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Research paper



A Study on Smart Irrigation System Using IoT for Surveillance of Crop-Field

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Abstract

In India, agriculture plays an important role for development in food production. In our country, agriculture depends on the monsoons which are not sufficient source of water. So the irrigation is used in agriculture field. Internet of Things (IoT) is a milestone in the evolution of technology. IOT plays an important role in many fields, one of that is Agriculture by which it can feed billions of people on Earth in future. The objective of this paper is aiming to overcome this challenge, the whole system is micro control based and can be operated from remote location through wireless transmission so there is no need to concern about irrigation timing as per crop or soil condition. Sensor is used to take sensor reading of soil like soil moisture, temperature, air moisture and decision making is controlled by user (farmer) by using microcontroller. The data received from sensors are sent to server database using wireless transmission. The irrigation will be automated when the moisture and temperature of the field is reduced. The farmer is notified with the information regarding field condition through mobile periodically. This system will be more useful in areas where there is scarcity of water and will be worth efficient with satisfying its requirements.

Keywords: *Smart Irrigation, Sensors, Bluetooth communication, Android.*

1. Introduction

In India, where 60-70% economy depends on agriculture, there is a great need to modernize the conventional agricultural practices for the better productivity. Due to unplanned use of water the ground water level is decreasing day by day, lack of rains and scarcity of land water also results in decrement in volume of water on earth. Nowadays, water shortage is becoming one of the biggest problems in the world. We need water in each and every field. In our day to day life also water is essential. Agriculture is one of fields where water is required in tremendous quantity. Wastage of water is the major problem in agriculture. Every time excess of water is give to the fields. There are many techniques to save or to control wastage of water in agriculture. The objective of the system is to a) conserve energy & water resources b) handles the system manually and automatically c) detects the level of water.

Due to the climatic changes and lack of precision, agriculture have resulted in poor yield as compared to population growth. Irrigation is mostly done using canal systems in which water is pumped into fields 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 smart irrigation system, contrary to a traditional irrigation method, regulates supplied water. The feedback mechanism of a smart irrigation system is a moisture sensor and temperature and humidity sensor. Evapo - transpiration (ET), thermal imaging, capacitive methods, and neutron scattering method and gypsum blocks are some of the technologies that enable moisture sensing. Capacitive sensors, however instantaneous, are costly and need to be calibrated often with varying temperature and soil type. Neutron probe based moisture sensors are very accurate but present radiation hazards, calibration difficulty and are costly.

A large agriculture field presents is with different part of areas, hence, moisture measurement at a single locating in the field does not make much sense. Consequently, what is required is a distributed number of sensor nodes and scattered pumping units to pump water to those specific locations covered by the sensor units. An automated irrigation unit, in conjunction with a low cost moisture sensor, is proposed in this paper.

2. Literature Survey

2.1. Automated Irrigation System using WSN and GPRS Module

Automated Irrigation system using WSN and GPRS Module having main goal is that optimize use of water for agriculture crops[1]. This system is composed of distributed wireless sensor network with soil moisture and temperature sensor in WSN. Gateway units are used to transfer data from sensor unit to base station, send command to actuator for irrigation control and manage data of sensor unit. Algorithm used in system for controlling water quantity as per requirement and condition of filed. It is programmed in microcontroller and it sends command through actuator to control water quantity through valve unit. Whole system is powered by photovoltaic panels. Communication is duplex take place through cellular network. Web application manage the irrigation through continuous monitoring and irrigation scheduling programming. It can be done through web pages.

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2.2. Crop Monitoring System based on WSN

The subsequent section introduces the Bluetooth technology. Wireless Sensor network crop monitoring application is useful to farmer for precision agriculture. The application monitors the whole farm from remote location using Internet Of Things (IOT). Application works on sensor netowrk and two types of nodes. Energy saving algorithm is used in node to save energy. Tree based protocol is used for data collection from node to base station. System having two nodes one node that collect all environmental and soil parameter value and the other consist of camera to capture images and monitor crops. In this System Environmental changes are not considered for sensor reading. System user is not able to program application. There is no controlling system for application.

2.3. Automatic Drip Irrigation System using WSN and Data Mining Algorithm

Data mining algorithm are used to take decisions on drip irrigation system. Automated drip irrigation system having WSN placed in all over farm and different type of sensors. [9]WSN uses ad hoc network which gives self configuration and flexibility. Sensor data is given to base station and data is received using zigbee. Data processing is done at base station for decision making. Data mining algorithm is used to take decision on data from sensor to drip. All observation are remotely monitor through web application. This system works on Naïve Bayes algorithm for irrigation control. Algorithm works on previous data set for decision making if any attribute is not frequent result is zero[11].

3. Components

3.1. Arduino Microcontroller

Arduino is an open-source electronics platform based on easy-to-use hardware and software[5][4]. Arduino boards are able to read inputs – light on a sensor, a finger on a button – and turn it into an output – activating a motor, turning on an LED. A microcontroller is a small computer on a single integrated circuit. In modern terminology, it is a system on a chip. It contains one or more CPUs along with memory and programmable input / output peripherals. Microcontrollers are designed for embedded application. There are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines and other embedded systems[4].



Fig. 1:. Arduino Microcontroller

Fig.1 shows Arduino microcontroller were the Arduino board can communicate at various baud rates. A baud is a measure of how many times the hardware can send 0's and 1's in a second. The software used by the arduino is Arduino IDE.

3.2. Sensors

In this system two sensors are used in order to obtain the data about the soil and environmental conditon, soil moisutre sensor and temperature and humidity sensor.

3.2.1. Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil[11] .Since the direct gravimetric measurement of free soil moisture requires removing, drying and weighing 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.

This sensor has two probes through which current passes in soil, then read the resistance of soil for reading moisture level. We known that water make the soil more prone to electric conductivity resulting less resistance in soil where on other hand dry soil has poor electrical conductivity thus more resistance in soil.

3.2.2. Temperature and Humidity Sensor

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor shown in Fig 3. It uses a capacitive humidity sensor and a thermostat to measure the surrounding air, and spits out a digital signal on the data pin.

It measures relative humidity. Relative humidity is the amount of water vapor in air vs. the saturation point of water vapor in air. At the saturation point, water vapor starts to condense and accumulate on surfaces forming dew. It detects water vapor by measuring the electrical resistance between two electrodes.

3.2.3. Bluetooth Wireless Technology

Bluetooth is a high-speed, low-power microwave wireless link technology, designed to connect phones, laptops and other portable equipment together with little or no work by the use. Unlike infra-red, Bluetooth does not require line-of-sight positioning of connected units. The technology uses modifications of existing wireless LAN techniques but is most notable for its small size and low cost shown in Figure 2. The current prototype circuits are contained on a circuit board 0.9cm square, with a much smaller single chip version in development. The fundamental strength of Bluetooth wireless technology is the ability to simultaneously handle data and voice transmissions, which provides users with a variety of innovative solutions.

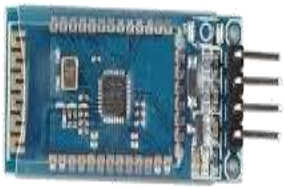


Fig .2 . Bluetooth Device

This technology achieves its goal by embedding tiny, inexpensive, short-range transceivers into the electronic devices that are available today. The radio operates on the globally-available unlicensed radio band, 2.45 GHz, and supports data speeds of up to 721 Kbps, as well as three voice channels. Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point-to-point or multipoint. The maximum range is 10 meters but can be extended to 100 meters by increasing the power. Bluetooth devices are protected from radio interference by changing their frequencies arbitrarily upto a maximum of 1600 times a second, a technique known as frequency hopping.

Moreover, Bluetooth devices won't drain precious battery life. The Bluetooth specification targets power consumption of the device from a hold mode consuming 30 micro amps to the active transmitting range of 8-30 milliamps.

Bluetooth device uses radio waves instead of wires or cables to connect to a phone or computer. A Bluetooth product, like a headset o watch, contains a tiny computer chip with a Bluetooth radio and software that makes it easy to connect. When two Bluetooth devices want to talk to each other, they need to pair. Communication between Bluetooth devices happens over short-range, ad hoc networks known as piconets. A piconet is a network of devices connected using Bluetooth technology. When a network is established, one device takes the role of the master while all the other devices act as slaves. Piconets are established dynamically and automatically as Bluetooth devices enter and leave radio proximity. The sensors are connected to the Arduino board. These hardware communicate via Bluetooth .

4. Proposed System

Irrigation can be automated by using sensors, microcontroller, Bluetooth, android application as shown in Fig.3. The low cost soil moisture sensor and temperature and humidity sensor are used. They continuously monitor the field. The sensors are connected to arduino board. The sensor data obtained are transmitted through wireless transmission and are reached to the user so that he can control irrigation.

The mobile application can be designed in such a way to analyze the data received and to check with the threshold values of moisture, humidity and temperature. The decision can be made either by the application automatically without user interruption or manually through application with user interruption. 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.

The sensors are connected to the Arduino board. These hardware communicate through wireless Bluetooth transmission so that user can access the data through his mobile that has an android application which can get the sensor data from the arduino via Bluetooth. As far as cost of device is considered Bluetooth technology is used which can be replaced by wi-fi. motor is switched OFF.

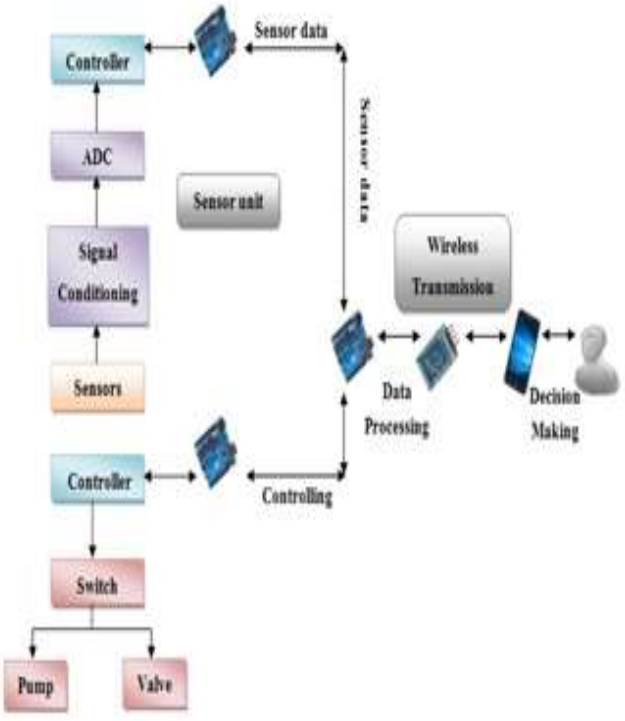


Fig.3:. System Architecture

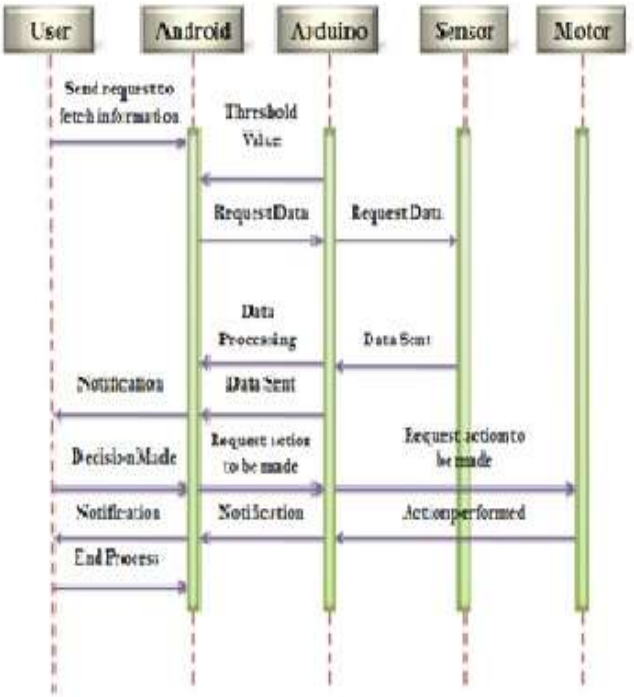


Fig:4:: Sequence Diagram for the automatic irrigation

The Arduino board is programmed using Embedded C in order to control the transmission of sensor data and the working of motor according to the decision made. The coordination of the motor and 3 sensors is maintained by the program fed into the arduino. Water is supplied to 3 different areas by using Servo Motor, motor that can move its head at different angles. Using this, the head of the motor is made to move at 3 different angle so that water can be supplied at different areas where the sensors are placed. The sensors continuously send data regarding moisture content of the soil. Whichever sensor indicates low moisture content to that place motor is switched on and then water is pumped, if it indicates high moisture content pumping of water is stopped by switching of the motor. All these are managed by the program that has been written into the Arduino Microcontroller. The coordination of all the components are shown in the figure 4.

The Arduino and the user communicate via Bluetooth. The range of Bluetooth technology is application specific.The threshold values for both soil moisture and temperature and humidity, will be set and stored in the arduino and mobile application. The sensor value varies according the climatic conditions. The soil moisture will be different in summer and winter seasons and so the temperature and humidity values. The threshold value is fixed after considering all theses 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.

The irrigation system is automated once the control received from the mobile application. Through Bluetooth the decision is sent to the arduino and accordingly the motor switches are operated.

The ultrasonic sensor is used to monitor water level in reservoir. The ultrasonic sensor work based on the piezoelectric method. It has trigger pin and echo pin. The trigger pin act as transmitter and the echo pin is a reflector. The trigger pin sends ultrasonic waves once it started functioning. The ultrasonic waves once it started functioning. The ultrasonic waves hit the water and reflected towards the echo pin. The duration to receive the echo is calculated and that indicates the water level.

The duration is converted to the distance using the following equation (1) and (2).

Distance in cm = (duration/2) / 29.1 (1)

Distance in inches = (duration/2) / 74(2)

Before the motor is switched on, the water level is checked to ensure that require amount of water is available for irrigation. If required amount of water is not present, the motor will not be switched on or only less amount water is supplied. The notification is sent to the farmer's mobile for further decision to be made. The farmer can also be able to switch on and off the motor from the mobile application[13].

5. Android Mobile Application

Android is used to develop mobile application for automatic irrigation. Android is a mobile operating system developed by Google, based on the Linux kernel and designed primarily for touch screen mobile devices such as smart phones and tablets. Android's user interface is mainly based on direct manipulation using touch gestures that loosely correspond to real-world actions, such as swiping, tapping to manipulate on-screen objects, along with a virtual keyboard for text input[13]. The sensor data and threshold value are stored in local memory of the mobile. The user can read the sensor data, and can set the system into automatic mode so that the system automatically switches motor depending on the sensor data and previously set threshold value. Also the user can set the system to manual mode and he himself can decide the switching of the motor. And he can get the notifications regarding the water level in reservoir so that he can make alternatives when there is scarcity of water in reservoir.

6. Conclusion and Future Work

The automated irrigation system implemented was found to be feasible and cost effective for optimizing water resources for agriculture production. This irrigation system allows cultivation in places with water scarcity thereby improving sustainability.
The irrigation system helps the farmer by making his work smarter. As the demand for water increases, along with the need to protect aquatic habitats, water conservation practices for irrigation need to be effective and affordable. As multiple sensors are used water can be provided only to the required area of land.
This system reduces the water consumption to greater extent. It needs minimal maintenance. The power consumption has been reduced very much. The crop productivity increases and the wastage of crops are very much reduced.
The extension work is to make user interface much simpler by just using SMS messages for notifications and to operate the switches.

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