) is a globally accepted standard for digital cellular communication. A GSM modem can be an external modem device. Insert a GSMC SIM card into this modem, and connect the modem to an available serial port.

Soil moisture sensor: Soil moisture sensor is used to measure the soil moisture in proposed system. A low cost soil moisture sensor[5] is installed under the ground at particular depth. The moisture sensor just senses the moisture of the soil. The change in moisture will be observed by amount of current flowing through soil. These sensors required very low power and having high resolution. This gives the capacity to make numerous estimations (i.e. hourly) over a drawn out stretch of time with insignificant battery utilization.

Relay: It is electromagnetic switch use to control the electrical devices. In our proposed system, two relays are used for switching. One relay is used for switching between microcontroller and GSM and another relay is used for switching between microcontroller and RF. Relay is acts as transmitter. Most of the relay uses an electromagnet to activate a switching mechanism mechanically.

Solenoid valve: A solenoid valve is an electromechanical device which is mostly used with fluid or gas. The valve is operated by an electric current through a solenoid coil. In this system solenoid valves are used to control the flow of water. Solenoid valves may have at least two ports: on account of a two-port valve the flow is turned on or off; on account of a three-port valve, the outflow is exchanged between the two outlet ports. Solenoid valves are the most as often as possible utilized control components in fluidics. Their jobs are to release, distribute shut off, or mix fluids. Solenoids is the best option for quick and safe switching, long life, high unwavering quality, great medium similarity of the materials utilized, low control power and compact design.

Microcontroller: Microcontroller is the heart of this system. Every sensor has to send signal to the microcontroller. Then the microcontroller has to take decision according to the situation. ARM-LPC2148 is commonly used IC from ARM -7 family. It is pre loaded with many programmes and manufactured by Phillips. It is useful option for beginners and as well as high end application developer.

Advantages of the system: i. Reduce the wastage of water and also control the flow of water by continuously monitoring the status of soil. ii. Conservation of water and labor: Since the systems are automatic, they do not require continuous monitoring by labor. iii. This system eliminate excess irrigation, under irrigation, top soil erosion and reduce the wastage of water. iv. The main benefit of this system is that it can be customize according to the situation (crops, weather conditions, soil etc.). v. This system will be implemented in agricultural, horticultural lands, parks, gardens, golf courses for irrigation. vi. This system uses natural source of energy and also it is pollution free.

Conclusion

This innovative smart irrigation system (SIS) is very beneficial for government as well as farmers. This is one of the best solution for energy crisis and water consumption. The smart irrigation system reduces the human intervention during the irrigation of field and also optimizes the water usages. Once the system is installed, unutilized energy produced by the solar PV can also be linked with grid system which can be revenue source for farmers. Hence, SIS is motivating farming in India and at the same time it is giving solution for the energy crisis. Despite the fact that it required high initial investment for implementation of SIS but in the long run this system is more economical than the conventional irrigation method. Government should also demonstrate this type of innovative system to motivate the farmers for adopting such type of system.

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