A Review on Smart Sensors Based Monitoring System for Agriculture

Swarup S. Mathurkar, D. S. Chaudhari

Abstract— Monitoring of environmental factors is very important over the last few decades. In particular, monitoring agricultural environments for various factors such as temperature, moisture, humidity along with other factors can be of more significance. A traditional approach to measuring these factors in an agricultural environment meant individuals manually taking measurements and checking them at various times. In this paper remote monitoring systems using wireless protocols used by different researchers for betterment of agricultural yield with best possible technologies is discussed. This is followed by proposed introductory model for agricultural monitoring with wireless protocol implemented using field programmable gate array (FPGA).

Keywords— Bluetooth, Field Programmable Gate Array (FPGA), Global Positioning System (GPS), LCD display, Microcontroller, Universal Asynchronous Receiver Transmitter (UART), Wireless nodes, Wireless Sensor Network (WSN), ZigBee

I. INTRODUCTION

In most country's economy, agriculture has been playing a vital role. Agriculture is the basis of livelihood for the population through the production of food and important raw materials. Moreover, agriculture continues to play an important role in providing large scale employment to the people. [1] Agricultural growth is considered necessary for development and for a country's transformation from a traditional to a modern economy and especially about India being well known for agricultural work. More than half of the workforce is related to the agriculture and its allied fields.

Almost all the farmers are still depending on the traditional orthodox way of farming. It is being observe that the yield of crops, fruits have not been increasing. Even in some parts it is declining. Automation has been achieved; humans have been replaced by machines. Directly speaking, science and technology has proved its importance in those fields. Therefore there is need to grab the fruitfulness of science and technology in the field for higher yield and growth in agriculture. Most of the papers signifies the use of wireless sensors network which collects the data from different types of sensors and then send it to main server using wireless protocol. The collected data provides the information about different environmental factors which in terns helps to monitor the system.

This paper provides the information related to previous work that had been done in the field of agriculture using the

wireless sensor network over a period of past few years as well as the proposed system which is useful in monitoring as well as controlling the data which provides the flexibility.

Also the wireless protocols that were used previously have limitation of short range which requires multi hopped networks. The multi hopping can be avoided by the use of appropriate long range wireless protocol such as ZigBee, bluetooth, etc.

II. AGRICULTURAL MONITORING SYSTEM

Nowadays, awareness about implementing technology for agricultural environment has increased into the industries. Manual collection of data for desired factors can be sporadic, not continuous and produce variations from incorrect measurement taking. This can cause difficulty in controlling environmental important factors. Wireless distinct sensor nodes can reduce time and effort required for monitoring the environment. The logging of data allows for reduction of data being lost or misplaced. Also it would allow placement in critical locations without the need to put personnel in hazardous situations. Monitoring systems can ensures quicker response times to adverse factors and conditions, better quality control of the produce and a lower labor cost. The utilization of technology would allow for remote measurement of factors such as temperature, humidity, atmospheric pressure, soil moisture, water level and light detection. Different organizations and researchers find the root causes for decrease in yield and tried to develop the efficient system that will help to increase the production.

III. LITERATURE REVIEW

After the research in the agricultural field, researchers found that the yield of agriculture goes on decreasing day by day. Use of technology in the field of agriculture plays important role in increasing the production as well as in reducing the extra man power efforts. Some of the researches tried for betterment of farmers and provides the systems that use technologies which are helpful for increasing the agricultural yield. Some of such researches carried out in field of agriculture are summarised here. N. G. Shah *et al.* developed a system for precision irrigation using sensor network mainly aimed for monitoring soil moisture and estimating evapotranspiration by considering soil moisture, soil temperature and relative humidity as parameters for measurement. The objectives of the system were to provide precision agriculture and irrigation, to increase the agricultural production, to provide precise monitoring system and to use resources at the fullest extends so as to give efficient system. The system was analysed for 3-4 months for calculating evapotranspiration rate. For more precise results, the system should be analysed for 3-4 seasons. [1]

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A remote sensing and control irrigation system using distributed wireless sensor network aiming for variable rate irrigation, real time in field sensing, controlling of a site specific precision linear move irrigation system to maximize the productivity with minimal use of water was developed by Y. Kim *et al.*. The system described details about the design and instrumentation of variable rate irrigation, wireless sensor network and real time in field sensing and control by using appropriate software. The whole system was developed using five in field sensor stations which collects the data and send it to the base station using global positioning system (GPS) where necessary action was taken for controlling irrigation according to the database available with the system. The system provides a promising low cost wireless solution as well as remote controlling for precision irrigation. [2]

In one of the studies related to wireless sensor network, researchers measured soil related parameters such as temperature and humidity. Sensors were placed below the soil which communicates with relay nodes by the use of effective communication protocol providing very low duty cycle and hence increasing the life time of soil monitoring system. The system was developed using microcontroller, universal asynchronous receiver transmitter (UART) interface and sensors while the transmission was done by hourly sampling and buffering the data, transmit it and then checking the status messages. The drawbacks of the system were its cost and deployment of sensor under the soil which causes attenuation of radio frequency (RF) signals. [3]

Some of the researchers developed a remote monitoring system in agricultural greenhouse using wireless sensor and short message service (SMS). The system was applied to strawberry farm and has capability to measure different levels of temperature and thus providing the necessary information to the farmers so that early precaution steps can be taken. System was divided into four parts namely data acquisition, data communication, data presentation and alert notification which also allowed the reverse communication i.e. from farmer side to the base station. The system was cost effective and reliable. The system can be made more effective by considering other environmental parameters and by using recent technologies such as artificial intelligence, neural network, etc. [4]

A Wi-Fi based smart sensor network for agricultural environment was developed by G. Mendez *et al.* considering temperature, humidity, light intensity, air pressure and soil moisture as main parameters. The objectives of the system were to develop a smart sensing wireless network for agriculture, to reduce cost and effort of incorporating wiring, to enhance flexibility and mobility for the system. The system was useful for transferring and logging the data from various nodes. The work can be done for interchangeability of nodes and for self powering from solar panels. [5]

M. Haefke *et al.* developed a ZigBee based smart sensing platform for monitoring environmental parameters such as temperature, relative humidity, pressure and sunlight with the use of microcontroller which serve as a smart weather station. The research was based on characteristics such as use of low cost equipment, accurate sensors and flexibility in data handling. Use of XBee module provided the wider range and reduced the current consumption of the circuit. The analysis was done by fabricating six prototype weather stations tasting for more than 24 hours. For better results and analysis system has to be reviewed for more time period. [6]

In one of the studies, researchers developed a drip irrigation automated system using wireless technology. The objectives of the system were to develop a low cost wireless controlled irrigation system, to monitor water content of soil in real time, to remove the need for workmanship for flooding irrigation. The designed system has three unit namely base station unit, valve unit and sensing unit which were applied for controlling drip irrigation of 1000 dwarf cherry trees. Sensors were placed 20cm deep and 50cm away from the trees. The analysis of the system produced the circa linear graph between volumetric water content and time for which system was analysed. It was a low cost and reliable system having advantages such as preventing moisture stress of trees, minimising excessive use of water and ensuring of rapid growing weeds. System may be more effective by considering other environmental factors. [7]

Some of the researchers narrated a FPGA based real time monitoring system for agricultural field by considering temperature (wet and dry both), humidity and light intensity as their main parameters. The proposed system was an embedded based which monitors and control microclimatic parameters on regular basis so as to maximise the production of crop with reducing human intervention. The system was low cost, automated and can be made effective by considering other environmental parameters and real time fault detection. [8]

Some researchers developed a monitoring system to measure the water level in agriculture using sensor network which offers precision irrigation. They developed a routing algorithm which provides information related to water level as well as useful in computing threshold values based on transmission range. The algorithm was based on distances of wireless information from source to sink node as well as on minimum angle between source and destination. The proposed system can be optimized by the use of algorithms based on genetics and neural network. [9]

IV. PROPOSED MONITORING SYSTEM

The betterment of agriculture depends on various environmental parameters such as soil temperature, soil moisture, relative humidity, pH of soil, light intensity, etc. Minute change in any of these parameters can cause problems like diseases, improper growth of plant, etc. mainly resulting in lesser yield. The block diagram of the proposed system shown in Fig. 1 consists of different types of sensing unit such as temperature sensor, soil sensor moisture,
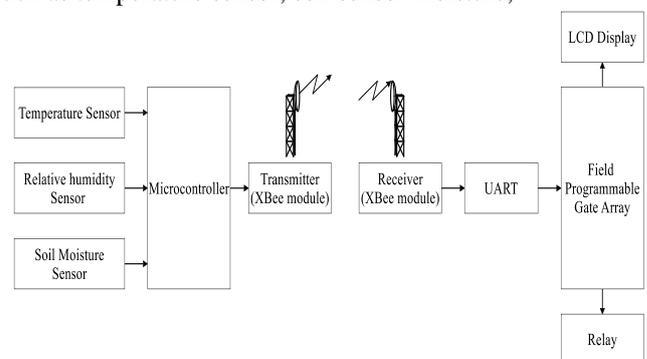

Fig. 1 Basic block diagram of proposed system

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relative humidity sensor for measurement, microcontroller for time domain multiplexing i.e. to multiplex the data obtained from different types of sensors as well as for converting the analog data into the digital one, XBee modules for wireless data transfer and receiver, a serial protocol UART for interfacing the data obtained from XBee modules to the computer, FPGA element for the analysis and monitoring of data, a display element and a relay as a control unit.

V. CONCLUSION

Smart sensors based monitoring system for agriculture have been used to increase the yield of plants by monitoring the environmental conditions (parameters) and thus providing the necessary information to the clients (farmers). The proposed system is mainly developed for the betterment of farmers. The use wireless sensor network over the wired one helps for deploying it in any type of environment for monitoring, making it flexible and robust. The use of FPGA element facilitates the system for re-configurability and re-programmability according to different environmental conditions.

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