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IoT Based Smart Irrigation and Environmental Monitoring System

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ABSTRACT: In agriculture, efficient water management is a major concern in many cropping systems. This problem inspired to the idea of having a smart irrigation system that able to cope with this situation. Smart irrigation system is a system which consists of a microcontroller, moisture sensor, temperature sensor, humidity sensor, a relay board, an electronic pump and a LCD to display the moisture level of the soil. When the condition of watering the agricultural farm is abnormal, then the system automatically switches ON the motor. This process will continue until an optimum moisture level is obtained by using the moisture sensor and the Arduino Uno controller. Humidity and Temperature sensors are used to monitor the environmental conditions. Hence, this system is designed to save the water used for irrigation. In addition, Global System for Mobile Communication (GSM) is used to inform the user about the exact field condition and also status of the motor. The watering system developed is suitable for any plants, since the system able to customize with different soil, and with different crops that need different kind amount of water.

KEYWORDS: Agriculture, Irrigation, Sensors, Crops

I. INTRODUCTION

The Internet of Things is often referred as internet of 'Everything' or the internet of Intelligent Objects. It is a technology which enables the direct connection between physical devices and computer based systems. With the continuous development in technology, today, the communication between people is decreasing while human beings are getting more interacted to their devices. The advantage of IoT technology is continuously increasing due to the growth of cloud computing, mobile technology and data analytics. It includes various technologies that cover wireless sensor networks, RFID enabled tracking, embedded systems, internet connected wearables and so on [2].

In the present situation, the farmers have been irrigating the land with manual control at regular intervals. This method sometimes consumes more water or sometimes the water reaches late due to which the crops get dried. Nowadays there are many technologies were developed to automate the irrigation system [5]. The Internet of Things (IoT) is transforming the agriculture industry and enabling farmers to compete with the massive challenges they face. The technology must overcome growing water shortages, limited accessibility of lands, difficult to supervise costs, while meeting the rising consumption needs of a global population that is expected to grow by 70% by 2050. New innovative IoT applications are addressing these issues and increasing the quantity, quality, cost effectiveness and sustainability of agricultural production.

In paper [10], the author proposes the Zigbee based environmental monitoring system by using the monitoring sensors and Zigbee. This system helps the farmer to see the accurate changes in the environmental conditions.

In paper [4], the author introduced the irrigation system with the help of GSM and microcontroller. Whenever the sensing logic senses that the soil is in dry condition, then the controller automatically turns on the motor.

In paper [11], the author provides the solution for the irrigation system by irrigating the land according to the water content present in the soil.

II. SYSTEM ARCHITECTURE

Fig. 1 describes the architecture of the proposed system Smart Irrigation System. In this system real-time monitoring parameters for temperature, humidity in the atmosphere and content of moisture level in the soil are the important factors for obtaining high-quality for system operation [3].

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At the beginning of a measurement interval, the Arduino Uno microcontroller supplies power to the circuit and sensors. A soil moisture reading is taken by measuring the frequency of the alternating signal from the binary counter. The temperature sensor [LM 35] and humidity sensor [DH 11] is also interfaced in the microcontroller to monitor the environmental conditions [3]. Checking the environmental conditions helps the farmer to choose appropriate crop at the particular season and improves the production.

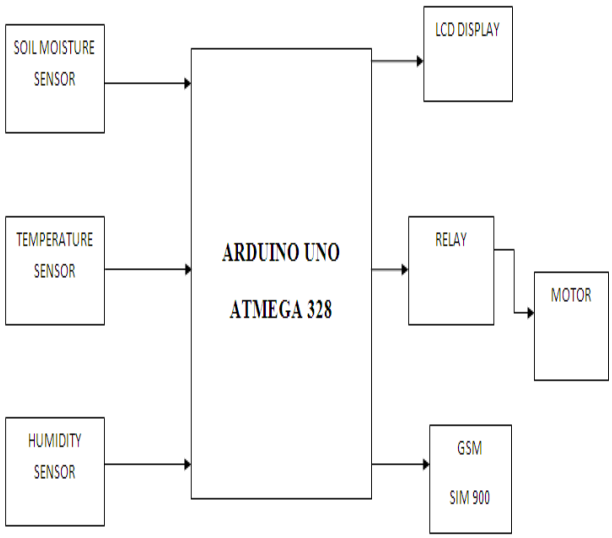

Fig. 1 Architecture Diagram

In the smart irrigation system, the motor can be automatically turned on whenever the moisture level of the soil is low. It can be achieved by comparing the sensor value with the predefined threshold values. Whenever the sensor value is less than the threshold, motor is switched ON and the Microcontroller sends message to the farmer in the form of SMS through GSM [10]. The temperature, Humidity and moisture data is also displayed in the LCD display connected to the controller.

III. SYSTEM DESCRIPTION

A proposed system gives water to the plants where water is needed with the required amount with the help of soil moisture sensor. When compared with the conventional irrigation system that works on the principle of timer based irrigation, gives water to the plants where plants are irrigated even when there is no need for water. This system also makes use of temperature and humidity values of the environmental conditions.

A GSM is a short message based interface which is used to send SMS to the farmer whenever the soil condition is abnormal and is also displayed in the LCD. In this system, the moisture value obtained from the sensor is compared with the threshold value and the plant gets irrigated whenever the soil level goes beyond the threshold level. Monitoring the environmental conditions will be useful for the farmers to know the types of crops to be cultivated at the particular season.

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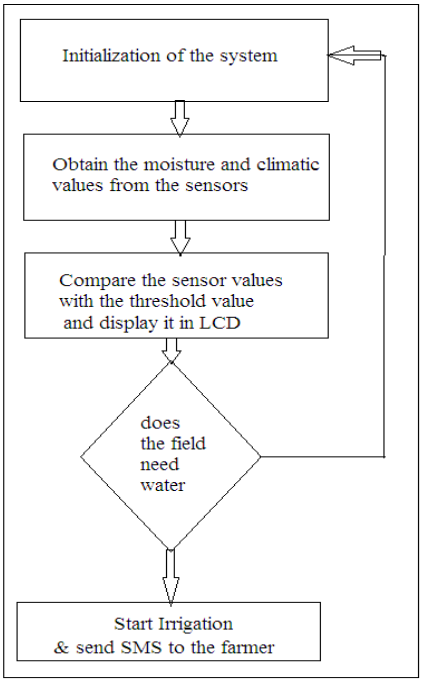

Fig. 2 Flowchart of the proposed system

1. Hardware Description

a. Arduino Uno Microcontroller

It is a microcontroller board based on ATmega328. The Uno comes preprogrammed with a boot loader for uploading a new code without the use of an external hardware program. It consists of a 16MHz ceramic resonator, 6 analog inputs, 14 digital input/output pins, a USB connection, a power jack, a reset button and an ICSP header. It contains everything needed to support the microcontroller. By connecting the controller to a computer with a USB cable or power it with an adapter or battery to get started.

Fig. 3 Arduino Uno

b. Soil Moisture Sensor

This sensor is used for sensing the water content of the soil in the field. The moisture sensor has two probes and uses them to measure soil moisture in the soil by telling how well an electrical current is passed between the two probes. The amount of current passing between the probes is directly proportional to the soil moisture content. Moist soil allow more current to flow between the probes while drier soils only allow a little current to flow between the probes. Better conductivity indicates a lower electrical resistance.

Fig. 4 Soil Moisture sensor

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c. Temperature Sensor

The LM 35[1] series are precision integrated- circuit temperature sensors. The cost is very low and it is small size sensor. Its temperature range is - 55° to +150°C.

Fig. 5 LM 35

d. Humidity Sensor

The humidity sensor is used to measure humidity of the field [1]. This sensor senses the field humidity and is connected to the microcontroller.

Fig. 6 DH 11

e. LCD

It is an electronic display module commonly used to display various devices and circuits [8]. 16x2 LCD display is very basic module and these modules are chosen over seven segments and other multi segment LEDs. It can display 16 characters per line and there are 2 such lines. This LCD consists of two registers, namely, Command and Data. The command instructions given to the LCD can be stored with the help of command register. The ASCII value of the character to be displayed on the LCD can be stored by using Data register.

Fig. 7 LCD

f. GSM SIM 900

It is a quadband solution which can be embedded with the customer application. It is a typical set developed by the European Telecommunications Standards Institute (ETSI) to describe technologies such as 2G and 3G. The packet oriented mobile data service can be obtained by General packet radio service (GPRS) on the 2G and 3G cellular messaging system's global system for mobile communications (GSM). GSM use serial communication to interface with the farmers and need Hayes well suited AT commands for communication with the any microprocessor or microcontroller system.

Fig 8 GSM-SIM 900

2. Software Description

Arduino IDE is the open- source Arduino environment makes it easy to write code and upload it to the input/output board. It runs on Windows, Linux and Mac OS X. The setting environment is written in C and based on Processing and other open source software. To upload a coding into the arduino controller it should be connected to the system using USB cable.

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IV. EXPERIMENTAL RESULTS

The moisture sensor which is inserted in the soil and the real time moisture value is compared with the threshold value (for example 500) by interfacing it with the microcontroller.

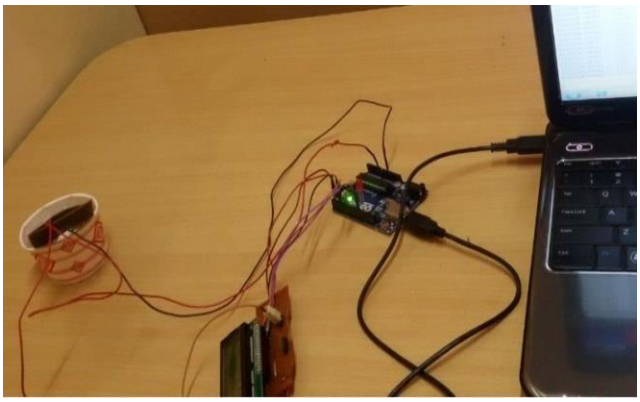

Fig. 9 Moisture Sensor is Interfaced in the Microcontroller

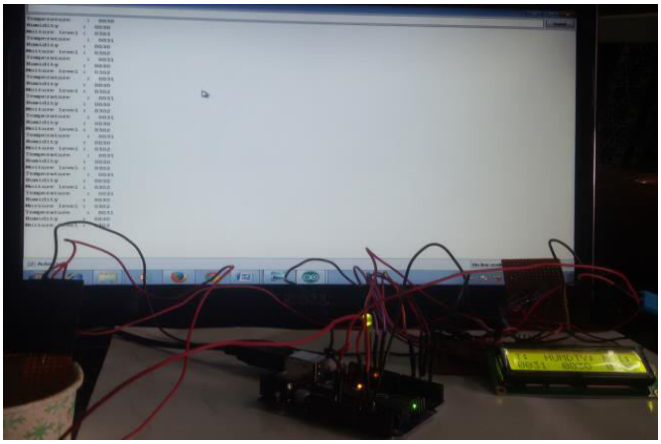

Fig. 10 Interfacing other two sensors and displaying the value in the LCD

The information is passed onto the user in the form of SMS. One can check the status of the field and motor status on mobile via SMS. The messages are sent from GSM to mobile with the help of AT Commands.

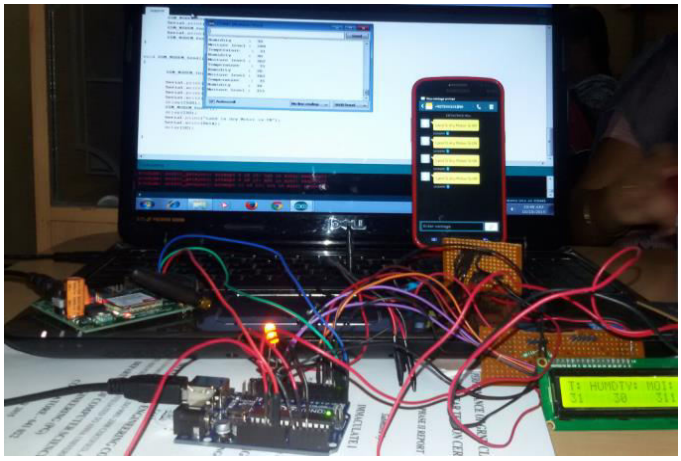

Fig. 11 GSM Interfaced with Arduino

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Fig 12 displays the message received by the farmer when the land is dry.

Fig. 12 User mobile

IV.DISCUSSIONS

In order to determine the different moisture level of the soil it is tested with different types of soil and environmental conditions. When the moisture sensor tested in different soil, it will have different reading, as there is change in resistance, hence the moisture sensor needed to be calibrated to suit with different kind of soil.

Table. 1 Calibration results for soil moisture sensor

Sensor Reading	Soil Condition
0 - 300	Dry soil
300 - 700	Humid soil
700 - 950	Saturated with water

Table. 2 Different sensor values at different timings

Time	Moisture level (%)	Temperature Level (centigrade)	Humidity level (%)	Motor status
10.00 AM	570	30	31	OFF
10.10 AM	570	30	31	OFF
10.20 AM	560	30	31	OFF
10.30 AM	560	30	32	OFF
10.40 AM	580	30	32	OFF
10.50 AM	570	30	30	OFF
11.00 AM	530	32	30	OFF
12.00 PM	290	33	30	ON
01.00 PM	700	33	30	OFF

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The above table shows experimental results for the system test in the field. In this node, the test has been started at the ten o'clock AM and the soil moisture sensor is placed in a wet soil. Therefore, the soil moisture sensor noted with 5V reading and according to the determined irrigation conditions (i.e) whenever the moisture value is less than 500 the node started the irrigation process.

Advantages of the Proposed System

1. It improves the quality and quantity of crop productions.
2. A user-friendly interface is developed to visualize the daily moisture data.
3. Wireless monitoring of field not only allows user to reduce the human power, but it also allows user to see accurate changes in it.

V. CONCLUSION AND FUTURE WORK

The SMS Based smart Irrigation System is built to reduce the human work and also to save the water by irrigating the field when it is needed. Monitoring the environmental conditions will help to suggest a type of crops to be cultivated at that particular season to increase the productivity. GSM Module board can be inserted into the system to notify the user regarding the moisture level of the soil, so that user able to get notification regarding his farm soil moisture level through a mobile phone.

The future work of the proposed system is to check the water level in the well. If adequate water is presented in the well then the Arduino microcontroller will activate the pump to water the plants else the controller will return notification which will be sent to the farmer via SMS. The system is also interfaced with pH sensor to test the pH values of the crops and cultivate accordingly.

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