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AGRICULTURE CROP MONITORING AND IRRIGATION AUTOMATION

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Abstract

Agriculture sector in India is diminishing day by day which affects the production capacity of ecosystem. It is mainly due to the scarcity of water. Deficiency in fresh water resources globally has raised serious alarms in the last decade. This paper presents a smart system, that use a low cost sensors that control the water supply in water deficient areas. The low-cost and wireless nature of sensing hardware presents the possibility to monitor the large agricultural field condition. Moisture, Temperature, Humidity, Light, pH data's were acquired from a sensors node are sent through XBee wireless communication modules to a centralized server that controls water supply.

I. INTRODUCTION

Agriculture plays a vital role in India's Economy. Major portion of India's financial status depends on agricultural products. More than 70% of Indian population also relies on agriculture for their sustenance. It is necessary to increase crop productivity with efficient and effective water. But climate changes and lack of precision agriculture have resulted in poor yield as compared to population growth. Irrigation is mostly done using canal system in which water is pumped into field after regular interval of time without any feedback of water level in field. This type of irrigation affects crop health and produces a poor yield because some crops are too sensitive to water content in soil. A similar situation exists in many other countries of South Asia. Many smart irrigation systems have been devised. A smart irrigation system, contrary to a traditional irrigation method, regulates supplied water according to the needs of the fields and crops. There are varieties of traditional irrigation systems that has been followed from the past. For instance, in flow irrigation the water resources like tanks or reservoirs are placed at great heights. The water starts to flow automatically down the channel when it is connected to the tank or reservoir. This type of irrigation is mostly used in plain areas. The other type of irrigation is lift irrigation where the field are at higher level than the water resources.

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To improve traditional methods, there has been many systems developed using advanced technologies that help to reduce crop wastes, prevent excessive and scarce watering to crops and thereby increase the crop yield. There are many modern irrigation systems developed so far. Such methods are drip irrigation, pot irrigation, flow irrigation. Water supply was regulated according to the needs of the fields and crops. The feedback mechanism of a smart irrigation system is a moisture sensor. Evapotranspiration (ET), thermal imaging, capacitive methods, and neutron scattering method and gypsum blocks are some of the technologies that enable moisture sensing.

A large agricultural field presents an additional problem in the sense that different parts areas of it may have different evaporation rates due to foliage, the presence of rocks at different heights underground, parts of the field being in close proximity to canals or ponds, etc. Hence, moisture measurement at a single location in the field does not make much sense.

Consequently, what is required is a distributed number of sensor nodes and some scattered pumping units to pump water to those specific locations covered by the sensor units. The need for multiple sensors further emphasizes the need for an inexpensive moisture sensor. Furthermore, the requirement of multiple sensors spread out over the field means the presence of many wires in it. This will create a lot of problems to ploughing, harvesting, etc. and isn't practical. Wireless connectivity to the sensors is a novel idea in this context. In this regard, this paper proposes a low-cost wireless device for data communication.

An automated irrigation unit, in conjunction with a low cost moisture sensor, is proposed in this paper. A system level description is provided, detailing the hardware and software design. Section IV provides a description of the working principle of the sensor. The subsequent section introduces the XBee technology. Then, two sections are provided detailing the hardware and the software used followed by some description of the experimentation.

II. SYSTEM DESIGN

In this work low cost soil moisture sensors, temperature and humidity sensors, pH sensors and light sensors are used. They continuously monitor the field condition and measure the parameters and send it to the web server using XBee. The sensor data stored in database. A web page is designed to analyze the data received and to check with the threshold values of moisture, humidity and temperature, pH, light.

The decision making is done at server to automate irrigation. If soil moisture is less than the threshold value the motor is switched ON and if the soil moisture exceeds the threshold value the motor is switched OFF. This method can also be used in green houses wherein addition light intensity control can also be controlled and automated.

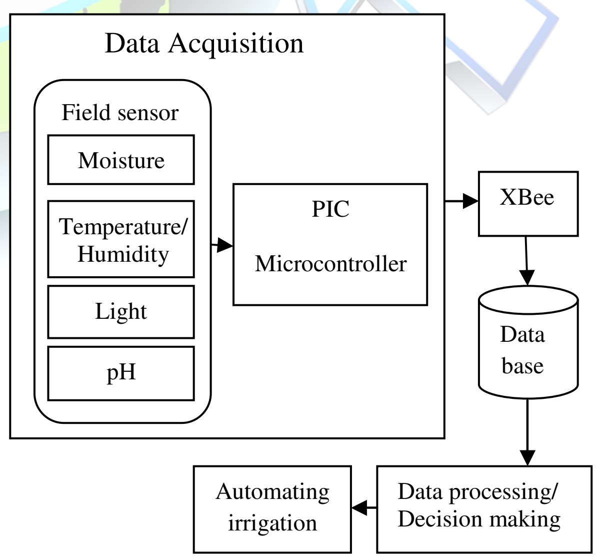

Fig. 1 System Design

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III. XBEE WIRELESS TECHNOLOGY

XBee is a low-cost and low-power wireless technology. Wireless technology was first introduced with XBee alliance being formed between Philips, Motorola, Honeywell, Invensys and Mitsubishi Electric in October 2002 under IEEE 802.15.4 WPAN standard. XBee operates in the 2.4 GHz band with a data transfer rate of 250kbps and it supports peer to peer, point to point and point to multipoint networking methods with current consumption ranging between 30 to 40mA for data transmission.

Table I Comparison between wireless networks

modes	Wi-Fi	XBee
Operating Band	1100+	20-250
Coverable Distance	100+	20-70 100+
Number of Nodes	32	25400
Power Consumption	300	30
Memory	70+	40+
Technical advantage	Bandwidth spectrum	Low Power consumption and Cost

Having the ability to connect to a number of devices into a network makes it feasible for larger sensory networks with over maximum of 65000 possible nodes achievable. The host acts as the hub or controller of the system that can communicate with any number of similar devices. Hence, it is possible to use this for data transfer, for example, from sensors that are located remotely. In this work, one XBee node is coupled to a ground moisture level detector unit in order to record moisture data on a host computer. The XBee host communicates with the computer via a USB or an RS232 serial port.

The current widely used technologies of Bluetooth and Wi-Fi are compared with the XBEE technology and the advantages of XBee over Bluetooth and Wi-Fi are numerous for our application as seen from Table 1. XBee works over a larger distance then the Bluetooth and with lower power requirements then the Wi-Fi tech. This allows for a mesh network to be created which can cover more area and can also remain active for 6months-2 years on two AA batteries .The XBee has better latency and takes 15ms to wake up from sleeping mode as compared to the Bluetooth which requires 3-4 seconds. With this small wake-up time it is possible for the node to sleep until critical data needs to be sent at which point it can wake-up, synchronize itself with the host node, transmit and go back to sleep. This results in higher power efficiency with the batteries lasting for longer periods of time. XBee also provides Self organization method to form a network with flexible topology. This allows for an efficient route for data transmission possible due to the dynamic routing protocol. The XBee technology exhibits a high three-tier security using protocols such as ACL or advanced encryption standard (AES-128) for Security.

IV. SENSORS

A sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics, whether as

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simple as a light or as complex as a computer. Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware.

A. Soil Moisture

Moisture sensor is a device that measures the relative moisture of any environment. There are various types of moisture sensors but most common are the impedance based ones. Impedance based sensors works on the change of impedance between two electrodes due to varying moisture content in the surrounding medium. Hence, when the electrodes are kept in soil, its moisture level changes can measured in a relative manner. This is the fundamental by which the proposed sensor works.

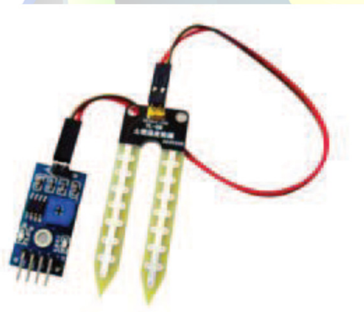

Fig. 2 Soil Moisture Sensor

The soil moisture sensor has two probes which is inserted into the soil. The probes are used to pass current through the soil. The moisture soil has less resistance and hence passes more current through the soil whereas the dry soils has high resistance and pass less current through the soil. The resistance value help detecting the soil moisture. Fig. 2. Shows soil moisture sensor.

B. Temperature and Humidity sensor

For measuring humidity they use the humidity sensing component which has two electrodes with moisture holding substrate between them. So as the humidity changes, the conductivity of the substrate changes or the resistance between these electrodes changes. This change in resistance is measured and processed by the IC which makes it ready to be read by a microcontroller. On the other hand, for measuring temperature these sensors use a NTC temperature sensor or a thermistor.

Fig. 3 Temperature Humidity Sensor

A thermistor is actually a variable resistor that changes its resistance with change of the temperature. These sensors are made by sintering of semi conductive materials such as ceramics or polymers in order to provide larger changes in the resistance with just small changes in temperature. The term "NTC" means "Negative Temperature Coefficient", which means that the resistance decreases with increase of the temperature.

C. Light Dependant Resistor

CadmiumSulphide(cds) photoconductive cells with spectral responses similar to that of the human eye. The cell resistance falls with increasing light intensity. Applications include smoke detection, automatic lighting control, batch counting and burglar alarm systems.

LDRs (Light Dependant Resistors) are a very useful tool in a light/dark circuits. A LDR can have a variety of resistance and functions. For example it can be used to turn on a light when the LDR is in darkness or to turn off a light when the LDR is in light. It can also work the other way around so when the LDR is in light it turns on the circuit and when it's in darkness the resistance increase and disrupts the circuit.

Fig. 4 Light Dependent Resistor

When light falls on the semi conductive material it absorbs the light photons and the energy is transferred to the electrons, which allow them to break free from the crystal lattice and conduct electricity and lower the resistance of the LDR.

D. pH sensor

pH, commonly used for water measurements, is a measure of acidity and alkalinity, or the caustic and base present in a given solution. It is generally expressed with a numeric scale ranging from 0-14. The value 7 represents neutrality.

A pH meter provides a value as to how acidic or alkaline a liquid is. The basic principle of the pH meter is to measure the concentration of hydrogen ions. Acids dissolve in water forming positively charged hydrogen ions (H+). The greater this concentration of hydrogen ions, the stronger the acid is.

The another method to uses a pH meter and pH probe. The pH probe is placed in the water sample and connected to the pH meter. At the tip of the probe there is a thin glass bulb. Inside the bulb are two electrodes that measure voltage.

V. WIRELESS DATA TRANSMISSION

The data acquired from sensors are transmitted to the web server using wireless transmission. XBee is used for wireless transmission between the field and the web server. XBee is cheaper than other wireless network such as Bluetooth, Zigbee. The transmitter and receiver modules are connected with PIC microcontroller. The transmitter is place in the field and the receiver is placed in the system end. The transmitter and receiver is given a id while configuring it. All the transmitters in the field should know the receiver's id which is the destination address. The receiver will receive data from various transmitters kept in the field. The receiver at the system end is connected to the web server via Ethernet.

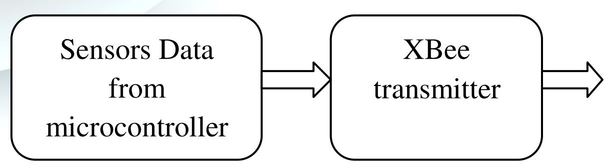

Fig. 5a Transmitter side

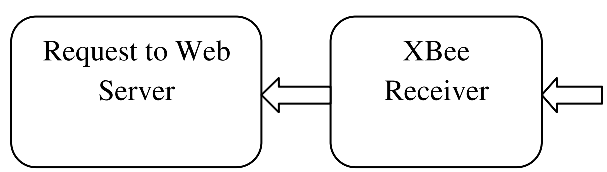

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Fig. 5b Receiver side

Fig. 5 wireless data transmission using XBee

VI. DATA PROCESSING AND DECISION MAKING

The data received from the field are wirelessly transmitted using XBee and then saved in web server mysql database using Ethernet connection at receiver end.. Periodically the data are received and stored in database. The data processing is the task of checking the various sensors data received from the field with the already fixed threshold values. The threshold values vary according to the crops planted. This is because different crops need different amounts of water. For example in a paddy field to produce 1 kg of rice 5000 liters of water and for wheat it is liters. Similarly, the temperature and humidity varies for different crops.

The sensor values also vary according to the climatic conditions. The soil moisture will be different in summer and winter seasons. The temperature and humidity also varies in summer, winter and rainy season. The threshold values is fixed after considering all these environmental and climatic conditions. The motor will be switched on automatically if the soil moisture value falls below the threshold and vice versa. The farmer can even switch on the motor from mobile using mobile application.

VII. AUTOMATED IRRIGATION

The irrigation system is automated once the control received from the web application. The relays are used to pass control from web application to the electrical switches using PIC microcontroller. A relay is an electrically operated switch. The circuits with low power signal can be controlled using relay. There different types of relays which includes reed relay, solid state relays, protective relay etc. The relay used here is Solid State Relay (SSR).If n external voltage is applied across the ends the relay switches on or off the circuit.

VIII. RESULT AND ANALYSIS

A. Monitoring Section

Thus the system is implemented to monitor the agriculture field by getting the parameters using wireless sensor based on XBee Network. Depending upon the level of agriculture parameters, the motor and incandescent light turned on and off.

B. Controlling Section

It has been shown that a low-cost sensor fabrication performs well, in a consistent manner, in sensing ground moisture. The communication device and the controller setup are shown to work as expected and record the moisture, light, temperature, humidity and pH data to a personal computer.

IX. CONCLUSION AND FUTURE ENCHANCEMENT

This project can be used as a solution to overcome the traditional method of manual collection of data and also use of technologies with short range. The system using XBee as wireless technology to continuously transmit the data in wide range with low-cost. It also addresses problems faced by the traditional use of wires and cables to distribute sensors. The sensor node can allow for battery operation,

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relocation, repositioning and addition of new sensors.

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