Monitoring agriculture parameters using WSN for improving crop production

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Abstract- *Agriculture is the backbone of a Country's economic prosperity and there is a strong interdependence between agri- cultural growth and economic benefits. The production scale of agriculture is continuously reducing in the recent periods. Therefore a new and effective technology is needed, which can improve the productivity, profitability and sustainability of the major farming systems. Real time monitoring of different clima- tological parameters is essential for the better maintenance and management of agricultural growth and production. Monitoring these parameters manually is difficult and time consuming. Wireless sensor nodes have the capability to reduce the effort and time needed for monitoring the overall environment. The main intention of this work is to design and develop an agricultural monitoring system using wireless sensor network for monitoring light intensity, soil moisture and soil pH, which will enhance the productivity and profitability of farming.*

Thus this work includes the set up of a WSN for monitoring agricultural parameters and development of a mobile application to notifies the farmer when critical change in one of the measurement occurs.

Keywords- wireless sensor network (WSN).

I. INTRODUCTION

In India, the agricultural sector occupies a significant po- sition in the overall economy[1]. Agriculture plays an indis- pensable role in providing the human livelihood. In addition to that, agriculture is the basis of providing huge scale occupation to the general population. Agricultural growth is fundamental because, it helps in transforming the nation's economy from traditional to an advanced economy. Particularly in the case of India, this transformation is well known for its agricultural production. Thus Agriculture posses a prominent position in Indian economy not just on account of its commitment to GDP but also because of the dependency of the large scale of the population on the sector for its livelihood[2].

But agriculture in India is undergoing a structural change, which leads to a drastic situation. The scale of production of agriculture is continuously reducing in the recent periods. The low agricultural productivity in India is a major problem that affects the economic growth of the country. The factors that inhibit the growth of agricultural production in India includes the natural factors such as uneven distribution of rain, deficiency of nutrients etc[3]. Nowadays going through the newspaper, there can see lot of news that had reported the crop loss in India[4][5]. And also the suicide rate of farmers are increasing due to this severe crop loss[6][7].

Therefore, a new and effective technology is needed, which can improve the productivity, profitability and sustainability of the major farming systems. Climatological condition mon- itoring is one of the most essential aspects in the field of agriculture, that has an immediate effect on the productivity and sustainability of field crops.

Most of the countries does not have any suitable framework for implementing such a programs to monitor crop production. The conventional method of monitoring parameters includes the field survey conducted by the staff from the appropriate Government authorities, during which they acquire the knowl- edge regarding their crops from the village officials or farmers. This information is then analyzed to improve the productivity of the monitored crops. This conventional and traditional sur- veys are considered to be both expensive and time consuming. Moreover, the information collected by the conventional and traditional methods are often erroneous and unreliable, which lead in an inaccurate crop yield forecasts. Also subsequent difficulties will be experienced for the agricultural experts on both a regional and a national scale.

In this contest, wireless sensor nodes have the capability to reduce the effort and time needed for monitoring the overall environment. Wireless Sensor Network (WSN) refers to a group of spatially distributed or deployed autonomous sensors[8] for cooperatively monitoring the physical, natural or environmental parameters such as light intensity, wind speed, temperature, humidity, sound, vibration or other parameters, which will transmit their data through the network to a destination. The importance of wireless sensor

network is increasing exponentially due to its usage in monitoring wide variety of applications.

Therefore this paper proposes an agriculture monitoring system that monitors the agricultural parameters and gives the alert message to farmers when critical change in one of the measurement occurs.

The rest of this paper is organized as follows: Section II presents the basic idea of wireless sensor network. Related works are described in section III. Section IV describes the proposed work that includes system architecture and the experimentation result. Finally, the paper is concluded in section V.

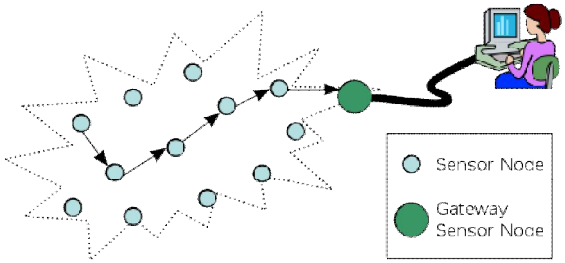

Fig. 1. Basic Architecture of WSN

II. WIRELESS SENSOR NETWORK

Wireless sensor network (WSN) refers to a group of spa- tially distributed or deployed autonomous sensors for coop- eratively monitoring the physical, natural or environmental parameters such as light intensity, wind speed, temperature, humidity, sound, vibration and many other factors.

A typical sensor node will consist of the following four key components: a sensing unit, a processing unit, a transceiver unit and a power unit. Going through the Fig. 1, it is clear that there are various sensors which are distributed or scattered in a particular region. These sensors sense the physical parameter using the sensing unit, process it and there is a transmitter with them, which will transmit the sensed data. The data sensed by one node is passed onto the next and to the next one and so on. Ultimately the data is send to the end system known as the gateway, that is the gateway of this network. From this end node, the data is send to the user. The user may be located at tones of kilometers away from the sensor nodes, and in between there is a communication channel.

Some of the features of wireless sensor networks includes:

- Random deployment of nodes.
- Heterogeneity of nodes.
- Cooperative effort of nodes.
- Scalability.
- Low power and memory.

Nowadays sensor networks are used in the field of health monitoring, military, environmental applications, agricultural applications, home applications and other commercial applications. Within an agricultural environment, wireless sensor network can contribute a vital role in improving the crop production.

III. MONITORING SYSTEMS IN AGRICULTURE

The study conducted by the researchers on the agricultural field revealed the fact that agricultural growth is decreasing day by day due to many factors. The efficient utilization of effective technology can increase the productivity of agricul- tural growth and can reduce the extra man effort required for that. So many researchers have studied different aspects of agriculture and came up with various monitoring systems that has the direct impact on increasing the agricultural yield. This section provides the idea of some researches that are carried out in field of agriculture.

The system developed in [9] is responsible for monitoring the parameters, such as light intensity, temperature and hu- midity. The proposed system is based on WSN consisting of following components: base stations, environmental monitor- ing nodes and communications systems. There is a particular structure for the hardware system and software system that are assigned the work of monitoring. As usual, the data collected by the sensors are transmitted to the sink wirelessly. The sink in turn transmit the data towards the control center. The control information can be transmitted by the control center to any node in the network if required. The proposed system had developed a system based on the cluster topology. It includes the sensors that follows the hierarchical routing protocols. The sensor nodes are grouped into some cluster. Thus it includes mainly two types of nodes, cluster-head node and common node. Each of this node have different functionality. The common nodes are responsible for collecting and transmitting the data towards the cluster-head node. The collected sensory information is saved within a database.

In [10], Izzat Din Abdul Aziz developed a remote tem- perature monitoring system based on wireless sensor network incorporated with Short Message Service (SMS) technology. System is subdivided into four parts namely data acquisition, data communication, data presentation and alert notification. Wireless temperature sensor is responsible for

monitoring the temperature data. The monitored information is then trans- mitted to the access point at the computer. The system's control panel will receive this data. The data is then stored in the database within the system. There is a provision for the farmers to set a threshold limit for the parameters. An alert message will be transmitted to the farmer's mobile phone, via GSM modem through the cellular network if the monitored parameters exceeds the particular threshold.

In [11], Gerard Rudolph Mendez considered temperature, soil moisture, humidity, air pressure and light intensity as the important measuring values. This proposed system is developed on the basis of WSN802G WiFi / 802.11 mod- ule. It is used for communicating data to a selected Server. Various sensors are linked with this WSN802G module. The parameters are monitored, transferred and saved in the server at user defined intervals. A standard Wireless-G router or a wired Ethernet connection are used by the server to have a connection with the network.

In [12], Ibrahim Al-Adwan developed a system with a central station and local stations. The role of the local station is to obtain the greenhouse environment factors such as tem- perature, humidity and light by the corresponding sensors. The control system consists of parts such as: Data acquisition of the environmental parameters through sensors, the processing of data, the actuation component carrying the necessary actions. Within the local station these sensors are connected to a PIC microcontroller. A ZigBee module is linked with the microcontroller to have a wireless connection with a central station. Each parameter has a desired value, which is compared to the received value from each local station. Based on both of this values, the central station acts as a controller for taking required action at each location.

In [13], Siuli Roy introduced a real life test-bed imple- mentation of a WSN for agriculture parameter monitoring. The system considered humidity, soil conductivity, soil pH and soil moisture as main parameters. It designed a wireless datalogger system called AgroSense which consists of four parts: an AgroSense Wireless Datalogger unit, a long Range Wireless Router, a Coordinator and a Web-based software. A maximum of four different types of agricultural sensors can be attached with the AgroSense Wireless Datalogger unit as per the demand of a specific crop. Long Range Wireless Router sends the monitored data from field to remote monitoring station. The Coordinator connected to the computer at the monitoring station retrieve the sensory data transmitted by the routers and a Web-based software with farmer friendly interface to provide required services.

By going through this section, it is clear that, various agriculture monitoring systems are developed by different researchers. Each of this developed systems have their own advantages and they concentrate on different agricultural pa- rameters. Monitoring of these parameters help the farmer to identify the unfavorable environmental conditions inside the land.

IV. PROPOSED WORK

An agriculture monitoring system using WSN is developed by setting up the three sensors such as soil moisture sensor, soil pH sensor and light sensor. The monitored information are transmitted to the PC through a ZigBee module in which it is logged within a database. The website and the android application will display these monitored parameters by reading it from the database. When critical change in one of the measurement occurs, an alert message is sent to the farmer's mobile.

A. System Model

The system block diagram is shown in Fig. 2. It is com- prised of sensor nodes with sensing capabilities to monitor parameters such as soil pH, soil moisture and light intensity. The sensor nodes are connected with a PIC microcontroller. The output of the microcontroller is transmitted to the ZigBee transceiver module which in turn passes the data to the ZigBee receiver module. The output of the ZigBee receiver module is transmitted to the system connected with the ZigBee. If the value of the parameters shows any critical changes, an alert is passed on to the farmer's mobile.

B. Hardware Setup

The hardware setup is shown in Fig. 3. As per the block diagram three sensors are connected with PIC microcontroller. From the microcontroller, the sensed data is transmitted to the ZigBee module through RS232 cable. ZigBee receiver transmit the data towards the PC. An android application code is build within the PC using Eclipse for alerting the farmer. The .apk file is installed within the android phone for running the code.

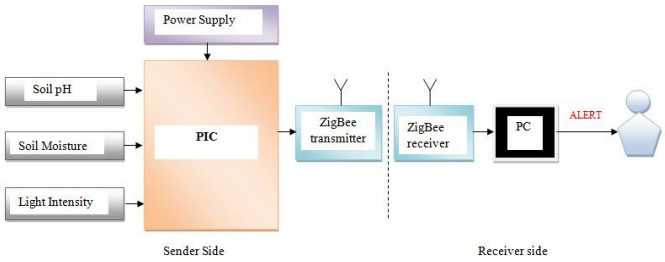

Fig. 2. Block diagram of the system

Fig. 3. Hardware setup of the system

C. Simulation test

Proteus simulator is used to simulate the circuit of the setup as shown in Fig. 4. The Proteus Design Suite is an Electronic Design Automation (EDA) tool including schematic capture, simulation and PCB Layout modules. It includes the circuit diagram of the microcontroller and three voltage supplies are given as input to the microcontroller indicating the three sensors. Virtual terminal is used to display the parameters indicating the Hyperterminal within the system.

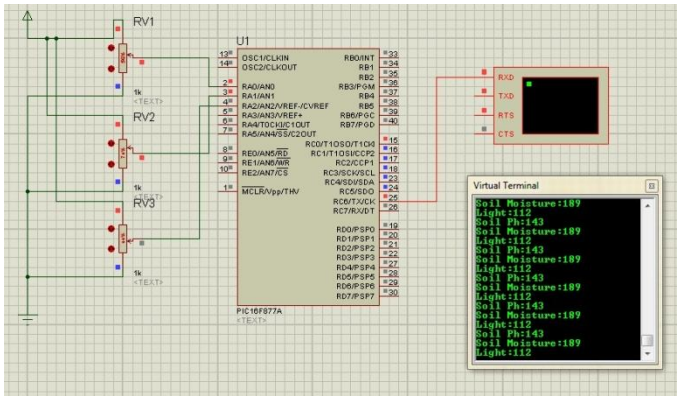

Fig. 4. Circuit Simulation

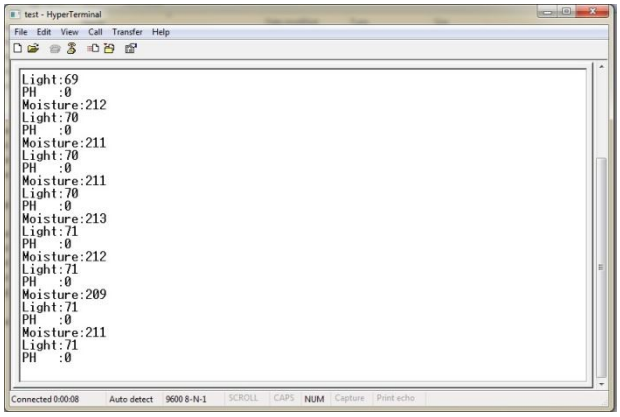

Fig. 5. Hyperterminal view of displaying monitored information

D. Experimentation Result

1) Hyperterminal View: Fig. 5 shows the display within the Hyperterminal. The value of the parameters sensed by the sensors such as soil pH, soil moisture and light intensity are displayed within the system. Thus Fig. 5 shows the value of each parameters measured by the corresponding sensors.

2) Website View: The proposed system had developed a website for agriculture monitoring system for displaying the monitored parameters. In this agriculture monitoring system, three databases are used. One for storing the login details of the admin, one for storing the details of the monitored parameters and the other for storing the details of the users. The website developed for agriculture monitoring system is shown in the following Fig. 6. The initial page is the login page for the admin. Whenever the admin is logged on to the site, corresponding username and password are verified by checking into the login database. If it is an authorised person, the monitoring details of the sensors will be displayed on the website. Otherwise an error message is shown in the site. The admin also has the provision to register a user by entering their name and mobile number which will be stored within the user details table. Fig. 6 shows the website view for displaying the parameters.

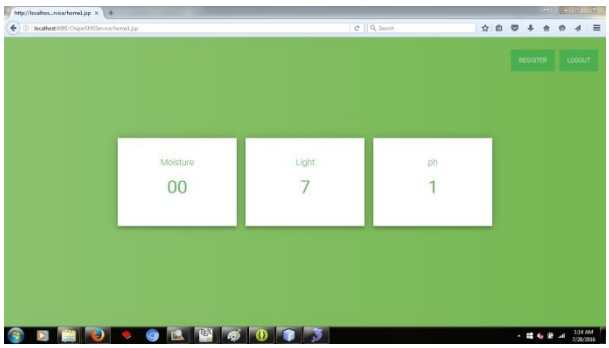

Fig. 6. Website view of displaying monitored information

3) Android application: The android application for agri- culture monitoring system is developed using the Eclipse

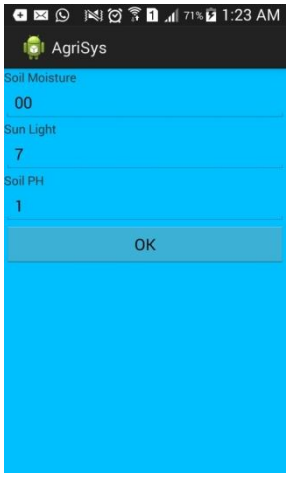

Fig. 7. Android app view of displaying monitored information

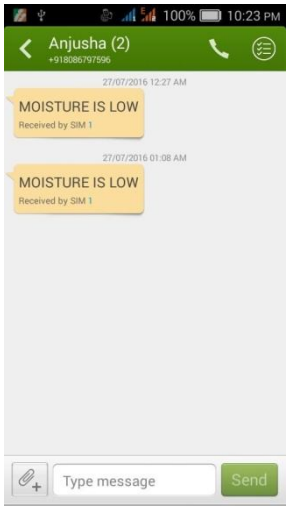

Fig. 8. Alert is passing to the farmer's mobile

software. Within the eclipse IDE, the src file contains the .java source files. An activity class is included within a MainActivity.java source file that runs when the application is launched using the app icon. The user interface for agriculture monitoring system is defined within the res/layout directory. The bin folder within the IDE contains the .apk file, that is the android package files built by the ADT during the build process and everything else needed to run an Android application. The .apk file is installed within the android phone for running the application. The initial page of the android application shows the login page for admin. When the admin is successfully logged in, admin can view the monitored parameters as shown in Fig. 7. When critical changes in one of the measurement occurs, an alert is passed on to the user's mobile as shown in Fig. 8.

V. CONCLUSION

In India, the agricultural sector occupies a significant posi- tion in the overall economy. The rate of growth of agricultural output is gradually reducing in the recent years. In order to improve the productivity, profitability and sustainability of the major farming systems, a new and effective technology is needed. Climatological condition monitoring is the most essential aspects in the field of agriculture, that has an im- mediate effect on the productivity and sustainability of field crop. In this contest with the evolution in wireless sensor technologies and miniaturized sensor devices, it is possible to uses them for automatic environment monitoring that helps in the enhancement of crop production. Wireless sensor nodes have the capability to reduce the effort and time needed for monitoring the overall environment.

WSN applications in the agriculture field presents an ex- citing new area of research that will greatly improve quality in agricultural production. Several agriculture monitoring sys- tem using WSN was developed to enhance the productivity and profitability of crop production. The proposed system for agriculture monitoring based on WSN had focussed on creating a website for displaying the monitored parameters and developing an android application for alerting the farmers.

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