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RESEARCH PAPER

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SURVEILLANCE OF CROP-FIELD WITH SMART IRRIGATION SYSTEM

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Abstract: In India, agriculture plays an important role in 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 the 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 a remote location through a wireless transmission so there is no need to concern about irrigation timing as per crop or soil condition. The sensor is used to take sensor reading of soil like soil moisture, temperature, air moisture and decision making is controlled by the user (farmer) by using a microcontroller.Using wireless transmission, these data collected are sent to the server database. The irrigation will be automated when the moisture and temperature of the field are 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 a 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 the decrement in the 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 the fields where water is required in tremendous quantity. Wastage of water is the major problem in agriculture. Every time excess of water is given 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 has 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 the field[1][2][6]. This type of irrigation affects crop health and produces a poor yield because some crops are too sensitive to the water content in the 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 [3][7][10]. Evapotranspiration (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 a 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. EXISTING SYSTEM

A. Automated Irrigation System using WSN and GPRS Module

Automated Irrigation system using WSN and GPRS Module having the main goal is that optimize the use of water for agriculture crop. This system[1] is composed of the 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 a command to the actuator for irrigation control and manage data of sensor unit. An algorithm used in the system for controlling water quantity as per requirement and condition of filed. It is programmed in microcontroller and it sends a command through the actuator to control water quantity through valve unit. The whole system is powered by photovoltaic panels. Communication is duplex take place through the cellular network. Web application manages the irrigation through continuous monitoring and irrigation scheduling programming. It can be done through web pages.

B. Crop Monitoring System based on WSN

The subsequent section introduces the Bluetooth technology. In Wireless Sensor network, crop monitoring

application is useful to a farmer for precision agriculture. The application monitors the whole farm from a remote location using Internet Of Things (IoT). The application works on sensor network and two types of nodes [3]. Energy saving algorithm is used in the node to save energy. The tree-based protocol is used for data collection from node to base station. System having two nodes one node that collects all environmental and soil parameter value and the other consist of a camera to capture images and monitor crops. In this System [4] Environmental changes are not considered for sensor reading. The system user was not able to program application and no controlling system for the application.

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

Data mining algorithm is used to take decisions on drip irrigation system. Automated drip irrigation system having WSN placed in all over the farm and different type of sensors. WSN uses an ad-hoc network which gives self-configuration and flexibility. Sensor data is given to base station is received using ZigBee [2][9][12]. Data processing is done at the base station for decision making. Data mining algorithm is used to take a decision on data from a sensor to drip. All observation is remotely monitored through a web application. This system works on Naïve Bayes algorithm for irrigation control. The algorithm works on previous data set for decision making if any attribute is not the frequent result is zero [11].

3. PROPOSED SYSTEM REQUIREMENTS

D. Arduino Microcontroller

Arduino is an open-source electronics platform based on easy-to-use hardware and software [4][5]. An Arduino board are able to read inputs – light on a sensor, a finger on a button – and turns it into an output – activating a motor, by turning on an LED. A microcontroller is a small computer on a single integrated circuit containing one or more CPUs along with memory and programmable input/output peripherals. Microcontrollers are designed for the embedded applications such as automobile engine control systems, implantable medical devices, remote controls, office machines and other embedded systems.

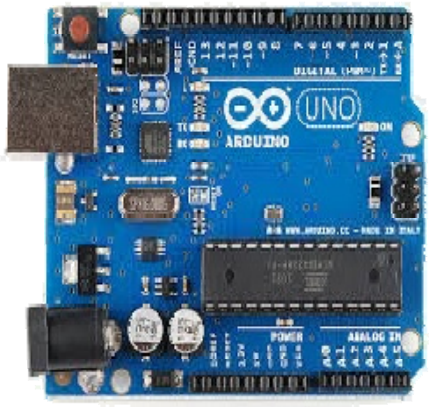

Figure 1. .Arduino Microcontroller

Figure 1 shows Arduino microcontroller was the Arduino boards 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.

E. Sensors

In this system, two sensors are used in order to obtain the data about the soil and environmental condition, soil moisture sensor and temperature and humidity sensor [7][8].

1) *Soil Moisture Sensor:* Soil moisture sensors measure the volumetric water content in the soil[6] shown in Figure 2. Since the direct gravimetric measurement of free soil moisture requires removing, drying and weighing of a sample, [7]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.

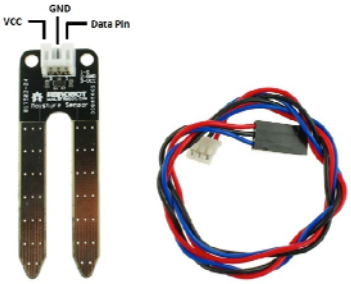

Figure 2. A Soil Moisture Sensor

As shown in the above figure, these sensors have two probes through which current passes in the soil, then detect the resistance of soil for reading moisture level[8][11].As we know that water makes the soil more prone to electric conductivity resulting in less resistance in the soil where on another hand dry soil has poor electrical conductivity thus more resistance in soil.

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 the 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.

Figure.3.Temperature and Humidity Sensor

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.

Figure 4. Bluetooth Device

The Bluetooth device uses radio waves instead of wires or cables to connect to a phone or computer. A Bluetooth product, like a headset or a 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. The sensors are connected to the Arduino board. This hardware communicates via Bluetooth.

4. SYSTEM DESIGN

Irrigation is automated by using sensors, microcontroller, Bluetooth, the Android application as shown in Fig.5. The low-cost soil moisture, temperature, and humidity sensors are used. They continuously monitor the field and are connected to the 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 is designed in such a way to analyze the data received and to check the threshold values of moisture, humidity, and temperature. The decision can be made either by the application automatically without user interruption or manually through the application with user interruption. If soil moisture is less than the threshold value, then the motor is switched ON and if the soil moisture exceeds the threshold value, then the motor is switched OFF. Here the sensors are connected to the Arduino board and the hardware communicates 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 the cost of a device is considered Bluetooth technology is used which can be replaced by wi-fi. A motor is switched OFF.

The Arduino board is programmed using Embedded C in order to control the transmission of sensor data and the working of the 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, a motor that can move its head at different angles. Using this, the head of the motor is made to move at 3 different angles 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.

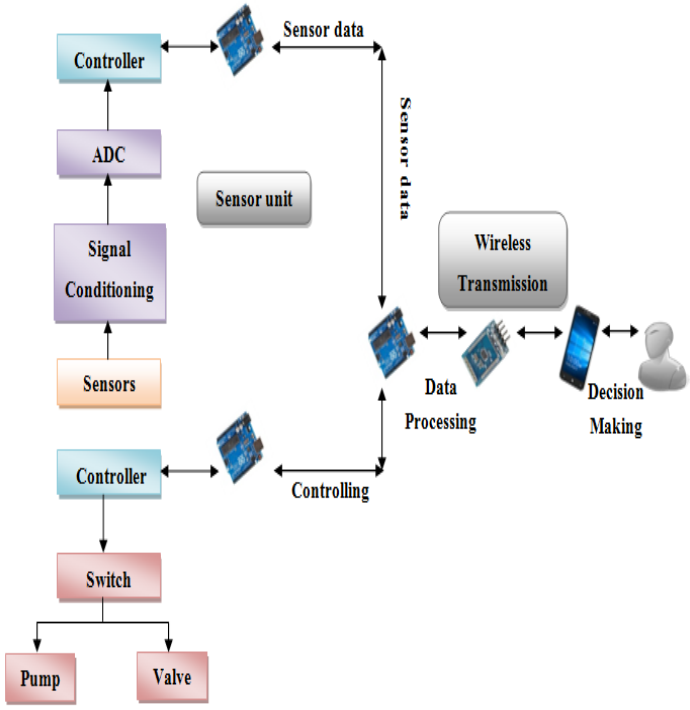

Fig.ure 5. System Architecture

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 to 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 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.

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 the water level in the reservoir. The ultrasonic sensor work based on the piezoelectric method. It has trigger pin and echoes pin. The trigger pin act as a 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 required amount of water is available for irrigation. If the 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.

5. ANDROID MOBILE APPLICATION

Android is used to develop a mobile application for automatic irrigation. Android is a mobile operating system developed by Google, primarily designed for touchscreen mobile devices such as smartphones and tablets. Figure 6 Shows the user interface listing all the Bluetooth users. Figure 7 shows the interface showing both options for manual and automatic operation. The sensor data and the threshold value are stored in local memory of the mobile. The user can read the sensor data and can set the system into an automatic mode so that the system automatically switches motor depending on the sensor data and a 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 the reservoir so that he can make alternatives when there is a scarcity of water in the reservoir.

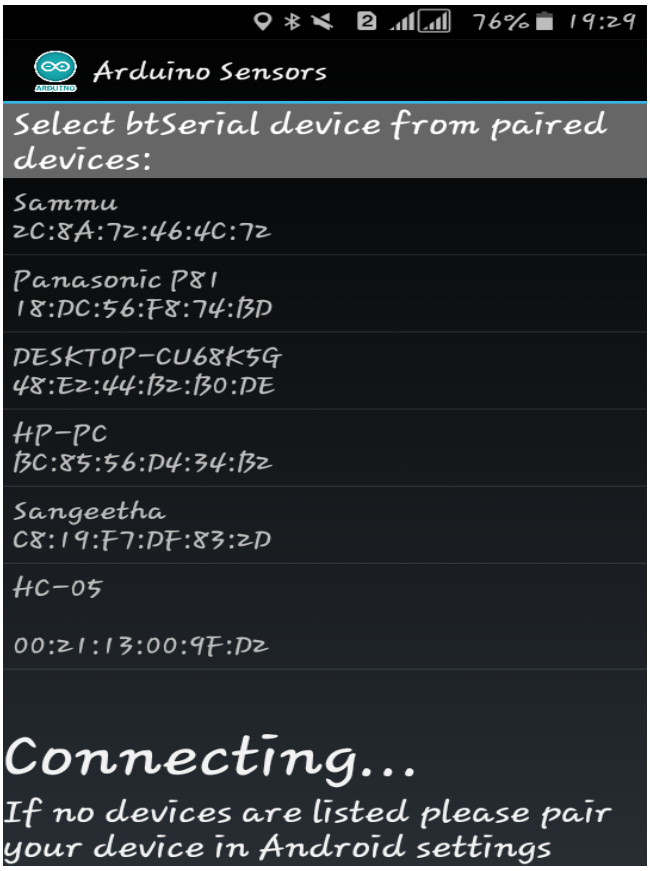

Figure .6

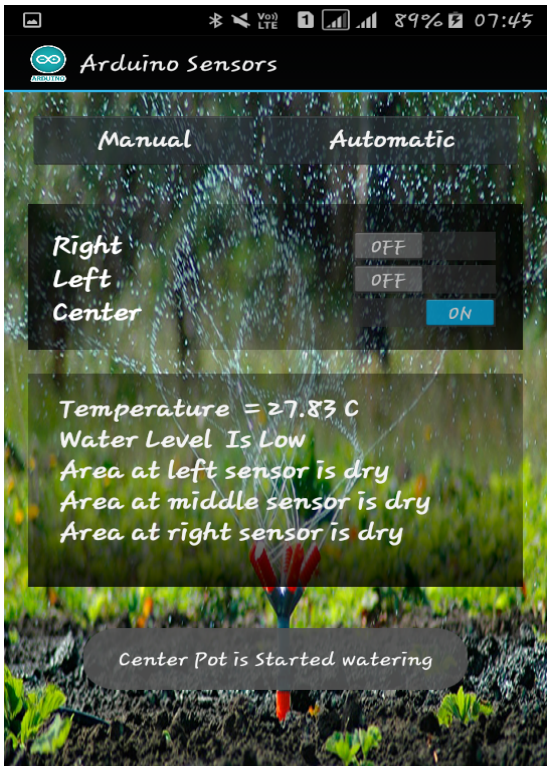

Figure .7

6. RESULTS

The system is developed and tested under various conditions. The soil moisture is tested in all climatic conditions and results are interpreted successfully. The soil moisture sensor is tested in all conditions. Different readings were taken under different condition. The temperature reading was taken under different weather conditions. The wireless transmission was achieved using Bluetooth. The data was stored in local database. The input voltage resistance values for different soil conditions obtained are represented in Table 1.

Table 1. Voltage Resistance values for different soil condition

Parameters	Soil Condition	Minimum value	Maximum value
Input value	-	3.6V	5V
Output value	Dry Soil	600	<600
	Humid Soil	350	750
	Water Soil	0	400

The power requirement for a single sensor system installed is discussed. The Arduino microcontroller requires a 5V power supply. The average power consumption because of the electronic components is 60 mAh in operational mode. However, the total average power consumption is 3Ah per day for a single motor pump.

7. CONCLUSION

The automated irrigation system implemented is found to be feasible and cost-effective for optimizing water resources for agriculture production.

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 the 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 the user interface much simpler by just using SMS messages for notifications and to operate the switches.

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