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ONTOLOGY BASED AGRICULTURE USING WIRELESS SENSOR NETWORKS

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ABSTRACT

Nowadays, changes in weather and environment cause many converse effects in day to day life of human being in this world. Especially in the field of agriculture. Due to deforestization and global warming people do not receive sufficient level of rain even in rainy season. And also the level of snowfall increases. Because of these two main reasons there is great fall in the productivity of agriculture. Decrease in rainfall, fertility deficiency in land soil lead to insufficient or sometimes nil productivity from agriculture. Hence now it is necessary to go for alternate kind of agriculture to increase the level of productivity. In this paper a prototype using wireless sensor network (WSN) to increase the productivity level of agriculture is discussed. The proposed method considers temperature, humidity, water supply, moisture content and nutrient level of soil in the agriculture land and conveys the farmer with the information such as type of grains to be cultivated depending on the above specified factors to increase the productivity which also develops life of farmers.

Keywords: WSN, agriculture, soil nutrient, productivity.

INTRODUCTION

Wireless Sensor Network (WSN) is one of the most emerging technologies in the 21st century. Agriculture is the backbone of Indian economy. Use of modern technologies and financial assistance to the farmers and the development of agriculture in terms of area of land under cultivation are absolutely essential. Economical improvement with all sectors of the population enjoying agricultural effect is most important today in India. One of the major problems present today is the less knowledge of the soil content & types, less knowledge of the type of fertilizers to be added, the irrigation amount and pattern depending on the soil porosity and its water retention capacity. Due to small size of land holdings the procedure of sending soil samples to a far off lab and then taking decision does not seem economically viable.

The technological developments in WSN made it possible to perform monitoring and controlling agriculture parameters in rural area. Uneven natural distribution of rain water makes it crucial for farmers to monitor and control the equal distribution of water supply to all crops in the whole farm or as per the requirement of the crop. There is no ideal irrigation method available which may be suitable for all weather conditions, soil structure and variety of crops culture. It is observed that farmers bear huge financial loss because of their incorrect prediction of weather and irrigation methods to crops.

Fig 1: Sensors placed in the agriculture field

This paper describes the use of Wireless Sensor Network technology to determine the level of temperature, humidity, water supply, moisture content and soil nutrients. Since there is no proven economical methods have been yet devised to effectively and efficiently allocate chemicals to meet crop needs, significant energy waste occurs in application of agriculture chemicals. Consequently chemicals and fertilizers are applied in uniform amount irrespective of local changes in soil chemical conditions etc. Wireless sensor networks are widely used in agriculture to increase the productivity and

monitor various physical and chemical properties of soil. Various types of sensors are used which perform their corresponding tasks like water supply monitoring, soil moisture monitoring, monitoring of soil chemical level and climate change effects. The sensor network in this paper senses the soil chemical condition in real time and as per the measured deficit or excess chemical condition, appropriate amount of fertilizer and compost are applied to the soil. [2].

Wireless Sensor Networks

A WSN is a system comprised of radio frequency (RF) transceivers, sensors, microcontrollers and power sources [4]. Recent advances in wireless sensor networking technology have led to the development of low cost, low power, multifunctional sensor nodes. Sensor nodes enable environment sensing together with data processing. Instrumented with a variety of sensors, such as temperature, humidity and volatile compound detection, allows monitoring of different environments. They are able to network with other sensor systems and exchange data with external users [3].

A general WSN protocol consists of application layer, transport layer, network layer, data link layer, physical layer, power management plane, mobility management plane and the task management plane [4]. In general, as frequency increases, bandwidth also increases allowing for higher data rates, higher power requirements and transmission distance is also considerably shorter [3, 5]. Multi-hop communication might well be possible in WSN since it consumes less power than traditional single hop communication [5]. For sensing soil nutrient level, the sensors are deployed spatially in whole field. Different sensors are deployed in different method but the basic technology employed in the sensors remains the same [6]. Sensors are arranged in a hexagonal geometry because of its larger coverage area. Efficient utilization of this kind of sensors arrangement plays an important role because it saves time, power requirement and also may decrease the channel traffic, thus increasing the overall efficiency of the whole network [7]. Each sensor works at different frequency and hence there is no problem of interference in between the sensors

The sensor nodes comprise of following:

a) Microcontroller: It controls monitoring operation for which various sensors have been employed.

b) Built-in radio transceiver: It is used to generate radio waves to transmit data obtained from sensors over wireless communications. The communication is carried out between a gateway and a sensor node and also between two sensor nodes.

c) Power generation and power storage devices such as battery. Repeating data relays, these sensor nodes safely transmit data to the gateway. Further, the gateway sends data to a server or the server. The server analyzes the data for convenient use. This system can support every aspect of wireless sensor networks, including uploading data to the internet via a gateway or router and distributing data to your smart phone or other terminal.

The entire network is based on the phenomenon of multi routing algorithm which is also termed as wireless ad hoc networking.

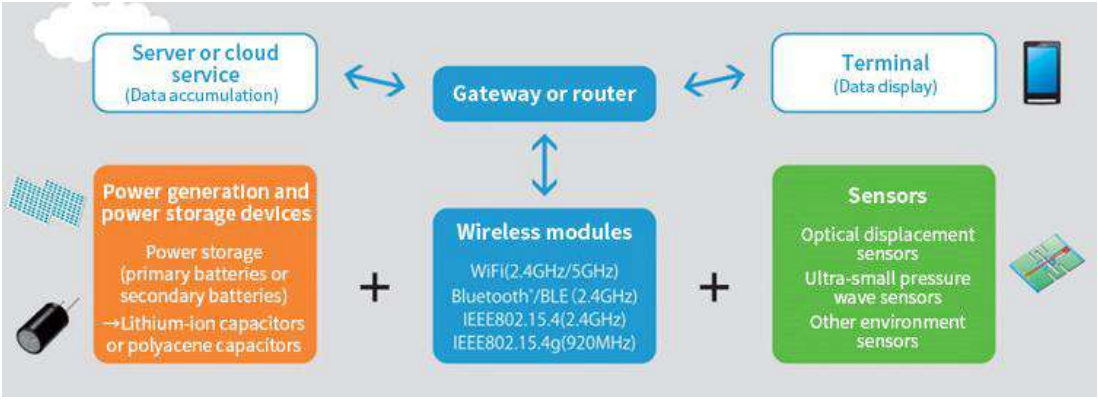

Fig 2: Sensor Network Technology [8]

RELATED WORK

Awati J.S., Patil V.S. and Awati S.B. designed an instrument that is able to monitor soil testing, measuring temperature, humidity, and controlling water supply [9] depending on moisture content of soil of an agriculture environment. The system put into practice a wide range of engineering skills to solve agriculture problems. Tests were done to verify the reliability and accuracy of the Temperature and Humidity monitoring system. Two different set of tests (1) Test conducted in closed room, (2) Test conducted with an open environment were performed.

Testing/monitoring of soil chemical level using wireless sensor network technology was performed by Purvi Mishra, Sudha Mapara and Preeti Vyas to increase the crop productivity [10]. The test results with the concept that recent advancement in Wireless Sensor Network (WSN) technology leads to various techniques to measure soil nutrients and on the basis of

knowledge of soil nutrients level, farmers can enhance the crop productivity because insufficient nutrient levels can adversely affect crop productivity. Sensor network technology will help the farmers to know the soil requirements which help them to take better decisions and preventive measures at the right time. This leads to tremendous improvement in the crop productivity and in turn saves their time, labor, money and makes effective use of resources.

Luis Ruiz-Garcia, Loredana Lunadei, Pilar Barreiro and Jose Ignacio Robla reviewed the technical and scientific state of the art of wireless sensor technologies [11] and standards for wireless communications in the Agri-Food sector. These technologies are very promising in several fields such as environmental monitoring, precision agriculture, cold chain control or traceability. The work focuses on WSN (Wireless Sensor Networks) and RFID (Radio Frequency Identification), presenting the different systems available, recent developments and examples of applications, including ZigBee based WSN and passive, semi-passive and active RFID. Future trends of wireless communications in agriculture and food industry are also discussed. Battery life, reliability of measurements and performance in real environments are critical issues that must be improved. The integration of WSN and RFID seems to be a good idea, taking advantage of the complementary features of both technologies. For this purpose, some theoretical approaches have been presented.

The real time information from the fields will provide a solid base for farmers to adjust strategies at any time. Instead of take decisions based in some hypothetical average condition, which may not exist anywhere in the reality, a precision farming approach recognizes differences and adjusts management actions accordingly [12].

PROPOSED APPROACH

In this section, we present a prototype based on wireless sensor network (WSN) to increase the productivity level of agriculture using ontology. The proposed method measures temperature, humidity, water supply, moisture content and nutrient level of soil using corresponding sensors in the agriculture land. The measured data is referred with the ontology and results with the information such as type of grains to be cultivated depending on the above specified factors to the farmer to increase the productivity which also develops life of farmers.

The sensor nodes are scattered in the desired locations. Theses nodes collect data and transmit it through radio transceivers over wireless communications modules to the base station or server where the data is accumulated. The stored data is then processed and is transmitted to data display terminal which can be a smart phone or laptop [8].

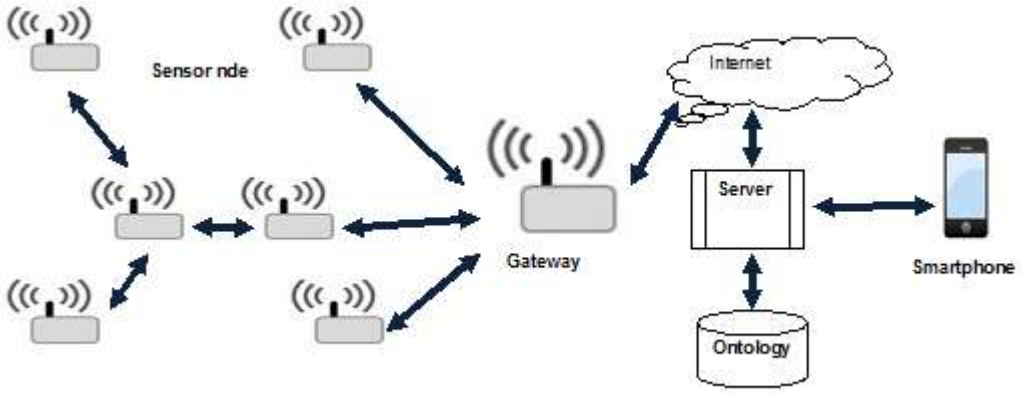

Fig 3: Block diagram for WSN based agriculture

As shown above in Fig 3, various heterogeneous sensors which measure temperature, humidity, water supply, moisture content and nutrient level of soil correspondingly and the data is transmitted to the server over the wireless channel for processing. The processed data is then referred with the ontology and the resulting information is conveyed through farmer's phone. Thus the farmer can get can get timely knowledge about his agriculture land and accordingly he can plan his farm work. The proposed system helps farmer by providing information such as grains to be cultivated in the specified field depending on the various environmental factors, composition of fertilizers to be applied with the exact time of application. Thus productivity increases by saving time, money, energy which also develops life of farmers.

TESTING AND RESULTS

Tests were done to verify the accuracy and efficiency of the proposed system. The results are presented in the following figures.

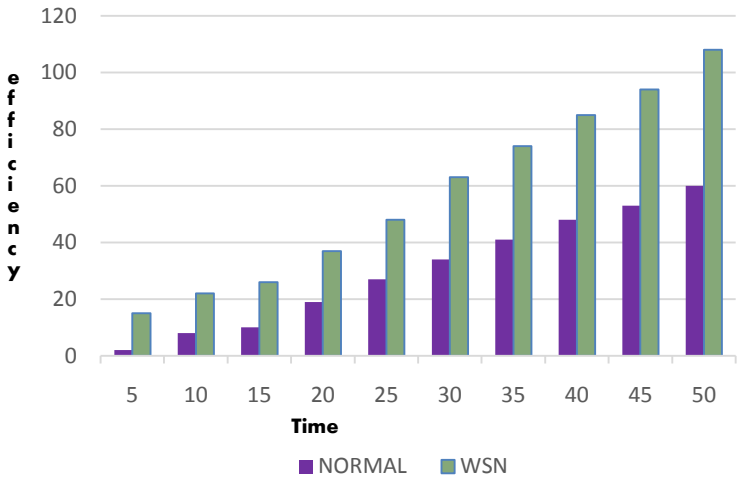

Fig 4: Efficiency of the proposed system

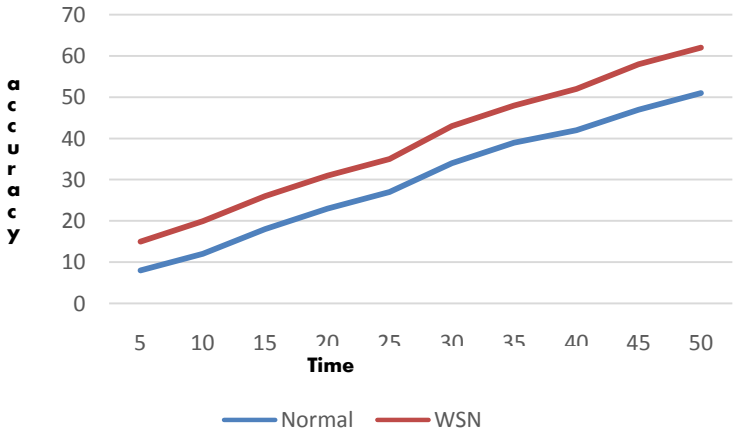

Fig 5: Accuracy at different time period

CONCLUSION

This paper has put into practice a wide range of engineering skills to solve agriculture problems. This paper deals it both technically and also in terms of how to manage and handle agriculture parameters. The use of WSN in agriculture has the potential to be an economical solution to the farmers. The value of technology can be best realized when integrated with agronomic knowledge, using the information gathered in the improvement of decision support systems. The collaboration and synergy of sensing, processing, communication and actuation is required to exploit the potential of these technologies.

Another important benefit of the system is the visibility that it can give along the food chain. Measurements obtained are consistent and provide valuable information on the conditions encountered during the life cycle of the products. It is possible to address, at regular time increments, what is happening with the product, whether it is temperature, humidity, acceleration, etc. Another advantage is providing effective support in legal situations as well as safety inspections.

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