

Internet of Things in Precision Agriculture using Wireless Sensor Networks

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Abstract: The Internet of Things (IoT), the idea of getting real-world objects connected with each other, will change the way users organize, obtain and consume information radically. Internet of Things (IoT) enables various applications (crop growth monitoring and selection, irrigation decision support, etc.) in Digital Agriculture domain. The Wireless Sensors Network (WSN) is widely used to build decision support systems. These systems overcome many problems in the real-world. One of the most interesting fields having an increasing need of decision support systems is Precision Agriculture (PA). Through sensor networks, agriculture can be connected to the IoT, which allows us to create connections among agronomists, farmers and crops regardless of their geographical differences. With the help of this approach which provides real-time information about the lands and crops that will help farmers make right decisions. The major advantage is implementation of WSN in Precision Agriculture (PA) will optimize the usage of water fertilizers while maximizing the yield of the crops and also will help in analyzing the weather conditions of the field.

Keywords: Internet of Things (IoT), Wireless sensor Network (WSN), Precision Agriculture (PA).



Introduction:

India is agriculture oriented country. 69% of Indian population has agriculture as their main occupation or side business. The production or cultivation of useful crops in the Ecosystem produced by the people is known as agriculture. From another point of view, the farmers are the ecosystem engineers who find new ways for cultivation of crops. As agriculture has gone through considerable transitions in terms of using technology in agriculture techniques. The first technology to agriculture was of the tractor. It proved to be more efficient and helpful machine to the farmers. The other invention was grain combine, a machine which can ripe grain and separate the kernels from the stem. Its drawback was more power consumption. The water management practices are also adapted by many villages which provided water for drinking and other purposes in the dry season. In present time, in Indian agriculture still faces the challenges:

Dependence on monsoon, fragmented land farming and holding, traditional farming practices, poor infrastructure in rural areas and less usage of technology applications. The advancement in the technology will help farmers increase the crop gain. The new concepts in the technologies now a days are (i)Internet of Things (IoT) (ii) Wireless Sensor Network (WSN) (iii)Precision Agriculture (PA). The internet of things is the network in which the real world objects are connected to each other which tends to form many embedded system including fields such as electronics and sensors through which the data can be transferred and received reliably. A real world thing/object in Internet Of Thing in terms of animal farming can be an animal with Biochip transponder which when assigned an IP address and an ability to reliable data transfer over the network can be helpful to the farmer. Also with the use of sensor, application on the mobile phones and the transfer of useful data generated by the system will make it easy to use. The system has wide area of applications like Open Farm, Greenhouse Farming. In Open Farming, irrigation, water level etc. can be managed with this system whereas in Greenhouse Farming, temperature control, moisture control are the applications of this system. The system is also useful in the field of Gardening.

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Literature Survey:

The concept of the Internet of Things first became popular in 1999, through the Auto-ID Center at MIT and related market-analysis publications. Researchers have proposed different models for agriculture sector with one or multiple technologies mentioned above e.g. irrigation system based on soil water measurement to decide irrigation amount of the water is described in [1]. Which uses the Bluetooth model for the communication which has its own limitations like limited range and device accommodation. In the year of 2009, an author suggested scheduling in the power supply to the sensors which will help in improve energy efficiency [2]. Use of IoT in agriculture is mentioned by an author in paper [3]. However it shows lack of interoperability which is necessary when we talk about large agricultural fields. For comparison of energy consumption between two appliances, Jinsoo han has provided an approach in paper [4] published in 2011. N.K. Suryadevara, S.C. Mukhopadhyay has used concepts of pervasive computing, data aggregation etc to monitor the environmental factors using Zigbee [5] in their paper. Increase in number of sensors is suggested by the author to improve the accuracy of the data collected. However it might raise the issue of more power consumption as more nodes has been deployed. Approach to provide the real time information to the farmers about the land and crops is defined in the paper [7], which provides the necessary information yet it's a standalone system. In the year of 2015 concepts of IoT, cloud-computing, Mobile computing are used in smart agriculture in paper [8], where by Prem Prakash Jayaraman, Doug Palmer, Arkady Zaslavsky the concept of phenonet was introduced [9], which is network of smart wireless sensor nodes who shares the information with each other as well as central system. Yet both the papers however does not provide any interpretation of the data even though large amount of useful data is generated. Although researchers have proposed few models in agriculture domain using one or more of the technologies mentioned, we aim to develop an integrated system of multiple functionalities with data interpretation and simpler interface.

Proposed System:

Therefore, considering the current need of agriculture and previous drawbacks we propose a system which integrates the control of all the deployed systems in a single system. Which will make it easy to handle and better understanding of the results by naive users. As well as it will keep the farmer updated by the notifications for almost every related event that occurs in the field.

System Architecture:

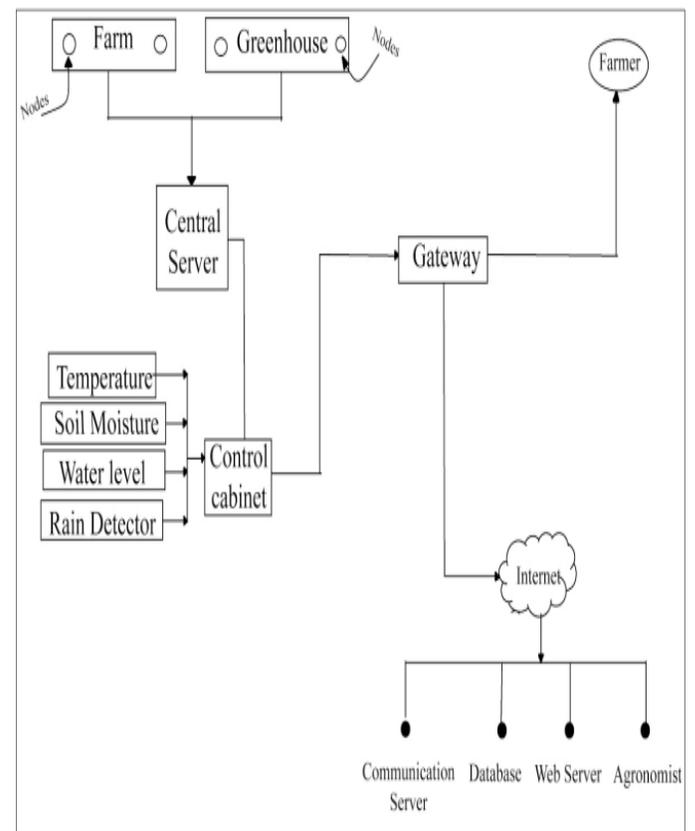


Fig 1 : System Architecture

As mentioned earlier this system has useful applications in Farm as well as Green House. The central system is the heart of this architecture, as it does half of the work of system. Central system is responsible for communications between nodes and central server and database management as well as communication with the outer world. Central System consist of three main entities those are Communication Server, Database, Web Server. Control cabinet provides the easy access to the nodes, which consists of Temperature sensor, Soil Moisture

sensor, Water Level sensor, Rain detector sensor. The data sensed by the nodes is transferred to the central system by central server. Any warnings or notifications are communicated with farmer via gateway provided. Agronomist is contacted by central system in case of unusual activities.

Flow of Algorithm:

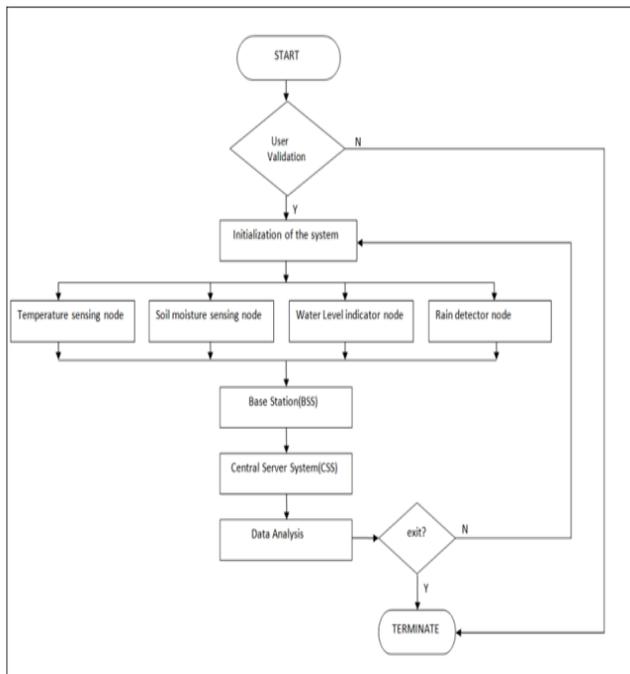


Fig 2 : Flow of Algorithm

The system will start its functioning as the user validation will occur with correct username and password. If username and password, neither of them matches, then the system will terminate. If username exists and the password is correct then the initialization of the system will take place, by initialization, it means that all the sensors in the field such as temperature sensor, soil moisture sensor, water level indicator sensor, rain detector sensor will be initialized to zero, hence refreshing the memory including data or archived values if any displayed. The data thus sensed by the sensors i.e temperature of the environment, soil moisture content, water level, possibility of rain, all these factors are sensed will be collected and transferred to the base server station located in the field. The base server station will further transfer the data to the central server system over a

reliable protocol. The central server station will analyze the data sent by the base server station based on the threshold values set for each entity. The analyzed data will then be displayed to the user. Based on this result, the farmer can take the decisions accordingly which are favorable for the efficient farming. if the user(farmer) wishes to continue with the system data then instead of exiting it will tell the system to continue and the sensors will be initialized again repeating the whole cycle again. If the user is satisfied and wants to exit the system, then the user will exit and the system will terminate.

This flow shows how the system will behave from user login to user logout. All the available activities are shown in the figure as well as central system, Base station and Data analysis these entities are enlisted which are key entities of the architecture. How this algorithm works can be better understood by looking at snapshots of GUIs which will show the options available for user, this is discussed in next section.

- **System Interface :**



Fig 3 : User Authentication



Fig 4 : System Interface

The above snapshot shows the overall layout of the system. The access of the system is secured through a username and password provided to the user. Therefore the data and notices will be only accessible by the valid user. When user is logged in to the system, the GUI (Graphical User Interface) will provide options to the user for next activity. Live monitoring of the farm, previous reports or last notifications can be viewed from the application. In case of any query it provides option for Help.

Conclusion:

As an important constituent part of the IoT, sensor networks enables us to interact with the real world objects. In this project we are dealing with the sensor network design that enables connecting agriculture to the IoT. The connection sets up the links among agronomists, farms, and thus improves the production of agricultural products. It is a comprehensive system designed to achieve precision in agriculture.

Future scope:

The future scope of this system will include the intelligent system which will take the decisions or actions according to the conditions prevailing. So that the farmer's interaction with the system will be minimized which will lead to less human efforts for the monitoring. This will allow farmer to vilipend the nominal warnings as system will take care of it, which will be a lucrative deal for the end user.

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