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Development of WSN System for Precision Agriculture

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***Abstract*—The agriculture sector is changing rapidly pointing to the future of automated and embedded systems with an array of sensors to monitor and control the growing plants in a way to protect workers, the environment and profits associated with it. The continuous monitoring and controlling of distantly located plants is labour intensive and technically challenging business. In modern precision agriculture, a Wireless Sensor Network (WSN) provides a simple cost effective solution to monitor and control. The basic parameters to be monitored are temperature and humidity (moisture content in the soil). A smart low cost WSN system for precision agriculture is proposed for monitoring and control using open software and electronic prototype - ARDUINO.**

***Index Terms*— Agriculture farm, wireless sensor network, ZigBee.**

I. Introduction

In India, the agriculture sector plays a key role in demand driven economy and contribute to its GDP. The agriculture industry is drastically changing and there is a need to develop automated systems to monitor and control the growing plants. In agricultural and environmental sciences, it is important to be able to easily monitor filed and gather environmental information over long periods of time, but such monitoring is difficult and requires much effort[1, 2]. Monitoring and controlling the remotely and distantly located growing plants is labour intensive and technically challenging business. In modern precision agriculture, a Wireless Sensor Network (WSN) provides a simple cost effective solution to monitor and control. Employing the WSN would enable the users to monitor and control the environmental parameters influencing the plant growth. The role of WSN is to sense the remote data from the desired location and transmit the same through the wireless network which can be viewed by the receiver. WSN is a collection of various sensors that are deployed at location where the parameters are to be sensed, monitored and controlled. A WSN has the capability to send the correct and accurate information to the observing station [3,4]. The sensed parameters are transmitted to the observing station through wireless network. If the measured values are above a threshold or critical value an alarm can be generated or process can be actuated which reduces the risk of disaster. The deployment of WSN nodes in agriculture [5] is shown in Fig.1.

Fig. 1. WSN application in Agriculture.

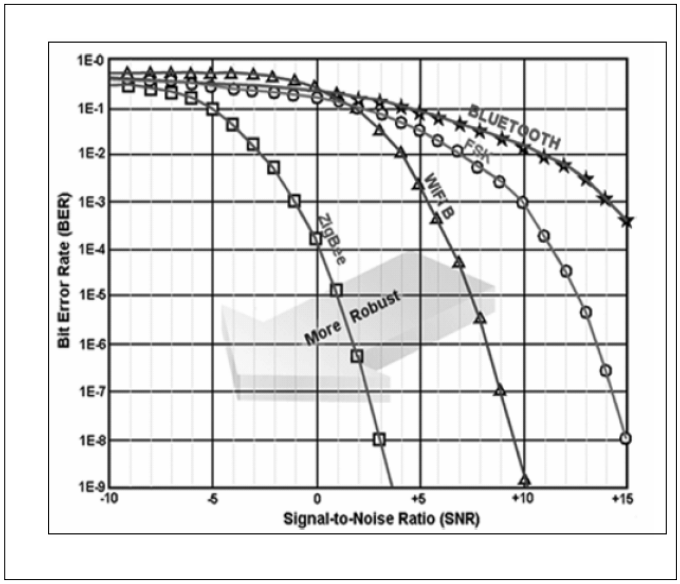

Fig.2. Comparison of ZIGBEE over other Wireless technologies.

The earlier monitoring systems had lot of limitations and were found to be inefficient. are inefficient and having many limitations such as distance and reliability factors. Earlier the wireless networks used RF technology and it was replaced by Bluetooth. Now the Bluetooth is replaced by ZIGBEE technology.

The Fig.2 depict the performance of ZIGBEE v/s other technologies. As the Signal-Noise-Ratio (SNR) increases the bit error rate (BER) decreases. This trend is observed in all the wireless technologies but ZIGBEE shows a prompt decrease of BER even for less SNR. This indicates that even in the presence of high noise strength almost equal to the signal strength, the system can trace the required signal eliminating the errors. This gives a very robust performance

II. Wireless Sensor Networks

WSN is a system consisting of a collection of nodes and a base station. A node is comprised of a processor, memory, sensors, radio and a battery. A base station receives the information and processes the data received by the node. The applications of WSN's are many and varied, and the applications in agriculture are still incipient. The crop conditions are to be monitored carefully to yield better harvest. To control and monitor the environmental factors, sensors and actuators are essential. The sensors are deployed in the field and the real parameters are monitored for distantly located plants. Thus WSN guarantees real time monitoring but also guarantee a better control. A WSN consists of two main parts: Data Acquisition Network and Data Distribution Network. The Fig.3 and Fig.4 shows a Real time schematic diagram and simplified block diagram of WSN respectively[6,7,8,9].

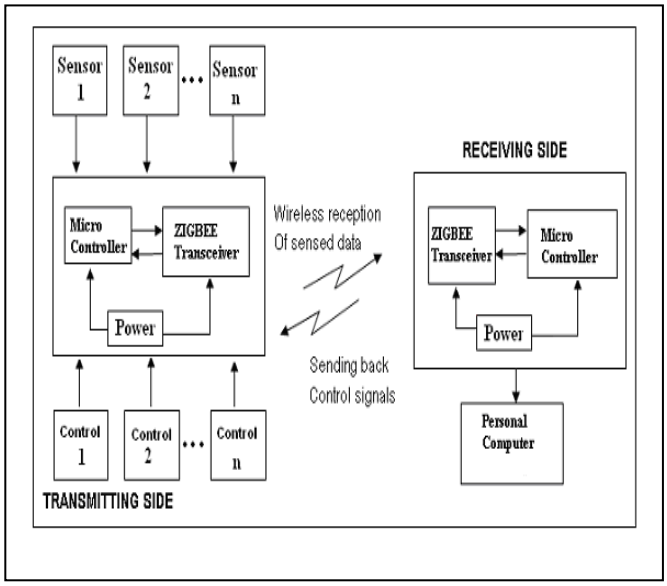

Fig.3. Simplified block diagram of WSN.

III. ZigBee

ZIGBEE is a specification for wireless personal area networks (WPANs) operating at 868 MHz, 902-928 MHz, and 2.4 GHz. A WPAN is a personal area network (a network for interconnecting an individual's devices) in which the device connections are wireless. Using ZIGBEE, devices in a WPAN can communicate at speeds of up to 250 Kbps while physically separated by distances of up to 50 meters in typical circumstances and greater distances in an ideal environment.

IV. Methodology

A systematic approach was considered for the overall design of the project and two parameters were monitored. The temperature and the humidity were the parameters to be monitored for the agriculture farm. The node is designed for the increased battery life and the ZigBee technology supports the same and is shown in Fig.5 below.

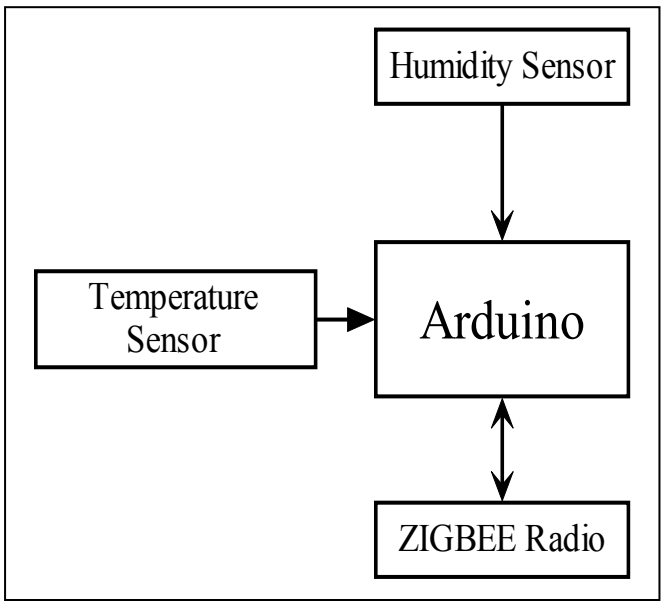

Fig.5. Proposed WSN Node using ZigBee.

A. Hardware Description

The Arduino/Freeduino board (ATMega328) is considered as microcontroller for this project. An input voltage ranging from 0 – 5V is required, which corresponds with the humidity sensor. An on-board 10-bit analog to digital converter (ADC), aids in the digitization of the analog signal acquired from the sensor. Arduino is open electronics prototype and open software and has a serial port/USB to communication with computer.

Temperature Sensor:

The LM35 temperature sensor produces an analog voltage directly proportional to temperature with an output of 1 mill volt per 0.1°C (10 mV per degree). The sketch (program) converts the analogRead values into milli volts and divides this by 10 to get degrees. The temperature sensor is shown in Fig.6 below. The lower and upper threshold are set to 20 and 30 respectively.

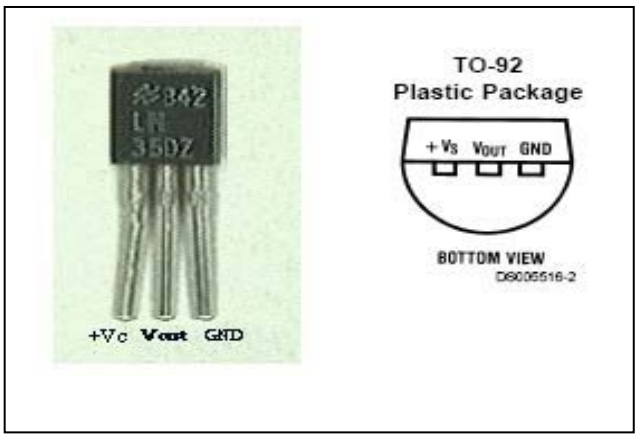

Fig.6.Temperature Sensor (LM35).

Humidity Sensor:
The soil humidity sensor is developed using op-amp LM358 and is given to the Arduino microcontroller. The soil humidity sensor circuit is shown in Fig. 7.

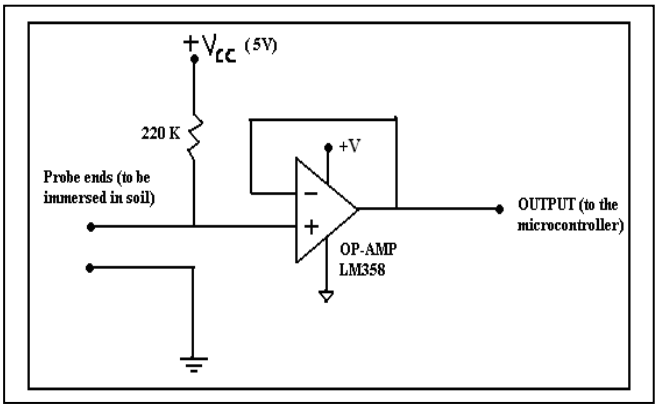

Fig.7. Soil Humidity Sensor Circuit.

B. Software Description

The software design consists of transmitter and a receiver. The sensors are connected at the transmitter side and the values are continuously monitored. The data obtained from the sensors i.e. temperature and humidity values stored in the data base. The receiving side is the base station and the Arduino with the display device is available. The sensed parameters with precision values are sent to the base station. The flow charts of the developed algorithm for the WSN system for agriculture farm and the base station are shown below in figures Fig.8 and Fig.9.

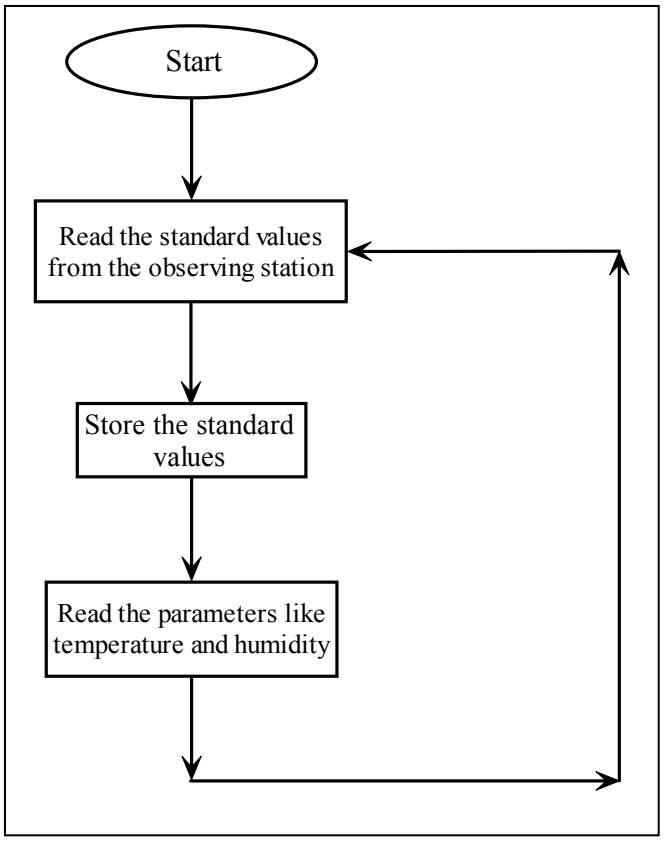

Fig.8. Flowchart for sensing agriculture farm data.

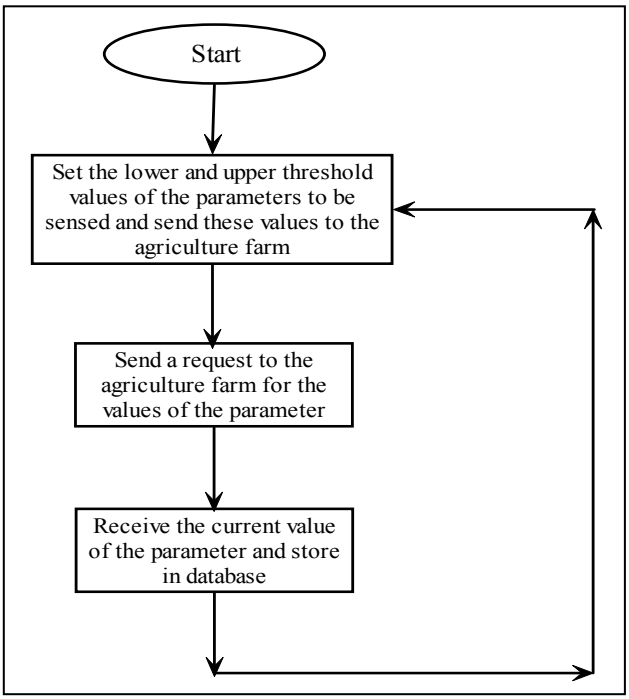

Fig.9. Flowchart for sensing agriculture farm data.

V. CONCLUSION

The low cost, low power WSN node is developed to monitor the agriculture farm. The parameters are monitored and sent to the base station using ZIGBEE protocol. The main contribution of this paper is the development of the WSN system to monitor the agriculture farm.

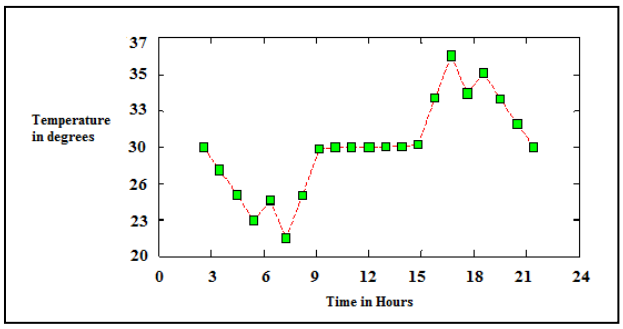

Fig.10.Temperature in degrees.

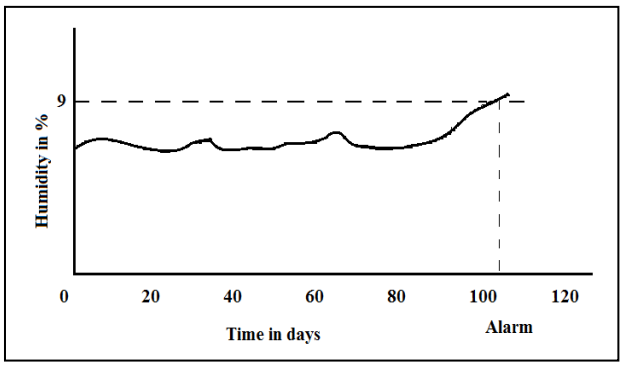

Fig.11.Humidity.

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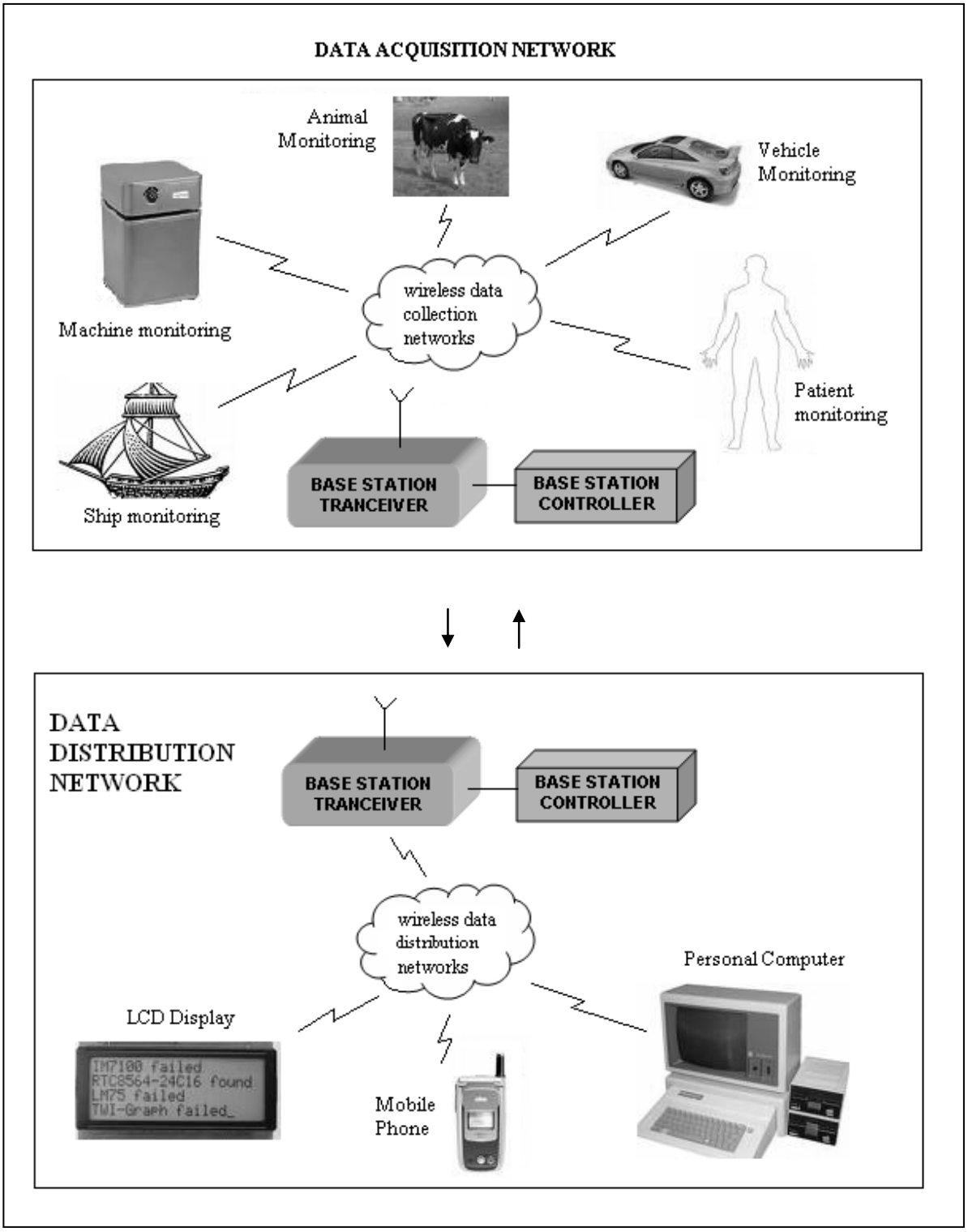

Fig.4. Real time schematic diagram