Real Time Monitoring of Environmental Parameters in Precision Agriculture using Wireless Sensor Network

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ABSTRACT

Wireless Sensor Network consist of group of sensors for monitoring and recording of physical conditions of environment. WSN organizes these recorded data at a central location. This technology is used in many applications like military, health care, agriculture, smart home etc. In the proposed system we use WSN technology for agriculture application for monitoring of soil parameters, such as soil temperature, soil humidity, soil moisture and send this data to microcontroller using wireless technology. Earlier, agriculture is done manually by performing the task such as planting or harvesting, against a predetermined schedule. Now by collecting the real time data on weather, soil, crop maturity and availability, predictive analytics can be used to make smarter decisions. We use the Arduino Uno R3, a microcontroller board based on the ATmega328P. It is used to obtain real time values of the plant and also performs analysis on the data acquired. The LM35 temperature sensor is used for measuring the soil and environment temperature. The Soil moisture sensor is used to measure the moisture content of the soil and the soil humidity sensor, LM393 comparator with humidity sensor measures the humidity of the plant.SIM900A is a Tri-band GSM/GPRS engine that enables message sending over the network to the particular mobile device, with details about the soil parameters such as soil moisture, temperature and humidity of the plant. The water motor is intended for the use of watering the plant. As the soil moisture of the plant or crop decreases, the motor automatically switches on. It runs until optimum moisture is reached and then switches off.

Keywords: Wireless Sensor Networks, Precision Agriculture, Remote Monitoring, Global System for Mobile Communication, Sensors.

I. INTRODUCTION

Wireless sensor networks are spatial sensors which are widely used in agriculture across India. WSN’s are used in order to increase the productivity of the crop as well as crop monitoring. The proposed system uses Wireless Sensor Network (WSN) technology for precision agriculture. The architecture of the system consists of sensor nodes for monitoring environmental parameters. These sensors sense the parameters like temperature, humidity and soil moisture and send this data to base station for decision making. This proposed system gives higher yields compared to traditional method of farming. The collection of real time data reduces labour cost and increases crop cultivation [1]. Sensors are deployed in the area where there is the need of environment monitoring and control decision and for the tasks that need more time resources if it is done manually. Some of the applications like animal tracking, electronic commerce, agriculture etc need real time data. These data which is obtained by sensors are correct, consistent and react in an efficient way.

In this paper we demonstrated with tomato plant in small area but this can be implemented by deploying sensors in large area. Sensors should be battery operated with integrated GPS within each sensor. Sensors are distributed in entire field for every 500m and each sensor is configured and has their own unique id. Sensors monitor the environment parameters at different times of day which helps in conserving battery power. Sensing very frequently consumes more power and sleep and wake concept can also be used for battery conservation [4]. Soil plays an important role in cultivation. Correct quantity of water to soil or crop at right time and at right depth of soil helps to yield more crops otherwise overwatering will affect growth rate of crop, seed quality and also effects productivity of crop. This proposed automated system has a benefit of irrigating crop at right time in right quantity and to right depth of soil.

II. AGRICULTURE FIELD MONITORING

It has been observed that the yield rate in agriculture has not been improving. So many agriculturists have developed
different methods and have come up with various monitoring and analysis systems which could help the overall crop yield. The advancement in wireless sensor technology is used in monitoring various environmental parameters in agriculture and farming. With the evolution of miniature sensor devices coupled with wireless sensor technologies, it was possible to monitor environmental values such as soil moisture, soil temperature and soil humidity. This paper was also presented for the automatic irrigation which is used to increase time and profit of the farmer and the motor runs only when there will be a requirement for watering the crop. Using this kind of automatic monitoring system this automatic monitoring system will help farmers to improve their yield [5].

Precision agriculture, using wireless sensor network will ensure higher crop yields and lower labour costs by real-time analysis and automatic monitoring of environmental and soil conditions using various sensors and also improving crop management, reduced waste and labour [2]. This project was implemented using tomato plant for trial to monitor real time parameters like soil moisture, humidity and temperature of soil using Wireless Sensor Network. To increase the productivity of the crop, optimum water for irrigation is useful in order to improve overall water management and we got the output which shows crop yield increase using this method. Wireless sensor network is used for the water pump to toggle between on and off position based on the soil moisture value to increase the crop productivity and to reduce the cost for cultivation and make use of real time values [7]. This system is developed to modernize the farming techniques in agriculture and also provide the adequate irrigation by using Arduino controller and GSM and sensors, which serves as an important part and is responsible for irrigation controlling on field and is sent to the receiver through receiver SMS alert[11]. The information was given on user request in the form of SMS. The GSM, SIM900A was controlled with the help of standard set of AT commands [12]. These commands were used to control majority of the functions of the GSM modem [11]. A GSM-short-message based interface was implemented for sending real-time measurements of environmental parameters, and alarm rings when a measurement is beyond some pre-defined threshold. Using this system the Farmer can remotely monitor the crops even though he is not physically present in the field [10].

### III. SYSTEM ARCHITECTURE

![Proposed System Architecture](image)

The system consists of the following components and is connected as shown in fig 1:

- Arduino Uno R3
- LM35 Temperature Sensor
- LM393 comparator with Humidity Sensor
- Soil moisture Sensor with Hygrometer
- 16X2 LCD Display
- SIM900A GSM Module
- Compact Demand Water Pump 12V DC
- Optocoupler
- Power supply with Relay

### IV. TOOLS INTRODUCTION

#### A. Arduino Uno R3

An Arduino Uno R3 is a microcontroller board based on the ATmega328P. It consists of 14 digital input/output pins, six analog inputs, a 16 MHz quartz crystal, an USB connection, a power jack, an ICSP header and a reset button.

#### B. Soil Hygrometer Detection Module Soil Moisture Sensor for Arduino

Soil hygrometer is a simple water sensor that can be used to detect soil moisture when the soil moisture deficit module outputs a high level, and output low we can use this sensor
to produce an automatic plant waterer device, so that the plants can be managed in the garden without the people.

C. **LM393 comparator with Humidity sensor**

It is a ultra low-cost digital temperature and humidity sensor which measure the presence of water in air [6]. It uses a capacitive humidity sensor and a thermistor to measure the encompassing air, and spits out a digital signal on the data pin.

D. **LM35-Temperature Sensor**

A LM35 sensor is a precision integrated-circuit temperature sensor, whose output voltage is linearly proportional to the Centigrade temperature. The LM35 do not require any external calibration or trimming to provide typical accuracies of ±1/4˚C at room temperature and ±3/4˚C by a full −55 to around +150˚C temperature range [9].

E. **Global System for Mobile Communication**

A standard GSM in general has one sim port and an antenna which receives the signals from the system. It is used to send the text message to the registered number in the code [8].

F. **Compact Automatic Demand Water Pump – 12v DC**

Water pump is intended for use in 4WD and other RV applications in conjunction with a BOAB poly water tank. Readily the pump can be connected to an open hose and a suitable12v switch used to turn the flow On/Off. Based on the level of moisture in the soil the pump is automatically turned on or off to supply water accordingly.

G. **Liquid Crystal Display(LCD)**

We used LCD which displays the three parameters such as Soil moisture and Humidity and soil moisture of the tomato plant. The variations in these parameters are constantly shown on the LCD display. Also it indicates the state of the water pump.

V. **IMPLEMENTATION**

A. **Soil Moisture Sensor and Irrigation**

Soil moisture with the hygrometer is a sensor which is connected to an irrigation system controller. This sensor can measure soil moisture content in the active root zone of crop before each scheduled irrigation event and it bypasses the cycle, if the soil moisture is above the user defined set point. Soil moisture sensors measure the real time moisture. The reading is taken in the month of May 2016 from 1 to 13th at 11.00 AM on daily basis as shown in fig 2.

Algorithm for sensing soil moisture

1. If (the moisture_value > 50)
2. Water_Pump turns off
3. LCD setcursor set to 0
4. Print High Moisture on LCD
5. GSM sends an SMS to registered number
6. else if   (moisture_value lies between 25 and 50)
7. Water_Pump remains off
8. Print Normal Moisture on LCD
9. If (moisture_value <25)
10. Water_pump turns on
11. Print Low Moisture on LCD
12. GSM sends an SMS to registered number

![Fig 2: Day Vs Soil Moisture Sensor](image)

B. **Temperature and Humidity Sensing**

We used LM35 sensor for sensing soil temperature which is a precision integrated-circuit which has an output voltage linearly-proportional to that of Centigrade temperature. The reading is taken in the month of May 2016 from 1 to 13th at 11.00 AM on daily basis as shown in fig 3.

Algorithm for sensing soil temperature

1. If (temperature is >45)
2. LCD setcursor set to 0
3. Print High Temperature on LCD
4. GSM sends an SMS to registered number
Fig 3: Day Vs Temperature Sensor

The LM393 is a comparator with humidity sensor attached. It makes use of capacitive humidity sensor and a thermostat in order to measure the surrounding air, and gives a digital signal on the data pin. The reading is taken in the month of May 2016 from 1 to 13th at 11.00 AM on daily basis as shown in fig 4.

1. LCD setcursor set to 0
2. Print Humidity_value on LCD

Fig 4: Day Vs Humidity

C. GSM Module AND SMS Sending

AT command tester is a free online software tool which is applicable in testing AT commands, Farmer receives SMS using SIM900 which is quad band modem which offers many GPRS functionalities and fig 6 shows how the farmer receives message and hat are message contents. T stands for Temperature, H stands for Humidity and M stands for soil Moisture. Moisture 1 indicates High Moisture and Moisture 0 indicates Low Moisture.

Algorithm for validating mobile number

1. Validate the mobile_number to which SMS is sent
2. Print AT+CMGS
3. Print Mobile_number
4. sends an SMS

Fig 5: Combined Module graph

Fig 6: Snapshot of SMS received on the receiver’s mobile phone.
D. Hardware Setup

![Fig 7: Hardware Connection of Proposed System]

VI. SCOPE AND FUTURE WORK

Precision agriculture technology enables the farmers to monitor and control farming activities more efficiently. Real time monitoring of the parameters such as temperature, soil moisture and humidity enables overall increase in yield optimization and also reduction in wastage. Based on the type of crop, the threshold value of these parameters can be varied accordingly, thus providing crop heterogeneity.

Further studies and future work include:

1. Analysis of Soil Nutrients and crop productivity
2. Automatic Maintenance of water level in tank
3. Efficient power supply means to run the entire system
4. Implementation of alternate energy resources and rain water harvesting techniques
5. Application of Clustering algorithm for sensor activity in fields

VII. CONCLUSION

The paper investigates the recent advances in remote wireless sensor devices, and how WSN of these devices used in crop field for monitoring environmental conditions. The proposed system architecture was developed and prototype hardware was built for monitoring environmental parameters like temperature, humidity and soil moisture and remote monitoring crop by sending SMS to farmer using GSM technology. This proposed system increases the crop yield with less man power and low cost. The device will successfully help in growth of a plant by monitoring temperature, humidity and soil moisture without human interference.

Acknowledgement

I would like to express my thanks to UG students Chandrakala, Deeksha, Nikhita Jayakumar, and Yashaswi G for supporting me to complete the work.

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