Wireless Sensor Network Based Water Well Management System for Precision Agriculture

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***Abstract*— Sensor networks are increasingly being implemented for environmental monitoring and agriculture to provide spatially accurate and continuous environmental information and (near) real-time applications. These networks provide a large amount of data which poses challenges for ensuring data quality and extracting relevant information. In the present paper we describe a river basin scale wireless sensor network for agriculture and water monitoring. Due to climate change, traditional fertilization and watering system become very hard to get success in certain areas. On the other hand, humanity depends on water and Agriculture for survival. As a result optimal, profitable and sustainable use of water is critical. Several researchers continue their research on precision agriculture for easy implementation, continuous monitoring and control of water for the community. Wireless Sensor Network (WSN) is a very reliable and successful technology in precision agriculture. This research proposes a WSN based approach using some convenient instrument that able to monitor and control water level in well using remote devices from distance location. This paper gives an overall description of a WSN based model and implementation that includes introduction and relevant argument indicating the importance and validity of this research, methodology and implementation.**

Keywords*— *Wireless Sensor Network,Precision Agriculture, Water Management, Wireless Communication,environmental monitoring.

I. INTRODUCTION

A **wireless sensor network** (**WSN**) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. Wireless Sensor Network (WSN) is an advance technology which is increasing attention to the modern world for its low power wireless communication, low cost implementation, low power sensor nodes and self-healing capabilities. This sophisticated technology drives emergence of sensor applications and rapid development in integration of digital circuitry which plays a vital roles in such area such as agriculture, environmental protection, intelligent machines etc.[1].

The aim of this work is to demonstrate how WSN based solution can improve in the construction of precision agriculture. The objective of this research is to develop a WSN based model that would assist to monitor and manage the water level of the well using remote devices. Moreover, this solution would help to control the sensors from remote location. The sensor networks and sensor webs have a profound effect on the collection and analysis of environmental data. The future improvement and recommendations has been discussed later in this paper.

II. RELATED WORK

Nowadays, the number of the development of more complicated and advanced monitoring and control systems is increasing due to the availability of cheaper and pervasive components such as processors and hardware in the current market. The trend is moving towards wireless solutions due To an increased interest in it as compared to the current wired based systems [6]. In addition, modern wireless technology can very much improve the efficiency of data collection and agriculture techniques, as compared to the traditional time consuming and labor-intensive manual practices [7]. Wireless Sensor Technology is very efficient for data collection and have a successful deployment history in precision agriculture compared to the traditional time consuming and labor-intensive manual practice [2].

This paper demonstrate a water level remote monitoring systems that use multiple sensors in combination of a gateway to collect data using other remote devices. Integration of a database and webserver, the system is able to provide real time information and the dynamic trend of

the water level at different monitoring sites. The data can be collected and analyzed at any time via the internet to know the current status and changes of the system.

III. PROPOSED SYSTEM

The main idea of this architecture is to make a platform and connecting the require devices or sensors with this platform with limited effort. The reasons of choosing WSN technology for this work are: a) some areas have limited access of cable connection. b) Harsh environment could damage cable connection. c) Not feasible to build communication infrastructure for each and every well that lead to a very expensive system. Water Well Management System (WWMS) introduce a prototype based implementation using low cost Soil moisture detector, Arduino board, Ultrasonic sensor.

"WSN based water well management system for precision agriculture" is introduced to overcome the drawbacks in the existing system. IoT based approach for plant irrigation provides a non-human intervention irrigation system. Soil moisture measurement gives the information about moisture content in the soil. Depending on the value it sends information about whether the plant needs water or it does not need. User interface for remote control provides the irrigation details about various plants. It will be helpful for the farmers who are new to the agriculture or particular crop. The farmer according to the information which he received in the application can decide whether to TURN ON the motor or not. The proposed irrigation system makes the efficient use of water. Water is fed to the plant whenever there is need. There already exist irrigation systems which water plants on the basis of soil moisture and temperature. Wherever these parameters are required in big agricultural fields their productivity of the crop matters.

IoT based approach for soil condition provides a non-human intervention irrigation system. Soil moisture measurement gives the information about moisture content in the soil. Depending on the value it sends information about whether the soil needs water or it does not need. User interface for remote control provides the irrigation details about various soils. It will be helpful for the farmers who are new to the agriculture or particular crop. The user according to the information which he received in the application can decide whether to TURN ON the motor or not. The proposed irrigation system makes the efficient use of water. Water is fed to the soil whenever there is need. There already exist irrigation systems which water soil on the basis of soil moisture and temperature. Wherever these parameters are required in big agricultural fields their productivity of the crop matters.

Arduino is the heart of the overall existing system. The Arduino incorporates a number of enhancements and new features. Improved power consumption, enlarged connectivity and greater IO are among the improvements to this powerful, small and lightweight GPIO (General Purpose Input Output) pins. The Arduino cannot directly drive the relay. It has only zero volts or 3.3 V. This needs 12V to drive electromechanical relay. In that case driver circuit is needed. The driver circuit takes the low level input and gives the 12V amplitude to drive the relay which operates at 12V, 2 relay to switch on Water motor. Soil moisture sensor, humidity sensor, temperature detection sensor are connected to Arduino board through Arduino. If the soil moisture value is low the moisture level and humidity is low at the given value and also if the temperature is high then the water motor will be on, whereas if the moisture level, humidity is high and temperature is low the motor will be off through the relay. The application will have a GUI which will show all the data to farmer. The modes as specified can be selected by the user on the app itself.

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IV. IMPLEMENTATION DETAIL

In this architecture, two sensors are used. Moisture sensor to measure the water content in the soil and ultrasonic sensor to measure the water level in the well. Farmer is notified easily using the Android App "TCP/UDP Tool Kit" which connects the master and slaves to communicate with each other.The port numbers for Client and Server communication and the IP addresses to connect to the WiFi are set to send the measured data. The farmer gathers information about the current status of the water level in the well and moisture content information for managing water. Notifications are sent to the app only if the moisture content in the soil is less than required by the crop and when water level in the well is low.

Soil Moisture Sensor:

Fig .1. Soil Moisture Sensor

This sensor can be used to test the moisture of soil, when the soil is having water shortage, the module output is at high level, else the output is at low level. By using this sensor

one can automatically water the flower plant, or any other plants requiring automatic watering technique. The soil moisture sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value. When there is more water, the soil will conduct more electricity which means that there will be less resistance. Therefore, the moisture level will be higher. Dry soil conducts electricity poorly, so when there will be less water, then the soil will conduct less electricity which means that there will be more resistance. Hence the moisture level may be low.. This sensor can be connected in two modes; Analog mode and digital mode. First, we will connect it in Analog mode and then we will use it in Digital mode.

Ultrasonic Sensor:

Fig.2. Ultrasonic Sensor

Ultrasonic sensors measure distance by using ultrasonic waves.The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception. An optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic sensor, a single oscillator emits and receives ultrasonic waves alternately. This enables miniaturization of the sensor head.

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves.An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.High-frequency sound waves reflect from boundaries to produce distinct echo patterns.

Ultrasonic sound vibrates at a frequency above the range of human hearing.Transducers are the microphones used to receive and send the ultrasonic sound.Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse.

V. IMPLEMENTATION

Algorithm:

Input: Values from soil moisture sensor and ultrasonic sensor

Output: Motor ON – YES/NO?

Step 1: Start

Step 2: Initialize serial communication and sensors.

Step 3: Initialize the master and slave.

Step 4: Check the moisture level of soil and ch eck the water level in the well.

If moisture level < min and water level is LOW.

MOTOR is ON

Else

MOTOR is OFF
Goto Step 3
Step 5: Stop

Working of this method is mainly handled by Arduino and sensors. Arduino is an open source platform which provides standard form factor that breaks out the functions of the micro-controller into a more accessible package. Sensor data is processed by Arduino and to work on these information, a new smart-phone application called "TCP/UDP TOOL KIT" is developed using android studio.

- Ultrasonic sensor is placed above the well.
- Moisture sensor is kept in the field near the roots of the crop.
- When the moisture level is less than the minimum required for the crop, arduino notifies the farmer that moisture level is LOW. Farmer has to send the water to the crops.
- Before the water is supplied, water level in the well is measured using ultrasonic sensor. If the water level is too LOW, farmer has to switch ON the motor.Else,water can be supplied from the well.
- Motor will be turned on by the farmer through the application.
- Communication is set up with the help of WiFi which has the range upto 100meters.
- Advantage of monitoring system with an application is that the farmer is informed about status of the well at appropriate time.
- The disadvantages of this method is the cost involved in the devices that are used and when the phone is in battery low condition, it may cause problem.

FLOW DIAGRAM:

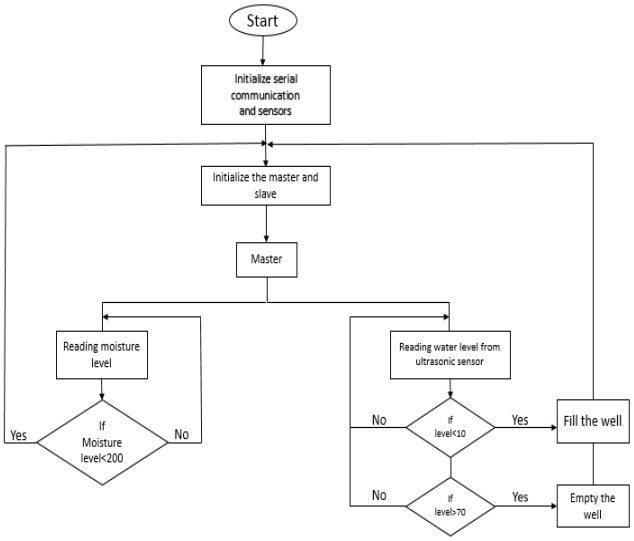

Fig.3. Flow Diagram

In order to initialize the master and slave serial communication sensors are being initialized. As shown in Fig.3.the master has to read moisture level and water level from ultrasonic sensor. If moisture level in soil is less than 200 then master slave device will be initialized and well water level will be checked. If well water level is less than 1 then well will be filled and if well water level is greater than 7 then the water will be sprinkeled on the soil. The master will get the signal when the water level is greater than 7 and the soil moisture reduces to 200.

VI. CONCLUSION

Automatic irrigation scheduling consistently has shown to be valuable in water use efficiency with respect to manual irrigation based on direct soil water measurements. The aim of the implementation is to demonstrate that the automatic irrigation can be used to reduce water use. The implementation is an automated irrigation system that consists of a distributed wireless network of soil moisture and ultrasonic sensor.Farmer is mostly benefitted by gaining information even if he is way from the farm. Hence man power is reduced and farmer can gain the advantage.

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