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A Prototype of Wireless Sensor Network Used In Precision Agriculture

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Abstract- A Wireless Sensor Network (WSN) consists of spatially distributed autonomous devices using sensors to monitor both environmental or physical conditions. In agriculture, WSNs are used for increasing the performance, high power efficiency and real time monitoring of environment. This paper proposes a real time system in which sensors are used and Arduino to monitor the temperature, humidity and soil moisture and hence presents the data to the users. We have also used solar sun tracker to increase the overall efficiency of the whole system. It uses Light Dependent Resistors (LDR) to sense the sunlight from the sun to convert it into voltage and generates electricity. This system can also be used in the remote areas.

Keywords- Wireless Sensor Network, Light Dependent Resistor, Precision Agriculture, Threshold.

I. INTRODUCTION

WSNs has different uses such as to monitor the area, industrial monitoring, healthcare monitoring. For all the countries, agriculture is the main source of food supply whether it is under developed, developing or even developed country. The demand of food has increased in a rapid rate due to high increase in population. Precision Agriculture (PA) is a system information based and technology- driven which is designed to improve the agricultural practices and processes to maximize the farm productivity. Environmental factors affecting agricultural activities are ambient temperature and humidity. Monitoring environmental parameters and to make use of the resources through the design and implementation of systems are important parameters. In this paper, we present a real time agricultural environmental monitoring system using WSN based on Arduino which is capable of measuring temperature, humidity and soil moisture. GSM Module sends the information gathered by the environment to the farmer's phone and this gathered informatio helps the farmer to decide further.

Rest of the paper is organized as follows, Section I contains the introduction of WSN, Section II deals with related work associated to WSN, Section III discusses the methodology for designing WSN which can be used for Precision Agriculture, Section IV discusses results and discussions, Section V gives the conclusion with future scope.

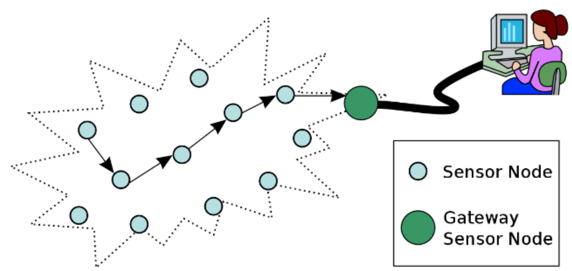

Fig 1: Architecture of WSN

II. RELATED WORK

Storage of various measured parameters, monitoring and acquisition are provided by WSNs. For control and optimization strategies, the stored data is applied for crop production. A low cost sensor system is also deployed which gathers the field data and displays it through a Graphical User Interface (GUI) [1]. Sensors such as humidity, temperature, moisture, electrical conductivity is used for data acquisition and Raspberry Pi which acts as a local server is used for data processing and transfer.

After potato and sweet potato, tomato is the world's largest vegetable crop. The tomato production highly depends on the climatic factors such as humidity, air temperature, soil temperature and soil moisture. Therefore, monitoring the climatic conditions is important for the high productivity of tomato. This work proposes a design that can monitor the soil temperature, soil moisture and water level of a reserve and the information is transmitted to a remote collector outside the field [2]. The system consists of a microcontroller, WSN base station, information gathering nodes and sensors.

In Precision Agriculture, WSN system is used that comprises of various sensor nodes and base station which communicate with each other and the information is gathered for making decisions [3]. It also discusses the opportunities and challenges for WSN used in Precision Agriculture.

There are many topologies available for WSN and each topology has its own importance [4]. In grid topology, access point is in the middle of each cell of the farm. The other topology which is random in nature is set just like grid topology. Sensors and access pints are distributed in an unexpected section. Random topology throughput is lower than that in grid.

The WSN is a real time system which is based on sensors and Arduino to monitor the temperature and humidity of the environment [5]. This system consists of sensor network which is built with Arduino for the parameter measurement and to present the result to the users, a web application is running.

For increasing the productivity of crop and profitability of farm, there are various irrigation mechanisms that are introduced in recent years. Different types of sensors are used for the monitoring of field and to control the agricultural farm. ARM LPC2148 microcontroller is used for such a system [6]. The sensors that are employed in this system are PH sensor, temperature, humidity, soil moisture sensor, level sensor, leaf sensor and phase sensor. The proposed system is a real time feedback control system that can monitor and control the irrigation system effectively. The user receives the information gathered in the form of SMS with the help of GSM Module which is used in the system.

The WSNs plays a vital role in the automatic monitoring of environment and to control the parameters of Greenhouse for Precision Agriculture. A Programmable System on Chip Technology (PSoC) is proposed to monitor and control various parameter of Greenhouse [7]. The system comprises of a data collection machine, a manager vehicle and a system to control the greenhouse parameters. This system handles local field survey and checks for the availability of water in the soil, local climate conditions, fertility of soil, yield of grain etc.

III. PROPOSED WORK

The growth of crop is affected by various agricultural parameters like temperature, humidity of the surrounding environment and soil moisture. We have used DHT 22 sensor to measure the temperature as well as humidity of the surroundings and soil moisture sensor to measure the available volumetric water content of soil. These sensors are connected to an Arduino microcontroller board which is called Arduino UNO. The power supply that is given to this system is the solar cell. We have used solar sun tracker as a power supply. As far as the power supply is concerned, there are still some places where there is no electricity. That's why we have used solar cells for giving the power supply. We can generate more energy with solar tracking as the solar panel can maintain a perpendicular profile to the rays of sun. LDRs are used for sunlight detection. The circuit consists of AT Mega 328P microcontroller. It is programmed to detect sunlight through LDRs. The solar panel gets positioned to a place where it detects maximum light. DC gear motor is used in the sun tracker. Tracking is used to increase the efficiency of solar panels and it reduces the cost. We have used dual trackers because they track sunlight from both axes and hence it is more efficient. We have used two LDRs for the solar sun tracking. This sun tracker will be in stable position when the two LDRs receives the same light intensity. When the sun moves from west to east, the intensity level changes and this change is calibrated into voltage with the use of voltage dividers. The changes in voltage are compared using built-in-comparator of microcontroller and motor is used to rotate the solar panel in a way as to track the light source. A photoelectric cell which is commonly known as a solar cell is used for the conversion of solar directly into electrical power. The solar sun tracker is programmed in such a way that if there is no light, then it is positioned to stop position. It also moves clockwise and anti-clockwise direction depending whether there is sun radiation or not. It is programmed through 8051 microcontroller. A variable resistance is used in the solar sun tracker to vary the intensity of LDR.

The comparator IC LM358 is used to amplify LDR signal. We have used this IC as it is low power and it is very easy to use. This signal is passed to 8051 microcontroller. After that it is passed to L293D which is motor driver IC. The microcontroller is programmed in such a way that when this signal is passed to motor driver, it rotates the motor clockwise and anticlockwise.

The sensor nodes collects the useful information of the surrounding environment. The data from each sensor node is sent by the GSM module which keeps it in a local database. The soil moisture sensor is fully buried into the soil for proper functioning. While the DHT22 sensor is placed in the open area since it is monitoring external factors such as temperature and humidity of the surroundings.

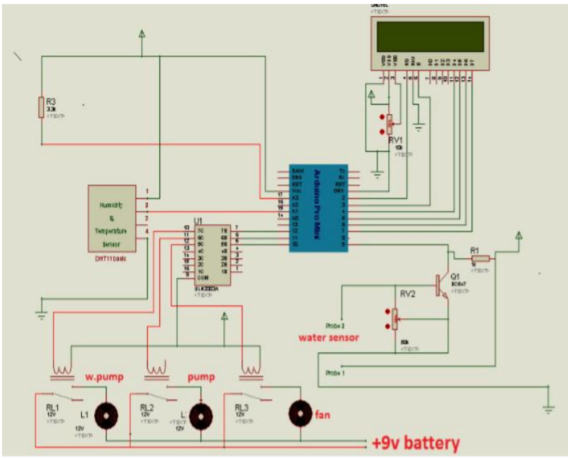

Fig 2: Circuit Diagram

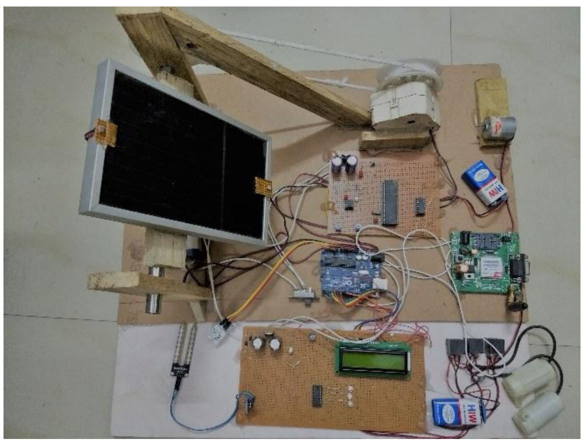

Fig 3: Figure of whole system

The sensor nodes continuously transmits data to the local server placed close to the system. The whole system will run on its own without any human disturbance.

We have used GSM module Sim 900A modem for the data transfer from sensor node to the user's handset. It is built with Dual Band GSM/GPRS engine which works on frequencies 900/1800 MHz It has RS232 interface which allows user to connect PC as well as microcontroller with RS232 chip. Using this modem, the information is sent to user's handset in the form of SMS. At the receiver's end, we have also used 16*2 LCD display for displaying temperature as well as humidity of the surroundings. The humidity and temperature range is kept within a certain threshold value. So when it exceeds above the threshold value, an SMS is sent to user's handset and hence it runs without human intervention.

IV. RESULTS AND DISCUSSIONS

In this section, the simulation of different components used in the system is shown. The sensor nodes are deployed in the network for getting precise information about the surroundings and moisture of soil. Arduino IDE is used for simulation purpose. It is an open source Arduino Software (IDE) that makes it easy to write codes and upload it to the board.

```
sketch_dec09a | Arduino 1.8.4
File Edit Sketch Tools Help
sketch_dec09a

void setup()
{
  Serial.begin(9600);
  lcd.begin(16,2);

  pinMode(soil, INPUT);

  pinMode(fan, OUTPUT);
  pinMode(spray, OUTPUT);
  pinMode(motor, OUTPUT);

  lcd.createChar(1, degree);
  lcd.setCursor(0,0);
  lcd.print("Green House    ");
  lcd.setCursor(0,1);
  lcd.print("  Monitering");
  delay(2000);

  lcd.clear();
}

void loop()
{
  /*-----Light Intensity------*/

  DHT.read22(dht_dpin);
  lcd.clear();
  lcd.setCursor(0,0);
```

Fig 4: Codes to give name to the system

```
sketch_dec09a | Arduino 1.8.4
File Edit Sketch Tools Help
sketch_dec09a

void loop()
{
  /*-----Light Intensity------*/

  DHT.read22(dht_dpin);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print(" humidity=");
  lcd.print(humidity=DHT.humidity);
  lcd.print(" % ");
// lcd.clear();
  lcd.setCursor(0,1);
  lcd.print("temperature=");
  lcd.print(temperature=DHT.temperature);
  lcd.write(1);

if(temperature > 40)
  {
    digitalWrite(fan, HIGH);
     Serial.println("AT+CMGD=1");    //Delete privious sent SMS
  delay(1000);

  Serial.println("AT+CMGF=1\r");   //Set SMS configuration
  delay(1000);
  Serial.println("AT+CMGS=\"+917488682089\"\r");   // 8700178776use your 10 digit cell no. here
     Serial.println("TEMPERATURE INCREASES FROM CRITICAL LEVEL");
     Serial.println("FAN TURNED ON");
```

Fig 5: Codes for temperature measurement

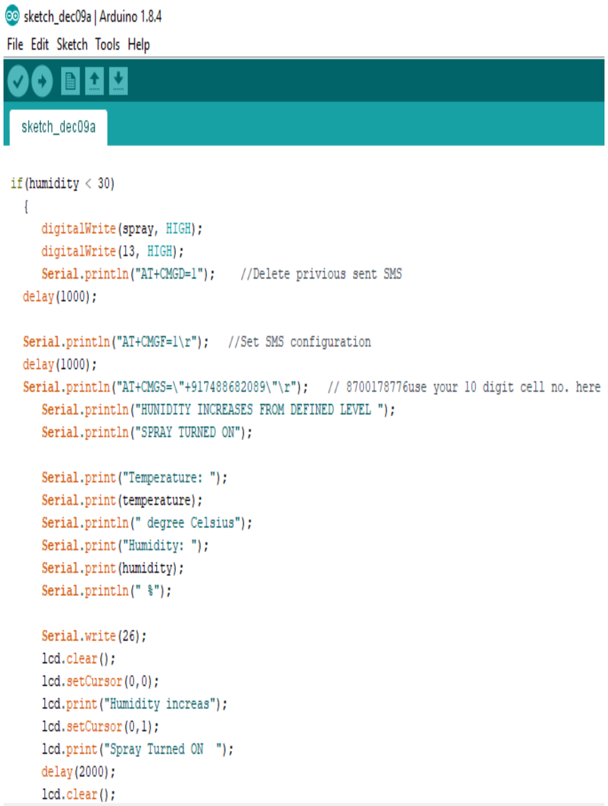

Fig 6: Codes for humidity measurement

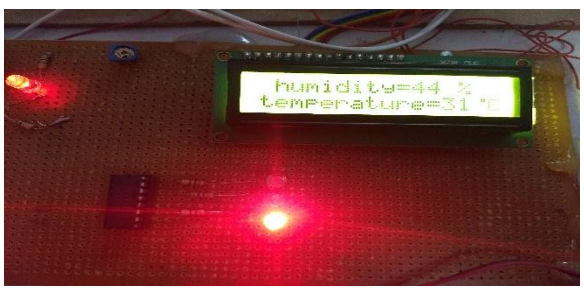

Fig 7: Humidity and temperature reading

There is one relay driver that drives the three relays in the circuit. The first relay is connected to spray, second relay is connected to fan and the third relay is connected to motor. There are also three LEDs which are connected to these relays. We have selected a threshold value for temperature and humidity of surroundings. The humidity for surrounding is kept below 30%. If the humidity goes above this value, then the first LED connected to first relay will glow and the spray will start automatically. Also we have selected a threshold value for temperature and this is above 40 degree Celsius. If the temperature goes below this value then the second LED will glow and the fan will move automatically and cools down the temperature. When the temperature is cool then the LED will be off by the relay. The third relay is connected to motor. The soil moisture sensor reads the water content of soil. If the soil is dry then it is read by the soil moisture sensor and LCD displays a message that water is required and automatically motor is turned on by the third relay. Hence we can maintain the environment for the growth of crops without any human effort. The whole system will run on its own without any human disturbance.

V. CONCLUSION

This study presents the development of a Wireless Sensor Network application as a sustainable and accurate solution in monitoring temperature as well as humidity of the surroundings. It also measures the available volumetric water content of soil. The whole system ran on its own without human intervention. When the user is far from the field, he can receive the messages which are gathered from the field in the form of SMS by GSM Module. Hence he can monitor the whole area even when he is far from the field.

It can be extended by adding more sensors such as the sensor for the measurement of ph. of soil, soil electrical conductivity sensor for the measurement of available nutrients present in the soil like Nitrogen, Phosphorus, Iron etc. which are useful for the proper growth of plants. This helps in increasing the productivity and quality of crops.

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Authors Profile

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