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A Survey of Wireless Sensor Network in Precision Agriculture with different Cloud based IoT Schemes

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Abstract - To solve the problems in the real- world the Wireless Sensors Network and the Internet of Things are nowadays commonly used to build decision support systems. Precision agriculture is one of the most important fields having an increasing need of decision support systems. This paper consists of a survey on wireless sensor network with different cloud-based IOT schemes on Precision agriculture. These methodologies are used to solve the agriculture related problems such as farming resources optimization, decision making support and land monitoring. The precision agriculture systems is based on the Internet of Things technology which is explained in hardware architecture, network architecture and software process control of the precision irrigation system in a detailed manner by using the basic principles of Internet and WSN technology. The sensors in feedback loop get activated by threshold value in the control devices. The needed data is been collected and it is relay to cloud-based back-end which is processed and analysed by the three-layer architecture. The analysed data can be sent back to the front-end nodes which are based on Feedback actions.

Keywords: Wireless Sensors Network, Internet of Things, precision agriculture, three-layer architecture.

I. INTRODUCTION

Precision Agriculture (PA) is used to improve the agricultural processes by monitoring and ensuring the maximum agricultural production and minimized environmental impact which are based on information- and technology-driven.The involvement of the modulation of fertilizers doses, sowing parameters, site-specific application of water, pesticide and herbicide [3]. The major method of crops production in Malaysia and rest of the world will be the greenhouse cultivation in the future. This project is mainly focused to contribute to national economic growth and sustainability by transforming traditionally small-scale production based sector into large scale agribusinesses. Most greenhouses are with obsolete technologies where the farmers have to be on duty all day and work very hard in the greenhouses.

Wireless Sensor Network (WSN) is a a modern technology which consists of knowledge of sensors, automation control, digital network transmission, information storage and information processing to provide effective solutions for variety of applications such as health monitoring, agriculture, environmental monitoring and military operations. PA has the benefit of providing the data collection which monitors the materials application to the crops which results for higher yields and lower cost and less impact to the environment. At appropriate time and duration each area receives only what is required for the particular space.

In this paper a cloud-based IoT architecture is been used which is composed of three layers .The Front-end layer applies the needed agriculture actions which is been collected as the environmental information, and it is widely used in many precision agriculture applications. The gateway layer connects the front-end layer to internet and process that takes place and the data storage is present in the back-end layer. A prototype is illustrated to test the performance, which is present in the proposed architecture. The efficiency, productivity and profitability of many agricultural production systems will increase in precision agriculture by the usage of Wireless Sensor Networks (WSNs).

II. METHODS AND TECHNOLOGY

In PA requires the WSN system which consists of a centralized control unit with user interface, communication gateways and routers, power elements and most importantly the sensors. A WSN for agriculture is similar to the usage in other industries for industrial controls, building automation and security systems. The following methods are commonly used in Precision Agriculture:

1. High-Level IoT Architectures
2. Crop Monitoring Platforms
3. Irrigation Control Platforms
4. Data Communications In Pa
5. Intelligent Greenhouse Management Systems (Igms)
6. Environmental Factors Effecting Plant Growth

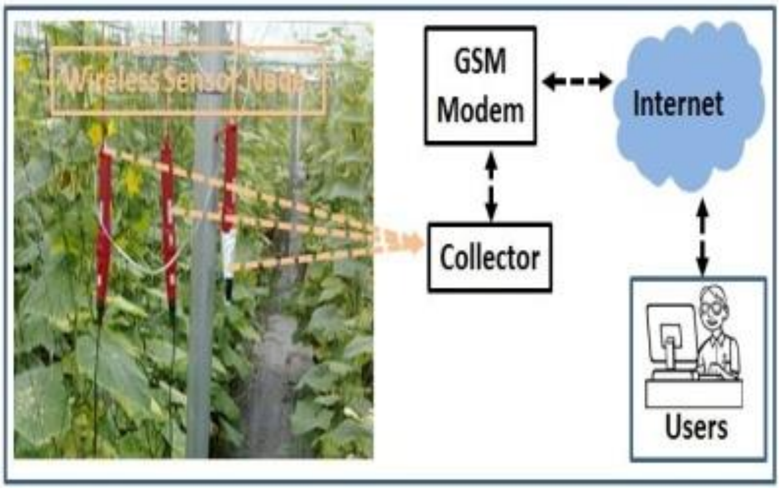

Fig.1 WSN Architecture

In Fig.1 the common Architecture of WSN in PA environment with several nodes are displayed.

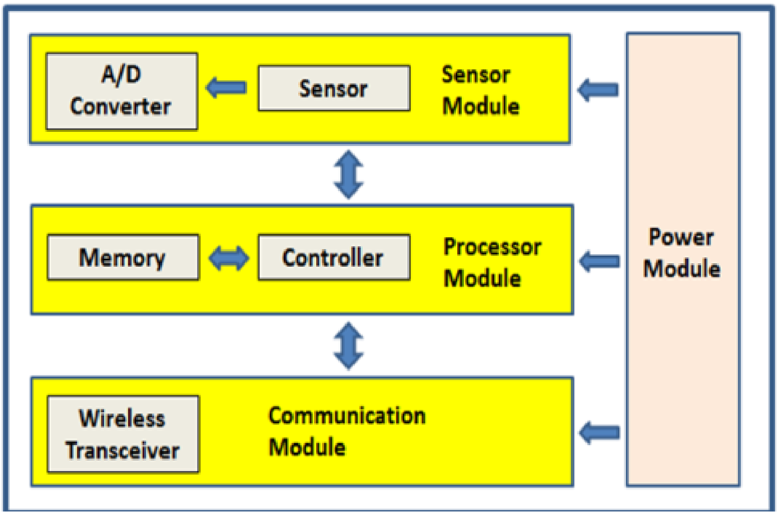

Fig. 2 WSN Node Architecture

In Fig.2 each sensor network node consists of a sensor module, processor module, communication module and power module using battery.

III. CLOUD -BASED AGRICULTURAL IOT ARCHITECTURE

The agricultural applications are depicted in the cloud-based IoT architecture which is composed of 3 layers: front- end, gateway, and cloud back-end. The front-end layer is composed of 4 modules which are microcontroller, the environmental sensors and actuators, interfacing circuits, and a wireless communication module which are present in the physical layer or sensing nodes. The sensor data is been collected and it relay it to a gateway by the different front-end nodes deployed in the agricultural field. The collected data is further relayed by the gateway and then sent to cloud servers in the back-end for storage and extensive data analysis.

The requests from the back-end to the actuators in the nodes is been forwarded by the gateway layer. The ability of accessing the sensed data to the end users is facilitated by the back-end. Several services are implemented which are not limited to data storage, data analytics and data visualization. In addition to providing an appropriate Application Program Interface (API) and software tools through which the end-user can access the data and it is achieved finally. We implement the back-end layer via the cloud-based server in our proposed architecture.

IV. PROTOTYPE PERFORMANCE EVALUATION

The prototype performance evaluation of cloud-based iot scheme for precision agriculture is as follows:

1. Wind Speed and Direction

The wind speed and direction data are collected. The rotation of the sensor for wind speed is been converted into velocity measured in Miles Per Hour (MPH). Different voltage values for different directions is given by the used SEN- 08942 sensor . Around 16 different directions is been given by the sensor used in the prototype. The wind speed collected over a 200 minutes. The variations of the wind speed by the minute over the observation window is been displayed in the figure. Using our cloud server different granularities are obtained. The wind directions are omitted.

2. Rain Volume

The results of the rain meter and the moisture sensors are presented. A 200 minutes window in which the rain existed only in the first 23 minutes.

3. Air Temperature and Humidity Results

The air temperature and humidity are the important environmental data for agricultural IoT applications. The water fertilizer consumption during irrigation is shown as detailed manner in Table1. The usage of water fertilizer for scheduled irrigation is 2,500 ml whereas in the automatic irrigation it is only 1,000 ml is been depicted in Table1. This clearly depicts that on average a savings of 1,500 ml per day per tree and the saving in total per day for 1,000 trees is 1,500 litres of water fertilizer.

Table1: water fertilizer consumption.

Type of Irrigation	**Total Irrigation per day**	**WF per Irrigation (ml)**	**Total WF (ml)**
Scheduled	5	500	2,500
Automatic	2	500	1,000

V. CONCLUSIONS

In order to get good yield and profit in precision agriculture we use Wireless Sensor Network and Cloud- based IoT Schemes. A comprehensive system in IGMS is designed to optimize agriculture production which is the best example. Increase in production efficiency, improvement in product quality, improve the efficiency of crop chemical use, energy conservation and environment protection can be obtained by precision agriculture system.

The automatic irrigation is more efficient compared to scheduled irrigation which is been tested clearly in a greenhouse environment using WSN. The optimization of the usage of water and fertilizer and furthermore maintain the moisture level and healthiness of the plant is carried out using Automatic irrigation. The IoT precision agricultural applications in a cloud-based architecture is outlined with three layers and their implementation details are explained in the proposed architecture. The different performance aspects of the proposed architecture is been illustrated in a prototype. The efficiency of the proposed architecture – despite its simplicity is been demonstrated in the preliminary performance evaluation results. Implementing a wide set of precision agriculture systems is considered as a good candidate in the proposed architecture. The future work will be based on the development of a mobile application that allows access of the data on handheld devices to secure the access of the data in it.

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