Effective Smart Irrigation Control System using IoT

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Abstract— The proposed system focus on a smart irrigation system which is cost effective and farmers can use it in their farm field. Automation not only allows us to control appliances automatic control but also provide comfort and reduces energy, efficiency and time saving. In last few years, the remotely monitored embedded system which is used for irrigation purposes have become a new necessity for farmer to save his energy, time and money. So here we design a protocol for smart irrigation technology in low cost which is usable by farmers and implementable in farm. This system controls the water motor remotely and checks the status of the farm through various sensors like soil moisture, water level indicator. The main objective is to apply the system for maintaining the quality of the soil and hence the health of the plant through multiple sensors and save electricity. Finally the sensed information of the farm field is displayed on the android app of the user. This approach provides real-time information about the lands and crops which is useful for farmers to make right decisions. By using the basic principles of WSN and the internet of things (IOT) technology is explained in detail especially on the hardware architecture, network architecture and the software process control of the precision irrigation system. The microcontroller monitors data from the sensors and activates the control devices based on threshold value. This project is proposing a complete agricultural solution for the farmer based on Wireless network.

Key words: Android App, AVR Microcontroller, Humidity Sensor, Human Detector, Soil Moisture Sensor, Water Level Sensor

I. Introduction

India being an agrarian country about 70% of Indian economy is from agriculture. Many problems are faced by farmers. Among those is scarcity of water, unavailability of labor, uncertainty of electricity. This system tends to solve this problem by using smart precision irrigation technique. This system tries to introduce automation into lives of farmers whose world is currently isolated from technology. Water management is done by irrigating farm only when it is required. It is done using soil moisture sensor which are implanted on field at various places forming a grid structure. These sensors continuously transmit sensed information to server which is then passed onto user's smart phone. Where it is compared with already set threshold value of water level content in soil for the value different than threshold value, farmer can directly switch ON/OFF the motor pump accordingly through smart phone. Availability of electricity will also be notified in real time to user/farmer.

As the existing system consist of missed-call based system handling of motor pump, this system will eliminate the missed-call and it will work through android app. 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 the climatic conditions are isotropic, but still we are not able to make full use of agricultural resources. One of the main reason is the less rain scarcity of land water reservoir. Extraction of water at regular intervals from earth is reducing the water level as a result of which the zones of un-irrigated land are gradually increasing. Also, the unplanned use of water inadvertently results in wastage of water. In an Automated Irrigation System the most significant advantage is that water is supplied only when the moisture in soil goes below a preset threshold value. This saves lots of water. In recent times, the farmers have been using irrigation technique in which the farmers irrigated manually the land at regular intervals by turning the water-pump on/off when required. 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.

II. Literature Survey

Lianjie Zhou et. al. [1] implemented system for Data storage limitation, Efficient Query Processing owing to less computational ability and Server Failure need to be tackled with. Cloud computing technology, NoSQL and distributed database cluster technology may provide new approaches to solve these future problems for Precision Agriculture. The inversion of remote sensing images is crucial task for mapping of soil moisture in precision agriculture. However, the large size of remote sensing images complicates their management. Therefore a remote sensing enhances remote sensing observation storage, processing, and service capability.

A N Arvindan [2] implemented the UI in the Android Smartphone allows the user easy remote control of the irrigation drive system that involves switching, on and off, of the drive motor based on commands from the android smart phone. The soil moisture data is retrieved and displayed on the smart phone screen. Depending upon the moisture value the user decides to switch the motor ON or OFF.

Dr. K. S. Vijula et. al. [3] presented the GSM based Precision Irrigation system using ARM controller. The moisture content is sensed using moisture sensor and it is given to the ARM controller which controls the entire system. The ARM controller gives a pulse to the GSM module which is used here as a communication interfacing unit, here the GSM technology helps in send and receive the information which the user send or receive. When the soil moisture level is greater than threshold value the system automatically turn off the motor pump and at the same time it also inform the user though the another message ''Motor Pump OFF'' without delay.

Oborkhale Lawrence et. al. [4] implemented An automated irrigation system has important advantages over some other manual methods which are used by the local farmers, it ensures the more precise application and conservation of water, high crop yield as well as the removal of human errors. The current trend in irrigation is to shift from manually operated type of irrigation to automated types. Hence, the parameters that influence irrigation control are Temperature of the environment, soil moisture content, light and source of water.

Pandurang H. Tarange [5] implemented system based on MySQL which is the relational database management system (RDBMS). It is open source software. Database stores the soil parameter information send by a sensor node in it with time. It provides the information to the web page for monitoring the system remotely.

Chandankumar Sahu et. al. [6] implemented the system in which RASPBERRY-Pi is used for control the irrigation system and connects with internet to send data to the registered mobile number. Automatic message sending is developed using python programming in raspberry-pi. By using the automatic irrigation system it optimizes the usage of water by reducing wastage and reduces the human intervention for farmers. It saves energy also as it automatic controlling the system. Automation in irrigation system makes farmer work much easier. Sensor based automated irrigation system provides promising solution to farmers where presence of farmer in field is not compulsory.

Ibrahim Mat et. al. [7] presented a system based on WSN which is a distributed sensor network to monitor physical or environmental conditions, such as temperature, humidity and moisture to cooperatively pass their data through the network to a main location. These networks are bi-directional and also al low control of sensor activity. The WSN is built of nodes which consist of a few to several hundreds or even thousands, where each node is connected to one or several sensors.

Prachi Patil [8] implemented the Real time automation system for agricultural environment", using PIC16F877A and GSM SIM300 modem is focused on automating the irrigation system for social welfare of Indian agricultural system.

Sabrine Khriji [9] implemented system using AVR microcontroller which is much faster than PIC. Use of multiple sensors as a device to control water quantity in irrigation system in real-time is done here. The design of the device is chosen because of its features that fulfil the requirement for low-power consumption, low cost, water's waste reduced, manpower reduced and reliable data communication between sensors nodes.

Pulkit Hanswal et. al. [10] presented system in which Soil moisture sensors situated at farms which controls the amount of water required for irrigation, which is different for different crops. Accordingly the threshold value of sensors is set. Water management is achieved with the help of protective duty. When there is shortage of water, the principle of water duty is applied, whereby the irrigation intensity is less than 100%. This is done by taking into account only some of the soil moisture sensors employed under the farm. Thus farmers can irrigate only a part of their farm due to limited availability of water. It hence provides equal distribution of scarce means and Prevention of acute famine.

III. IMPORTANCE OF IRRIGATION

The 70-80% rainfall in INDIA of the total annual rainfall occurs in four months, i.e. from June to October. The proper irrigation is very important to farm field during the rest of the eight months, because rainfall of our country depends on monsoons. Rainfall controls agriculture, as the monsoon rainfall is uncertain, irregular and uneven or unequal so the agriculture is said to be "the gambling of the monsoon". So irrigation is essential for agriculture.

IV. PROPOSED SYSTEM

The proposed system contains of AVR microcontroller, various sensors, server and android app as user interface. The sensors which are used to sense the data from the farm of the farmer are implanted at various places proportionally. Each Sensor is integrated on an "AVR" development board. The data received by the AVR microcontroller is compared with the already set threshold value of the sensors so that appropriate data will be generated. The data manipulated by the controller is transferred to the server and stored in the specific format in the MYSQL database. Then farmer will be able to retrieve the data in real time and the data will be shown on its android app so that it became helpful to monitor farm remotely. A smart irrigation tells that the total system can be controlled by autonomous mean over the total irrigation system even though farmer is not present in his farm field. Also farmer can get notifications about the information of farm field and change in operation of the farm field. So this will reduce the human efforts and waste of water as compared to previous system.

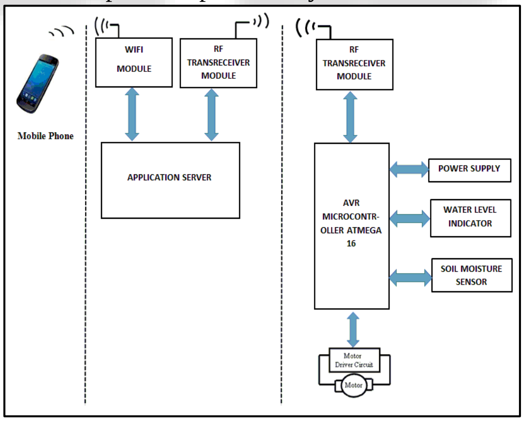

Fig. 1: Architecture Diagram

V. OVERVIEW OF THE SYSTEM

The data from soil moisture sensor and water level sensor are received, identified, recorded and analyzed. The microcontroller receives data from sensors and forwards to server. This processed information is send to web page where status of all these sensors are display graphically using graphical user interface through WIFI.

Condition	Soil Moisture Sensor	Water Level Sensor	Motor Status
1	DRY	FULL	ON
2	WET	FULL	OFF

3	DRY	LOW	OFF
4	WET	LOW	OFF

Table 1: Different conditions for irrigation system operation

VI. SYSTEM COMPONENTS

A. *Soil Moisture Sensor*

Soil moisture sensors are used to estimate volumetric water content in the soil or we can say it as this sensors measure water potential in the soil. These sensors are also referred as soil water potential sensors and include gypsum blocks. Removing of drying, weighting of a sample is required for direct gravimetric measurement of free soil moisture. Soil moisture sensors measure the volumetric water content by using some property of the soil, such as dielectric constant, electrical resistance, or interaction with neutrons, as it acts as a proxy for moisture contents. The relation between the measured property and soil moisture may vary depending on environmental factors such as temperature, soil type, etc. The Reflected microwave radiation gets affected by the soil moisture which is used for remote sensing in hydrology and agriculture. Also the instruments which are portable probe can be used by farmers or gardeners.

B. *Water Level Sensor*

The Water Level Indicator/Sensor is used to indicate and detect the water level in a water tank or any other water container used for preserving water. The sensing of water level is done by using the nine probes which are situated at nine different levels in the tank walls (with probe9 to probe1 placed in increasing order of height, common probe is placed at the base of the tank). The level 1 is used to represent the "tank empty" condition while level 9 is used to represent the "tank full" condition.

Fig. 2: Soil Moisture Sensor

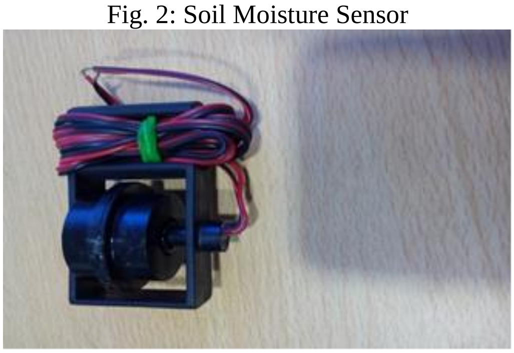

Fig. 3: Water level Sensor

C. *Humidity Sensor*

A humidity sensor measures and regularly reports the relative humidity in the air. This means that it measures both air temperature and moisture

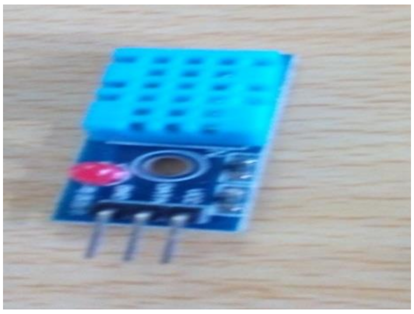

Fig. 4: Humidity Sensor

D. *ATMEGA 16 AVR Microcontroller*

It is used to control the motor according to the sensors value. The Threshold value is set as per the crop type and the sensor value is compared with it.

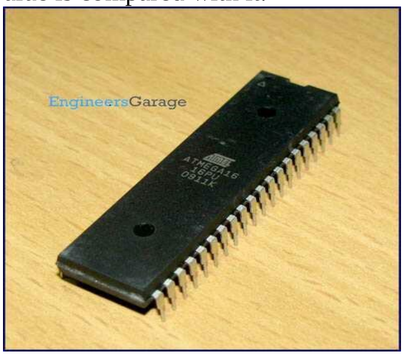

Fig. 5: AVR Microcontroller

VII. EXPERIMENTAL SETUP

We have abstracted three pots containing soil with different moisture level as irrigation fields. Field-1 contains dry soil, Field-2 contains soil with normal moisture and Field-3 contains soil with high moisture. Soil moisture in each field is measured by a sensor node equipped with a soil moisture sensor. Two probes of soil moisture sensor are inserted into soil to measure soil moisture in the field.

Let us assume S*Mδ* is the required soil moisture value in each field. Now S*M1* < S*Mδ*, S*M2* < S*Mδ* and S*M3* > S*Mδ*. Where S*M1* is the soil moisture value in field-1; S*M2* is the soil moisture value in field-2 and S*M3* is the soil moisture value in field-3.

Fig. 6: Hardware connection

VIII. WORKING AND RESULTS

The system is experimented in following cases:

- Case 1: sensor node deployed in field-1 and controller is set to auto mode.

- Case 2: sensor node deployed in field-1 and controller is set to manual mode.
- Case 3: sensor node deployed in field-2 and controller is set to auto mode.
- Case 4: sensor node deployed in field-2 and controller is set to manual mode.
- Case 5: sensor node deployed in field-3 and controller is set to auto mode.
- Case 6: sensor node deployed in field-3 and controller is set to manual mode.

In case 1, sensor node deployed in field-1 senses soil moisture S*M1* and sends it to controller. Controller compares S*M1* with threshold value and water level value. Since S*M1* < threshold and water level is high then motor is switched ON and notification is displayed on mobile phone. If water level is low then motor is switched OFF. Now the soil moisture in field-1 increased. After certain time, sensor node in field-1 again senses the soil moisture and sends it to controller for checking. Now since S*M1* > *threshold* the motor is switched OFF and notification is displayed on mobile phone

In case 3, sensor node deployed in field-2 senses soil moisture S*M2* and sends it to controller. Controller compares SM*2* with threshold value and water level value. Since S*M2* < threshold and water level is high then motor is switched ON and notification is displayed on mobile phone. . If water level is low then motor is switched OFF. Now the soil moisture in field-2 increased. After certain time, sensor node in field-2 again senses the soil moisture and sends it to controller for checking. Now since S*M2* > *threshold* the motor is switched OFF and notification is displayed on mobile phone

In case 5, sensor node deployed in field-3 senses soil moisture SM3 and sends it to controller. Controller compares SM3 with threshold value and water level value. Since SM3 > threshold and water level is high then motor is switched OFF and notification is displayed on mobile phone. If water level is low then motor is switched OFF. Now the soil moisture in field-3 decreased. After certain time, sensor node in field-3 again senses the soil moisture and sends it to controller for checking. Now since SM3 < threshold the motor is switched ON and notification is displayed on mobile phone.

And in manual mode user will decide either to Switch ON or OFF the motor as per the requirements.

IX. Conclusion

Managing of water and electricity is the crucial task in the agriculture field because its availability in the agriculture is global challenge in upcoming years. A complete irrigation solution based on a WSN and IOT has been designed with the appropriate technology and components which satisfies many engineering design constraints such as economic or energy. In this paper we present a prototype for automatic controlling and remote accessing of irrigation motor. Prototype includes sensors, micro-controller and mobile phone. The sensors are deployed in irrigation field for sensing soil moisture value, water-level value and the sensed data is sent to micro-controller. On receiving sensor value the controller compares it with threshold value of soil moisture value. When soil moisture in irrigation field is not up to the required level and the water-level is HIGH then the motor is switched ON to irrigate associated agriculture field and notification is displayed on mobile phone. Mobile phone is used for switch on/off the irrigation motor. Prototype is experimented by abstraction three pots containing soil with different moisture level as irrigation fields. The proposed system is a low-cost system where information is displayed via android app which makes the system more flexible and efficient. The experimental results show that the prototype is capable for automatic controlling and remote accessing of irrigation motor based on the feedback of soil moisture sensor. The prototype can facilitate farmer in monitoring and controlling irrigation activity from remote location.

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