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Comparative Analysis of Agricultural Field Monitoring Techniques

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Abstract- In the recent year Wireless Sensor Networks (WSNs) have fascinated much attention in various research areas. The wide and useful applications of WSNs are tremendous. They are starting from collecting, storing up to sharing sensed data. WSNs have been used for numerous applications like Area monitoring, health care monitoring, environmental/earth sensing, industrial monitoring etc. Nowadays Wireless Sensors Network (WSN) widely used to provide solution on Precision agriculture to overcome various problems in the real-world (field). This paper best describes review on WSN different technologies associated it with that results as the best way to solve the agricultural problems related to farming like resources optimization, decision making support, land monitoring etc. The comparison also made between various parameters like technology, monitoring system etc to understand the system in depth for further research purpose.

Keywords- WSN, Precision Agriculture,M2M Communications, ZigBee, GSM.

I. INTRODUCTION

In today's era, agriculture needs such tools and technology that improves the efficiency and quality of production and reduce the environmental effects on the yield. The wireless sensor network in agriculture may put forward the fundamental solution contribution to precision agriculture. The precision agriculture is defined as the technique of applying the right amount of input (water, fertilizer, pesticides etc.) at the right location and at the right time to enhance production and improve quality, while protecting the environment. A wireless sensor network is simply defined as collection of nodes organized into a cooperative network.[1] Each and every node having its own processing capability. It consists of number of components like controllers, CPU and coprocessor or DSP processor, may contain multiple types of memory (program, data and flash memories), have a RF transceiver (usually with a single Omni-directional antenna) have a power source (like batteries, solar cells etc), and accommodate various actuators and sensors and the nodes communicate wirelessly and often self-organize after being deployed in an ad hoc fashion.

In view of increased competition for resources and the need for increased agricultural production to ensure national and global food security, it is clear that we need to increase our efficiency of irrigation water use, to adapt to these changing conditions. Not only do we need to increase the overall efficiency of irrigation water use to optimize crop yields, but there is also a need to provide farmers with better information on root zone water availability and daily crop water use, especially at critical times during flowering, fruit set and fruit or seed development. Although crop yield is oftentimes related to water use, most growers don't know the water requirement of the crop they grow at any real level of precision. Since irrigation costs in developed countries are usually a small fraction of total production costs, there are few incentives for growers to optimize their use of irrigation water. Therefore, the amount of water applied is mostly based on the availability, rather than actual crop water needs. The development of precision (low volume) irrigation systems as shown in figure1, has played a major role in reducing the water required to maintain yields for high-value crops, but this has also highlighted the need for new methods for accurate irrigation scheduling and control. Table1 shows Existing Remote Monitoring and Control Systems.

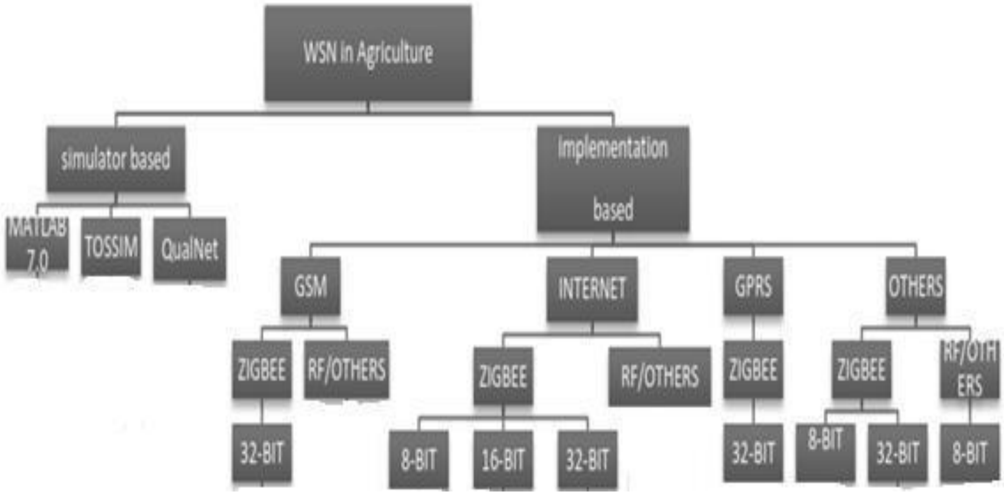

Figure 1. Classification of systems[1]

Monitoring System	Technology	Module Interfaced	Processor	Sensor Interfaced
Laptop	Zigbee, internet	-	89c52	Moisture sensor
Mobile	Zigbee, GPRS	JN5121	ARM9	Soil moisture/ temperature
LCD	RF	CC1110	8051	-
Laptop, pda	Zigbee, internet	CC2420	MSP430	Temperature/ humidity/ illumination
-	GSM, RFID	-	-	Camera nodes, cattle sensor network, soil moisture.
Laptop, PDA	RF, internet	C43271	C43271 and PSOC	Touch, Temperature, moisture, Light
-	Single sensor node	-	89C52	Temperature/ humidity / ph
PC	Zigbee	nRF905	89C51	Temperature/ humidity
TFT-LCD	Zigbee	nRF905	MCF52235	Temperature/ humidity
PC	Zigbee, Internet	Zigbee module 3160	SPCE061A	Temperature/ humidity/soil temperature/ soil moisture/co2/ illumination
Laptop, pda	Zigbee, internet	MSENS SoC		Air Temperature/ humidity/soil temperature/ soil moisture/ anemometer /radiometer /rain gauge/ CMOS image
PDA	Zigbee, internet	Zigbee transreceiver & 8-Bit MCU		Light/ temperature / humidity
PDA	Zigbee, internet	JN5121 with On chip 32 bit core		Light/ temperature / humidity/ wind speed
NRF905	wired ADSL, internet	PC	Atmega-128	-
Mobile	WSN & GSM	-	-	Temperature / Soil Moisture/ Humidity

Table1: Classification of Existing Remote Monitoring and Control Systems

II. LITERATURE SURVEY

A .Sensor-based M2M Agriculture Monitoring Systems

Machine to machine (M2M) communication in [6] is an emerging technological framework where daily use machines such as refrigerator, micro-oven, cell phone, laptop, tablet, smart phone, electric meter can communicate with each other and send data to the M2M central server or cloud through M2M area networks (e.g., sensor, RFID, Bluetooth) and core networks (e.g., WLAN, 3GPP, IP, WiMAX). Thus, monitoring devices and applications are connected to each other to work as a large scale framework of M2M. Figure 2 illustrates M2M communication network architecture. A machine is known as a machine type communication (MTC) device. The MTC devices communicate with each other and send data to the MTC gateway of M2M area networks through multi-hop communications. The MTC gateway again transmits data to the backhaul core networks through MTC routers having a large communication range. Hundreds of low cost, energy and computational power wireless sensor nodes are mostly used as MTC devices in the M2M area networks since sensors can be deployed easily, controlled automatically and monitored remotely. Sensors include low power radio and power management mechanisms to conserve energy for a longer time network operation.

B. Wireless Monitoring Using Zig-Bee

paper[6] gives a review of remote control and monitoring systems based on existing technologies and a GSM-ZigBee based remote control and monitoring system with automatic irrigation system is proposed. The proposed hardware of this system includes 8 bit AVR, Bluetooth module, Temperature, humidity and soil moisture sensors, LCD. The system is low cost& low power consuming so that anybody can afford it. The data monitored is collected at the server. It can be used in precision farming. The system should be designed in such a way that even illiterate villagers can operate it. They themselves can check different parameters of the soil like salinity, acidity, moisture etc. from time to time.
During irrigation period they have to monitor their distant pump house throughout the night as the electricity supply is not consistent.
The system can be installed at the pump house located remotely from the village, it is interfaced with the pump starter & sensors are plugged at different location in the field for data acquisition. Using this system they can switch on their pump from their home whenever they want. The two Transceivers are designed. As shown in figure 3 & 4 system works in two parts.

- Transmitter
- Receiver

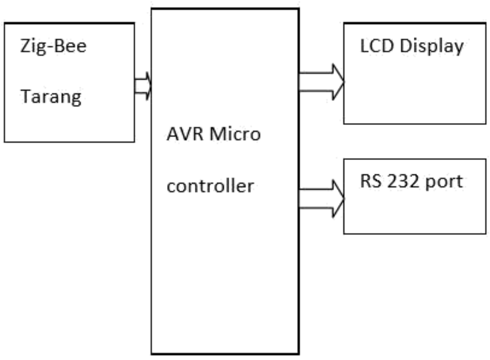

Figure 2. Transmitter

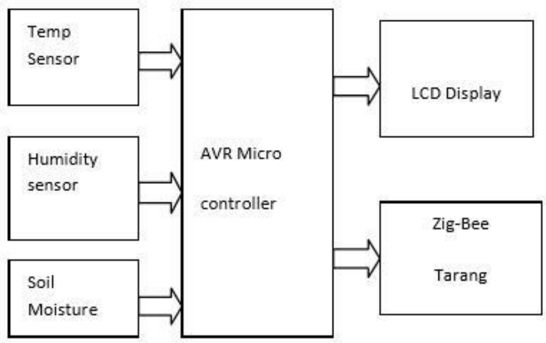

Figure 3. Receiver

C. Cloud IoT and Android System

There are direct and indirect measuring techniques in [7] that are used to measure the soil moisture. The Gravimetric, nuclear and electromagnetic techniques are direct measuring techniques. Capacitive, resistive, tensiometric and hygrometric are indirect measuring techniques. A gravimetric technique which is a direct measurement technique can be a reference method for measuring Soil Water Content (SWC). In this technique, weight of the soil with the container is measured before and after drying at 105ºC for 24 hrs. The fraction of the weight of water (Mw) to the weight of dry soil (Ms) gives the gravimetric water content (W = Mw/Ms). But this technique is not suitable for regular monitoring of soil moisture; especially in agriculture fields because it is laborious and cumbersome processThe hardware is developed in the present work is built around the Texas Instruments' SimpleLink Wi-Fi module available in the form of LaunchPad: CC3200 and the FC-28 soil moisture sensor. The firmware is developed using Energia Integrated Development Environment (IDE). The methodology involves sensing the moisture using FC-28 sensor and these values are processed to a CC3200 LaunchPad. Using on-chip Wi-Fi the values are uploaded to Cloud technology and mobile application for monitoring. The real time sensor data will be seen in AT&T'sM2X webpage and Blynk application on a mobile phone.

D. Monitoring using RF Module

In this study, Rain sensor was placed on the Field. When rain falls on the field, its shorts the rain sensor and activate the shield via PIC. The shield rolls a sheet across the field. Now, when raining stops, the shield was activated to its initial state. Thus rain sensor-pic-shield provides protection from rain.

Soil moisture sensor was placed across the field to check the moisture level. The moisture level was classified into 3 types: low, medium, high. According to the above moisture level, the valve was opened. When the moisture level is low, the valve was opened for 5sec . This was a continuous process till the moisture was increased to medium. When the moisture level was medium, the valve was opened for 3sec. This process was a continuous one, till the moisture level was high. When the moisture level was high, the valve was closed.

Temperature sensor was placed on the field. When the temperature was high, the fan was activated via PIC. The critical temperature at which the fans get activated was decided by the PIC. Thus the temperature sensor helps in stabilising the temperature with less tolerance. nemometer along with the IR module was used to measure the wind speed. Depending on the wind speed, the window frame was adjusted using PIC. The outputs of the rain sensor, moisture sensor, anemometer and temperature sensor were send to the monitor using a RF module. The RF module consists of a RF transmitter and receiver operating at 434MHz. An encoder and a decoder were placed along with the transmitter and receiver respectively for proper data transfer. The receiver was placed near the screen. The output of the receiver was send to the screen to monitor the field. The Humidity Sensor is used to find the humidity of the Greenhouse. The control units have the MCU to check the reading and make the fan ON or OFF. Then status of the Greenhouse will send to the user Mobile through GSM Module.

E. Monitoring and Automation using GSM

The monitoring and GSM systems in [9] are developed in this project is for use in green house applications, where real time data of climate conditions and other environmental properties are sensed and control decisions are taken by monitoring system and they are modified by the automation system and sends SMS that what operation is performed by them to user . The architecture of a green house monitoring system comprises of a set of sensor nodes and a control unit that communicate with each sensor node and collects local information to make necessary decisions about the physical environment

III. PROPROSED WORK

Here we have dynamically monitored agriculture parameters using IoT. The proposed system consists of Microcontroller LPC2138, LCD Display, Soil moisture sensor, Temperature sensor, Rain sensor, Relays, Fan, Solenoid valve, DC motor, Shield, Bluetooth module and Field phone to store the data received from the farm. All the sensors are interfaced to microcontroller. This microcontroller-based system monitors and records the values of temperature, light, soil moisture and rain drop of the natural environment that are continuously updated in order to optimize them to achieve maximum plant growth and yield.

All this data is sent via Bluetooth module to the field mobile where we have built Android APP to monitor the parameters. This field mobile acts as a server. Later this data can be accessed from anywhere using web servers. The user can continuously monitor and control the parameters according to his need. Figure 4 shows the block diagram of our system.

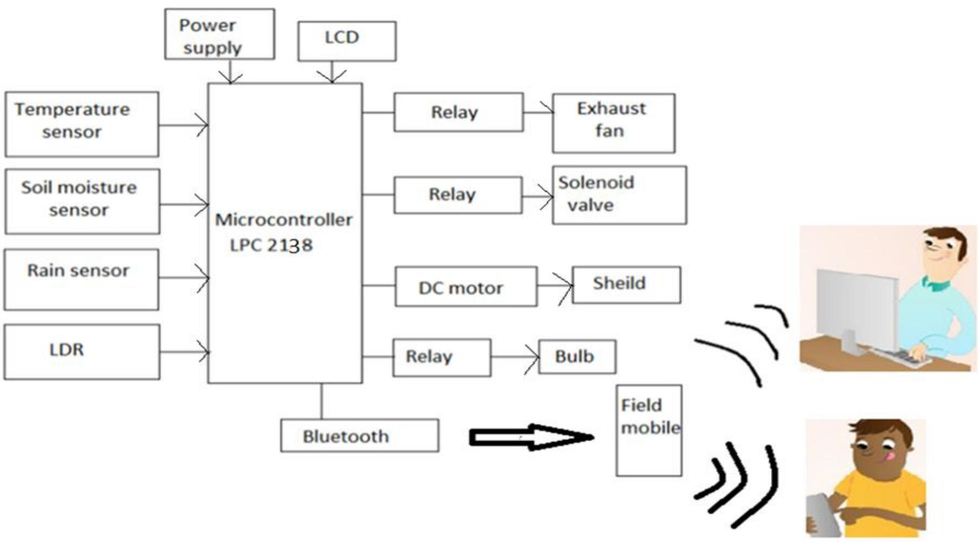

Figure 4. Block diagram of system

Here, Fan is used to maintain the temperature at desired level i.e. if temperature exceeds above threshold then Fan will be turned ON to maintain the temperature otherwise Fan is OFF similarly, Solenoid valve is used to control the supply of water flow, shield is used to limit the amount of water falling on plants and LDR is used to control the light intensity.

IV. TEST CASES AND RESULTS

To verify the agricultural parameters and monitoring system proposed in this paper, a prototype was built and tested.

Soil moisture sensor (YL69) -

The two copper leads act as the sensor probes. They are immersed into the specimen soil whose moisture content is under test. The conductivity of soil depends upon the amount of moisture present in it. Soleniod valve turns on immediately when the moisture level goes below the threshold level.in this way the moisture of the soil is retained.

Rain sensor (FC37)-

Servo motor controlled shield is made to protect the crop from direct exposure to rain. If the intensity of rain is above threshold level rthe shield is closed .

Temperature sensor (LM35) –

Fan is used to maintain the temperature at desired level i.e. if temperature exceeds above threshold then Fan will be turned ON to maintain the temperature of the field otherwise Fan is OFF.

LDR-

It is light dependent resistor. The resistance of LDR changes with change in intensity of light. If the intensity is less than the threshold value then the bulb will lit up to provide the sufficient light to plants.

Hardware section:

Prototype of greenhouse has been made here. We have monitored different parameters like temperature, rain, soil moisture and light. Accordingly changes were made via feedback parameters as shown in table 2.

The threshold values set for the sensors are as follows-

Temperature sensor – above 35 degree celcius the exhaust fan switches on
Moisture sensor- below 22mm of moisture level motor turns ON to supply water
Rain sensor- above 32mm of rain shield closes
LDR- below 50% of light intensity level bulb turns ON

Figure 5. Greenhouse protoype

SENSORS USED	FEEDBACK PARAMETERS
Temperature	Exhaust fan
Moisture	motor
Rain	shield
LDR	bulb

Table 2. Sensors and feedback parameters for controlling action

Software section:

We have developed an Android application using ECLIPSE software which acts as an server for storing the real time results. This application is installed in field mobile. When the Bluetooth gets connected to this field mobile the real time values of the parameters are displayed on the screen and also on the web page.

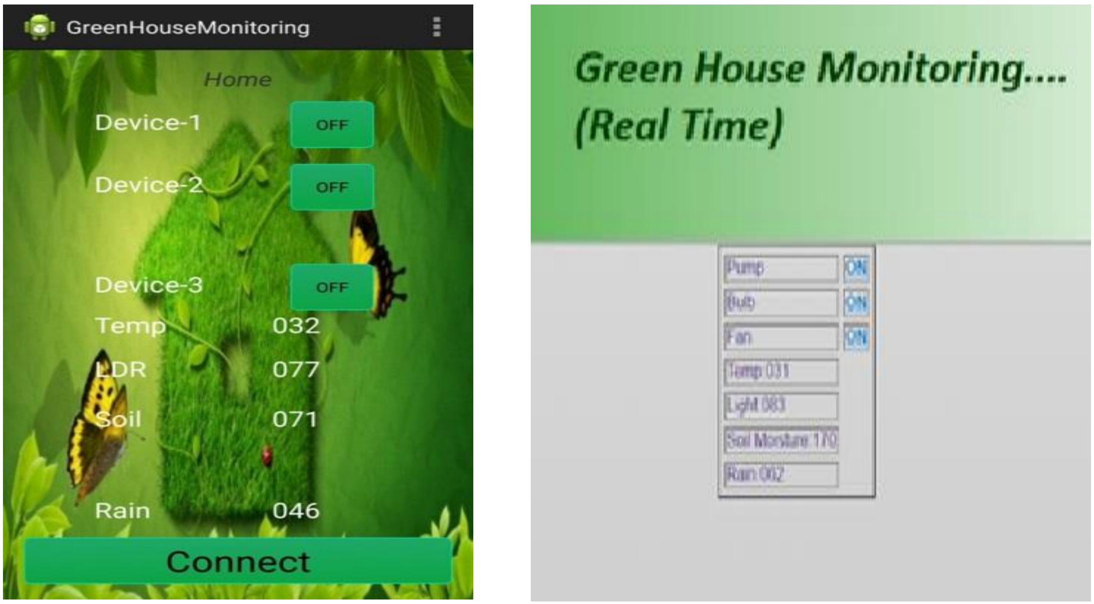

Figure 6. Real time results

V. CONCLUSION

Using IoT technology the person can observe the data anywhere and can react quickly to the changing parameters of farm Excess watering and scarcity of water in the soil can be easily monitored and can be controlled. If two anemometers are put at different heights on the same mast can provide useful additional information about the wind shear. As the shield is provided , rain water harvesting technique could be effectively utilized.
With the wide improvement of wireless and GSM technology. The system may be cost with wireless sensors may little cost but it works with more effectively.

The system may be implemented with the help of many technologies but this technology is more reliable, easy to implement, works effectively and easy to operate. It is a comprehensive system designed to achieve precision in agriculture with keeping farmer's ease of access to the data in mind.

VI. FUTURE ENHANCEMENT

Agriculture is the main occupation of rural areas. But the main problem in rural areas is load-shedding. So when the electricity cuts-off our system will halt as it requires continuous supply. To overcome this we can utilize solar energy to charge the rechargeable batteries which can then be used as power source when electricity cuts-off. NPK sensors can be used to monitor the NPK contents of the soil. Also the amount of fertilizers present in the soil can be monitored .

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