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Exploration of Crop Production Improvement through Various Agricultural Monitoring Systems

B. Balaji Bhanu, Mohammed Ali Hussain, Ande Prasad, Mahmood Ali Mirza

Abstract*: Most wireless sensor network (WSN) are widely used to adopt various crop monitoring systems which overcome many issues caused due to lack of an efficient crop monitoring system. As there is an increasing need of various decision support systems at different field locations which constantly monitor the crops for good yield. The main focus of this paper is to review the latest available crop monitoring system designs and their implementations using wireless sensor network which results in increasing the crop yielding and quality of farming without manual observation of the farmer. Many physical events such as relative humidity, soil moisture, water levels etc. are most important for the crop productivity, growth, and quality of plants in different agricultural fields. Sensors have to transmit the collected information through a gateway to the data server. The experts can observe the crop growth by calculating various natural factors from the cloud server simultaneously. The analysis of crop growth at various optimal environmental conditions is analyzed and achieved for maximum crop productiveness through this type of continuous monitoring.

***Index Terms*: WSN, Precision Agriculture, Temperature, Humidity, IoT.**

I. INTRODUCTION

India is very famous for its different agricultural innovations on a global scale by adopting modern technologies which helps in careful analysis and assistance of communication through various controlled devices. WSNs have become the most essential parts of modern computing technologies which are sometimes called as Wireless Sensor and Actuator Network. It consists of various sensors which monitor crop continuously based on various physical and environmental conditions like temperature, sound, pressure, etc. It helps in distribution of of real time data collection which incorporates a gateway to enable connectivity between the outside world and distributed nodes in a field. These developments rise to various applications related to military for battlefield surveillance, industrial and consumer applications, health monitoring, and so on. This paper presents a brief survey on various crop monitoring systems that are designed to enable effective delivery of real time agricultural field data. Based on the latest research [1] on advanced agricultural systems, the monitoring and control of various yield processes are adopted by many organizations for effective production. The main necessities for this crop monitoring systems are discussed as follows:

- Hardware component requirements such as sensors, actuators, connectors, outers, computers, generators and many more.
- Software component requirements such as communication, data filtering and gathering and many more.

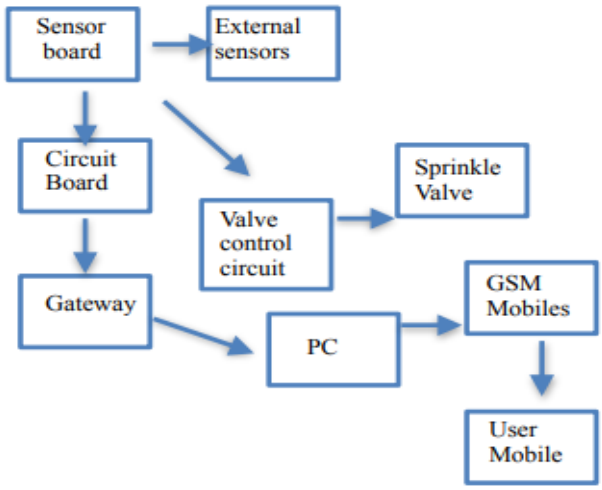

Figure:1 - System Architecture [2]

The complete system consists of various WSNs for effective sensing capabilities which consist of a gateway for collecting data and a constant monitoring interface to interact with various environment factors. There is a need for effective solutions which focus on different crop management systems to enhance and raise the crop yields. An efficient method in modern agriculture which increases crop yield reduces labor cost and protects environment gives raise to Precision Agriculture which is developed as an alternative to control pesticide and fertilizer utilization. Hence there is a need for developing a system which reduces power consumption of these WSNs in the agricultural fields.

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*Correspondence Author(s)
B. Balaji Bhanu, Research Scholar in CSE, SCSVMV University, Kanchipuram, Tamilnadu, India
Mohammed Ali Hussain, Professor, Department of ECM, KL Deemed to be University, Vaddeswaram, Guntur Dist., AP, India
Ande Prasad, Head Dept. of Computer Science, Vikrama Simhapuri University, Nellore, AP, India
Mahmood Ali Mirza, Professor, Department of Computer Science Engineering, Krishna University, Machilipatnam, Krishna Dist., AP, India

II. SELECTION OF WSN

A. Sensors

Generally, sensors detect and respond to an input signal like light in any physical environment. It is generated as an output which is able to convert human-readable display at various sensor locations over a trusted network for further processing. So, sensors are aimed for detecting and responding to various signals which are transmitted. Generally, sensors will convert various physical worlds into a measurable equivalent signal for further data analysis. These are helpful in monitoring and collecting data for various estimations such as soil fertility, temperature, climate and many more.

Different types of sensors

Some of the following important characteristics are necessary for selection of sensors:

- Span
- Range
- Calibration
- Resolution
- Sensitivity
- Linearity
- Precision
- Environmental condition

Temperature Sensor (LM35):

This sensor is used to measure temperature with an equivalent electrical output. The temperature is measured with high accuracy rate which is utilized for any agricultural field.

Humidity Sensor HR202:

The humidity sensor output is proportional to both the ambient temperature and water vapor pressure on any agricultural land.

Water Level Sensor:

This sensor is spherical, cylindrical, that are flexible in water. They are non-electrical hardware devices which are frequently used for different indicators for surface level measurement.

Soil Moisture Sensor:

Moisture sensor principle is dielectric permittivity is a function of the water content in a soil. So this sensor develops a voltage proportional to the dielectric permittivity, and the water content of the soil.

Figure:2 – Soil Moisture Sensor [8]

Radio Platform:

The radio platform is a single board processor which is configured to run different applications for data processing and satellite communication simultaneously.

Data Acquisition Board:

For managing special kinds of sensors, a data gathering board is adopted which has a versatile data acquisition circuit model contains various sensors onboard.

Sensor node:

Each sensor node consists of data acquisition board. Different sensors used for a project will ensures full control of mote communication capabilities to attain optimized power management [6-7].

B. Role of Internet of Things

The interconnection of different physical devices, are embedded with electronic board, software, sensors, actuators, and network connectivity which enable objects for accurate collection of data and their exchange. The infrastructure of different societies allows various physical objects to analyse and control various remotely across existing network infrastructures. When an IoT is deployed with different sensors and actuators, the technology becomes an instance of dissimilar physical systems, which develops technologies such as agriculture, smart homes, industry etc. Each physical system is uniquely identified through its embedded computing system and is interoperated within the available network infrastructure.

III. SURVEY ON WSN PROGRAMMING

There are different network programming techniques for sensing wireless devices which are adopted by different crop monitoring systems like XMesh [9]. It is a multi-node, ad-hoc, mesh networking protocol developed for accurate transmission of data through wireless networks. More energy conservation required transmission Higher cost of the physical devices involved in a monitoring system indicates more energy required to make the transmission. The idea is to reduce the total cost for transmitting the data to a base station node [10]. Where each node in the mesh network will broadcast through the beacon which includes the number of different hops to send a message to the base station node along with a packet sequence number. The total signals received are based on careful monitoring of sequence numbers to the received messages.

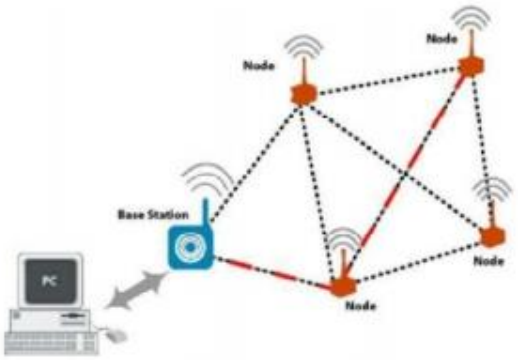

Figure: 3 – XMesh Setup in a practical environment [11]

Data Management:
This is used as an interface between a user and different wireless sensor nodes. It provides a user interface design for visualising and analysing the sensor data.

Data Acquisition:
The short messages which are received from various locations are parsed to the data fields by incorporating different data networking protocols.

Data Log:
The necessary updates regarding the relevant data fields are updated which represent various environmental parameters from the database respectively.

Data Visualisation:
Data is being extracted from the database by creating different types of visualisations like charts and curves which are very flexible for administrators to analyse the data sensors.

IV. SURVEY ON WSN IMPLEMENTATION

Implementation-1 [12]

After installing the physical monitoring devices in the agricultural farms which analyses various temporal and spatial variations in environmental parameters like relative humidity, temperature and moisture. The data collected from these sensors nodes are maintained from this centrally located database continuously.

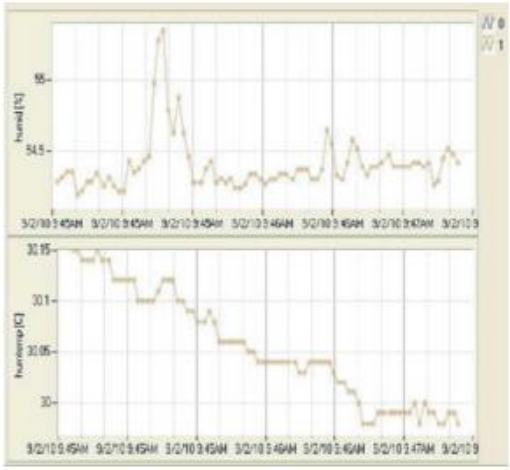

Figure: 4 – Visualisation of temperature and humidity data

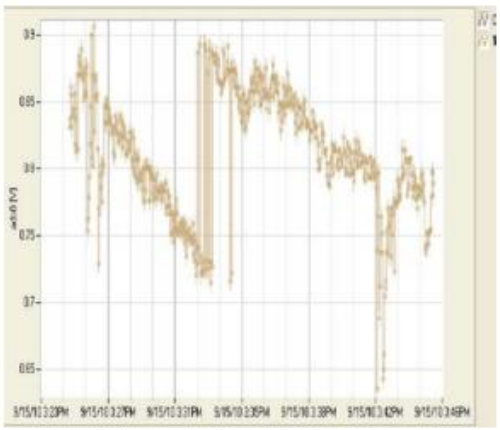

Figure: 5 – Visualisation of soil moisture data [12]

Implementation-2 [13]

Different sensors are most widely used nodes from various IoT families. It is efficient and reliable option for many agriculture fields which consists of 32kB on chip with sufficient memory for on chip FLASH memory.

More amount of memory is required for different agricultural field applications. Some of the minimum hardware requirements necessary for data collection and management are as follows:

1. DC Power Source
2. Quartz Crystal Oscillator
3. UART
4. Reset switch

The purpose of the different processors connects all the physical components associated with IoT kit. Each pin is assigned with particular component of the kit for performing its necessary action. The threshold value for various sensors is set which is responsible for switching the motor which is gathered for pumping water to the agricultural land. The values are updated to the system through IoT gateway. The features of sensor must have an excellent linearity, low energy consumption, good range of measurement, speedy response. In the next stage of development module itself, the integration of code for transmitting and receiving various signals are used to gather data collected from multiple sensors by using microcontroller and these values will be sent to various IoT modules.

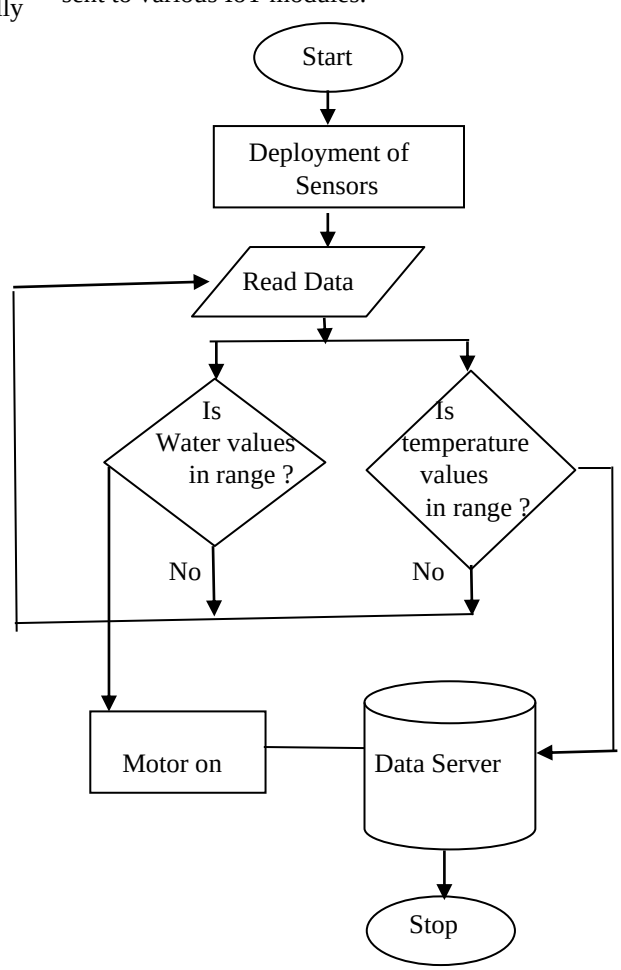

Figure: 6 – Control Flow of implementation [13]

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By using below gateway solution of collecting the data by their equipped integrated sensors, the values in the browsers are refreshed for a specific period of time.

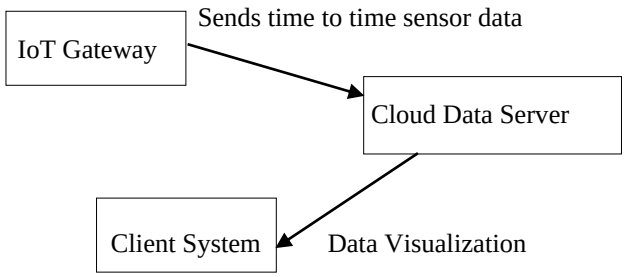

Figure: 7 – IoT Gateway [14]

V. CONCLUSION

This work focuses the utility of wireless sensor networks technology in the field of agriculture for better yields by collecting and monitoring the field data through a crop monitoring system. Ecological parameters like wind speed , humidity, soil pH etc. are taken into consideration for data collection. Parameter specific sensors are deployed in the field and the relevant data is uploaded to the cloud through an IoT gateway. The registered farmers can access the data of the monitored parameters, assess the conditions of farming and thereby enact according to the situation. This helps the farmer efficient enough to take precise farming operations at right time which is especially needed for improving quality, and profitability of the crop.

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