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Design and development of solar based sensor networks for irrigation system

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ABSTRACT

Irrigation is one of the most powerful sources in India but it is hard for an individual person to monitor continuously and regularly. In order to make this irrigation easier our system comprises some changes in the usual irrigation system. Either power supply or long-distance cable is hardly available within field scale. For the necessity of monitoring soil water dynamics at field scale, this study presents a wireless soil moisture sensor based on the impedance transform of the frequency domain. The sensor system is powered by solar energy, and the data can be instantly transmitted by wireless communication.

I.INTRODUCTION

Soil water content plays an important role in governing crop growth and yield. In today's world most of the water is used for the irrigation system. In order to minimize this, a system has to be developed to perform irrigation automatically which acts dynamically upon the weather conditions. This system mainly concentrates on the conservation of the water resources by watering the crops whenever it is needed and it is made through moisture sensor in the fields. This paper concerns the irrigation system which reduces the wastage of water and to avoid the pesticide in the crops. In this study, we developed a soil moisture sensor that does not require external cables but rather uses a solar battery for power supply and a wireless module for data transmission, and then a field evaluation was conducted. The manuscript includes, firstly, the description of the electrical methods that are used to determine soil water content for sensor system. Moreover, the description experiments to illustrate the calibration equation of water content sensor in the designed sensor system. Subsequently, the obtained results in the cited experiments are discussed. Finally, some conclusions about the experiments and the possibilities of the employment of this device for irrigation management are added.

II.PROPOSED METHODOLOGY

To make the irrigation system simpler, the complexities involved in irrigation is tackled with automation system using microcontroller and GSM. The various environmental parameters such as soil temperature, soil moisture, relative humidity are monitored using the field. The GSM sends a MSG to the farmer, when these parameters exceed the set value defined in the program. The proposed system includes a sensor network 16F877A microcontroller, a relay, GSM, LCD display.

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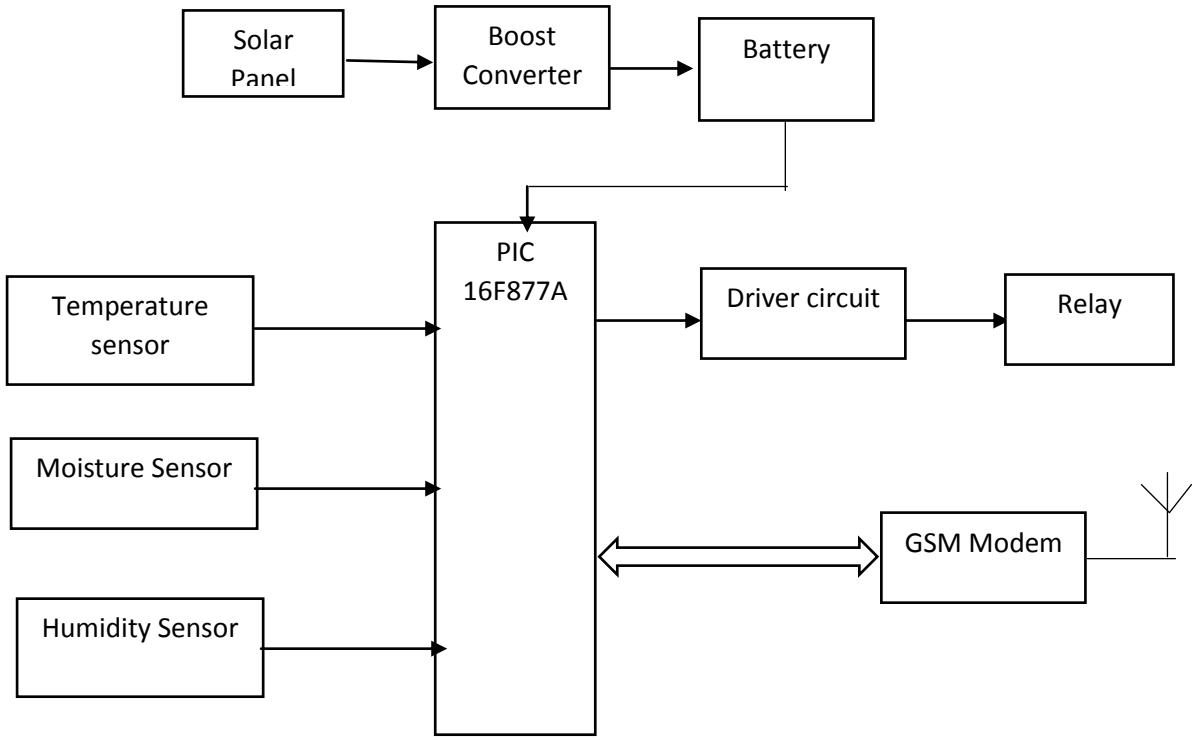

Figure 1 Block Diagram of Solar Irrigation System

III.SOIL MOISTURE SENSOR

Normally sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer/instrument. In this paper, we proposed a model of designing sensor as presented in figure 2. Two metal plates such as A and B are used to form a sensor; at where 5V Dc power is attached with plate A, and plate B is connected with a microcontroller. Normally plate A and plate B are isolated from each other and voltage signal passes to the microcontroller. When the water fills the gap, the metal plates A and B gets connection and voltage signal passes to the microcontroller.

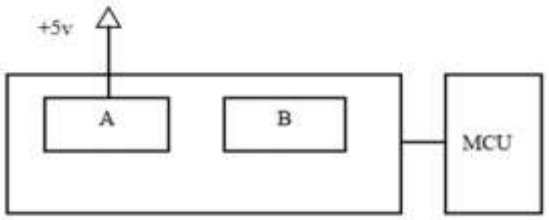

Figure 2. Soil Moisture Sensor

According to our design model, if the water level reaches to 0%, the microcontroller will automatically start the motor through relay switch according to the command of the microcontroller pin. The farmer will be confirmed by a message.

IV.SOLAR PANEL

The project utilizes an 18W, 12V Solar Panel to charge the battery. The panel is connected to the 12V battery via a relay. The relay cuts off the supply from the panel when the battery charge monitoring system measures an overcharged level. The project utilizes an 18W, 12V Solar Panel to charge the battery. The panel is connected to the 12V battery via a relay.

V.BATTERY

Electrical storage batteries are commonly used in PV system. The primary Functions of a storage battery in a PV system are: 1) Energy Storage Capacity and Autonomy: to store electrical energy when it is produced bythe PV array and to supply energy to electrical loads as needed or on demand. 2) Voltage and Current Stabilization: to supply power to electrical loads at stable voltagesand currents, by suppressing or smoothing out transients that may occur in PV system. 3) Supply Surge Currents: to supply surge or high peak operating currents to electrical loadsor appliances we have selected 12v 80AH lead acid battery. Since the lead acid battery withstand against the variable amount of current

VI.RELAY

The 12 V solid state relay is used. When the controller scans the high data through the input channel; it sends the high signal to relay to switch ON 230 V ac supply voltage.Relay switch is operated by the microcontroller and used to control the motor. The motor will remain switched ON until the water level reaches to the secured level i.e. 100%. When thesensors sense the water level is above 100%, microcontroller will make the motor to be switched OFF; as it is receiving the status of water level from the sensors. At the secure level (100%) the microcontroller will not operate. However, if thewater level goes down to mid-level (30%) the sensors willsend a signal to the microcontroller. After receiving the signal themicrocontroller will send a message (for example, WATER LEVEL LOW) to the user's cell phone through the GSM interface.

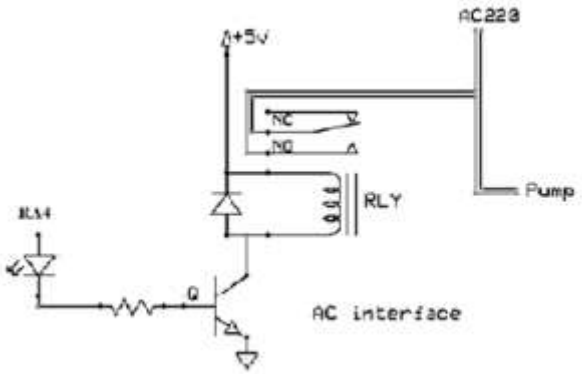

Figure 3 Relay

VII.GSM

A GSM modem is a wireless modem that works with a GSM wireless network. Computers use AT commands to control modems. Both GSM modems and dial-up modemssupport a common set of standard AT commands. So we can use a GSM modem just like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. GSM is one of the most vital components in our set up since all the communication between the users and centralized unit takes place through this modem. An external GSM modem is connected to a computer through a serial cable or a USB cable. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. The current status of the soil will be send to the farmer as SMS.

VIII.TEMPERATURE SENSOR

The TMP36 is a low voltage, precision centigrade temperature sensor. It provides a voltage output that is linearly proportional to the Celsius temperature. It also doesn't require any external calibration to provide typical accuracies of ±1°C at +25°C and ±2°C over the −40°C to +125°C temperature range. We like it because it's so easy to use: Just give the device a ground and 2.7 to 5.5 VDC and read the voltage on the Vout pin. The output voltage can be converted to temperature easily using the scale factor of 10 mV/°C.

IX.HUMIDITY SENSOR

A humidity sensor (or hygrometer) senses, measures and reports both moisture and air temperature. The ratio of moisture in the air to the highest amount of moisture at a particular air temperature is called relative humidity. Relative humidity becomes an important factor, when looking for comfort.

Figure 4. Humidity Sensor

Humidity sensors work by detecting changes that alter electrical currents or temperature in the air. There are three basic types of humidity sensors: capacitive, resistive and thermal. All three types of sensors monitor minute changes in the atmosphere in order to calculate the humidity in the air.

Capacitive: A capacitive humidity sensor measures relative humidity by placing a thin strip of metal oxide between two electrodes. The metal oxide's electrical capacity changes with the atmosphere's relative humidity. Weather, commercial and industries are the major application areas.

Resistive: Resistive humidity sensors utilize ions in salts to measure the electrical impedance of atoms. As humidity changes, so does the resistance of the electrodes on either side of the salt medium.

Thermal: Two thermal sensors conduct electricity based upon the humidity of the surrounding air. One sensor is encased in dry nitrogen while the other measures ambient air. The difference between the two measures the humidity.

X.SOIL MOISTURE SENSORS

Soil moisture sensors measure the volumetric water content in soil.Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensingin hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

Figure 5. Soil moisture sensors

XI.RESULTS

Various experimental tests showed that the system was able to function as expected and observed that the sensitivity of sensor was affected by temperature during checking of soil moisture level to determine watering.This somehow resulted in variations in the measured moisture values at different times from the set moisture values to trigger watering. 80% out of10 trials were successful in responding correctly. Similarly, the pump shut-down mechanism was depend largely on the soil moisture values, small deviations in the measured values affects the control algorithm leading to the auto-stop not to respond when the tolerable moisture level was attained.The system also showed a success rate of 80% out of 10 trials using SMS to change the control parameter for operation, set system operational conditions, and modify user records. One challenge encountered during the testing is the duration of the back-up battery power supply. Since power supply is very critical to the smooth operation of the controller system, it is important that the battery power source should be able to serve the system for a long time so as to provide the user with field records even though unavailability of the main power source will render the irrigation pump non-functional.

XII.CONCLUSION

In this project automatic controlling of solar pump sets and SMS alert has been discussed fruitfully. The overall idea is that users to take advantage of the globally deployed GSM networks with its low SMS service cost to use mobile phones and simple SMS commands to manage their irrigation system.To demonstrate the functionality and performance of the controller system, the prototype was implemented and tested. Results showed that it will be possible for users to use SMS to monitor directly the conditions of their farmland, schedule the water needs for crops, automatic control of water and set control operational conditions in accordance with the water needs of crops. This will help to minimize over water in gand crop production cost. Further, it will help users to take advantage of the prevailing GSM networks to provide value added services.

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