Farmer's friend: Utilization of IoT and Web application in Agriculture

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Abstract -*With the advent of IoT, we have seen a lot of changes in every fields including transportation, Education and so on. We are also aware about the advantages of IoT in the agricultural field. This paper deals with how IoT can be implemented in every fields of agriculture. The main aim is to develop a smarter agricultural system. We know that sensors and actuators play an important role in IoT as a result we are using them in order to get the automated measurement. The gathered data will be sent to cloud and it is fetched by the experts and they are responsible to send the feedback and also guide regarding the crops which will be suitable for a particular land. This feedback can be viewed by the farmer either through his smart phone or can access through the web application. In addition to it includes the nearest water resources, weather report which will be fetched from the satellite.*

***Key Words*: Gateways, Cloud, IoT, Wireless sensors**

1. INTRODUCTION

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuator s, and connectivity which enables these objects to connect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure.

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities.

"Things", in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras streaming live feeds of wild animals in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental or food or pathogen monitoring, or field operation devices that assist firefighters in search and rescue operations. Legal scholars suggest regarding "things" as an "inextricable mixture of hardware, software, data and service". These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices.

2. FRAMEWORK

This section presents the framework for automation in agricultural sector using the concept of IoT. The proposed Smart Agriculture has 4 different steps as shown in Fig -1. Those steps are Things or Objects, Local Gateway, Internet, Cloud.

2.1 Things or Objects

Things or objects form the first layer of the proposed Smart Agriculture framework. It consists of different physical objects like sensors, actuators, mobile phones, RFIDs and other items which are typically used for surveillance, information gathering from the application area. In most of the cases some sensor nodes will be attached with multiple types of sensors like temperature detector, humidity detector, insect detector etc.

The user will have the power to regulate or access the objects through the Internet. In this layer different challenges are involved. The object must know its geographical position so that the user may know its position. Without using expensive Global Positioning System (GPS) the object/sensor node needs to localize using other efficient algorithm/s. There is a chance that messages to and from node/s may collide with each other. Thus we require an efficient Medium Access Control (MAC) protocol [1] to prevent this. Energy is one of the valuable resources in Wireless Sensor Networks. Therefore the routing protocol and MAC protocol should ensure optimum energy dissipation.

2.2 Local Gateway

The data which are accumulated by the thing or object has to be sent to the local gateway either by multi hop way or single hop way. After getting those data the local gateway will aggregate those data to eliminate the redundant and non-relevant data. After aggregation the data will be uploaded to the cloud via Internet. Local gateway will act as one of the communicating media between user and the object.

2.3 Internet

The data coming from the deployed application will be uploaded to the cloud through internet. User will get notification about this through internet. Internet is the common upper level communicating media in case of IoT. Through internet Smart Agriculture can get advanced weather report too. From the weather report Smart Agriculture can regulate the utilization of water and application of insecticides/pesticides in the affected area.

2.4 Data Cloud and Mobile Phone Application

Cloud computing is basically on demand computing without purchasing efficient hardware, necessary system software or application software. Cloud is basically a blend of advanced technology and business model where the service provider and service buyer can be profited. In the framework of Smart Agriculture the cloud resides in layer 4. As per the definition of cloud the Smart Agriculture cloud will also have the basic features like Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) which are well defined in several papers [2]. Here in case of Smart Agriculture the user needs to buy the infrastructure for setting up layer 1 and layer 2. For layer 3 and layer 4, especially for the cloud layer he needs to buy the services. With increasing number of users cloud service will ultimately become more and more cheap.

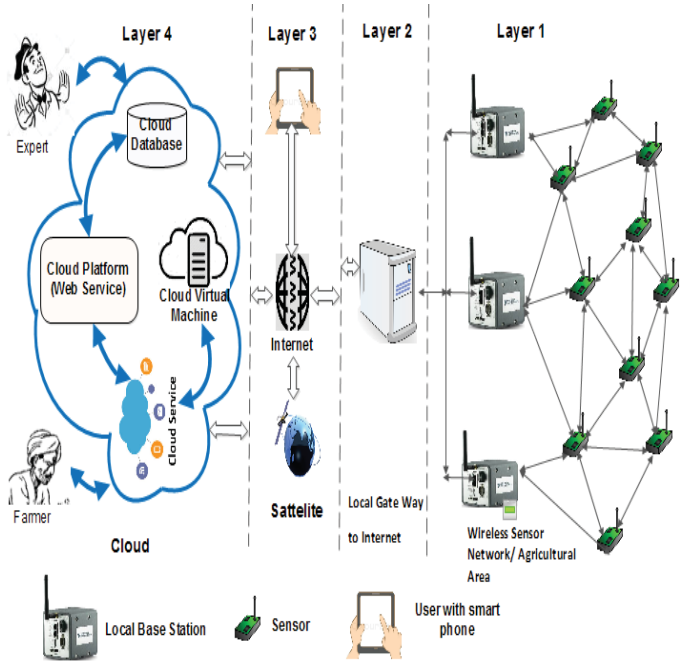

Fig -1: Framework

Base station aggregates data and routes to local gateway. On the other side, local gateway aggregates and uploads the value to cloud. The satellite periodically sends weather data to the cloud. The cloud collects weather reports from satellite and field data from sensors. An expert collects these data from cloud and analyzes all received information and provides suggestions for better farming. Lastly farmer collects this suggestion from cloud and takes appropriate measures on controlling the sensors.

We need to design another application for the user of Smart Agriculture to control the agricultural process through their mobile phone. User can get notification about the current scenario in his/her agricultural area. Through mobile phone user will be able to regulate or reschedule the activity of different object/sensor. User will get such types of notifications from cloud system. User can get direct access to the object via cloud, internet and gateway.

3. MESSAGE COMMUNICATION

In Smart Agriculture four types of message communication can occur: First is the human to object (things) communication and second is the object (things) to object (things) communication, third is the object to Internet communication, and the last but not the least is human to internet communication. In the first case human may get information about the agricultural area from the object via internet. In case of object to object communication one device may communicate with the other device with or without the intervention of human. A device can communicate with the cloud system via internet in the third type of communication. That means the data which is collected by devices has to be uploaded to the data cloud. In the fourth mode of communication, human can communicate with the cloud via internet to get the uploaded data from the cloud and/or able to regulate the IP-based device according to the need of the user.

3.1 Use case diagram

We design AgriTech using the object oriented design approach. Different actors in our proposed system are namely, Sensor node, base station, local gateway, satellite, cloud, Farmer and expert. Fig. 2 and Fig. 3 show the use case diagrams which depict roles of players. For simplicity we have drawn use case layer wise. Sensor nodes are responsible for sensing different parameters in the deployed area (field) and send the same to base station using some routing protocol.

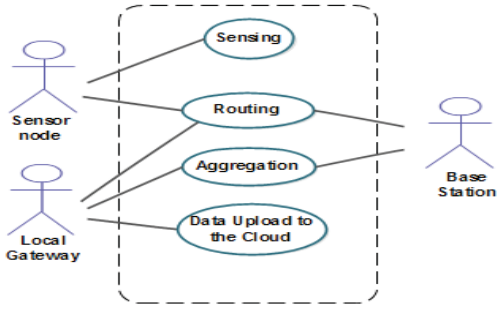

Fig -2: Use case diagram for layer 1 and layer 2 of AgriTech

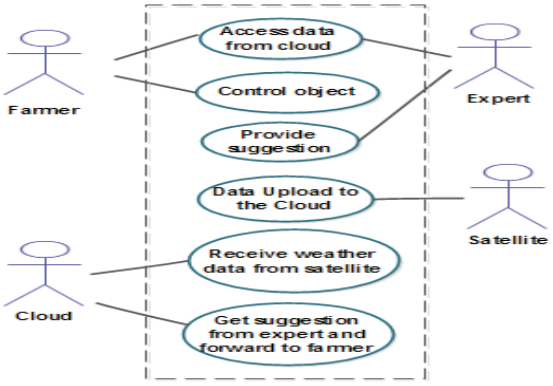

Fig -3: Use case diagram for layer 3 and layer 4 of AgriTech

4. PRACTICAL IMPLEMENTATION

The Smart Agriculture is the technology which will be used for agricultural automation. The Smart Agriculture may be applied in our country India for detecting soil moistures, weather monitoring, growth monitoring, automatic irrigation controlling. It can also be used to find the best time for plantation and harvesting, improve the crop yields while ensuring the quality of crops, etc. In this section we will discuss how Smart Agriculture will change the society of any third world country whose economy mostly depends on the agricultural sector. The economy depends on agriculture and agriculture solely depends on farmer. But the condition of the farmer is very poor in a so called third world country. It is the ground reality that now-a-days agriculture is becoming a tough profession due to economic uncertainty.

There are several threats to farmers, such as excessive rain, lack of rain, excessive crop output, lack of output, attack by insecticides, attack by pesticides etc. A farmer may have lack of knowledge about which crop in which season would give the maximum profit depending on the weather condition and thereby minimize the loss. These kinds of support can be provided by our proposed Smart Agriculture technology. By automating irrigation, Smart Agriculture will optimize water utilization which leads to saving ground water and also saving the electricity consumed by the irrigational sector. Humidity sensors will be attached with the sensor node to measure the moisture level of soil. If the moisture level comes down to a certain level then Smart Agriculture will spray some water in the farmland. This type of approach will help to save ground water and to maintain environmental balance.

Smart Agriculture can optimize the water utilization further. Before watering the agricultural field it may consult with the online weather prediction report. If the weather prediction says that there are chances of rain within short period of time then it may wait expecting rain. The attack by insects and pests will be detected by the insect detector/pest detector sensor. After that the Smart Agriculture will spray insecticides or pesticides in the agricultural field or notify the user to take necessary and quick action. Since the problem will be detected early a huge loss in crop yield and quality can be avoided with minimum cost and time. Therefore it is apparent that Smart Agriculture can reduce the cost of Agriculture process.

Farmer gets the information of all mentioned above using web application developed by the experts or they can access using the android apps. Web application helps the farmers who are not aware of using the android. These web applications can be access in the cyber points available in their places. Along with this farmer also receives the notification messages to their registered mobile number from the experts.

He may concentrate on selling the agricultural products directly to the market. The Smart Agriculture might increase the earning of farmers and reduce the differences of different economic classes in the society. The farmer may be involved in small scale industry which depends on agricultural product. By exporting those products our country may earn revenue and the farmer might get better profit. In a nutshell, we can say that if we can improve the economic condition of major class of people who live in the below poverty level then that is the overall improvement of the country as well as the entire humanity.

5. CONCLUSIONS

This paper proposes a framework called Smart Agriculture that consists of smart devices, WSN, and Internet by which agricultural processes will be automated. With a mobile in hand the crops and farmland may be better monitored by the farmer without even reaching there. Using smart mobile phones the farmer can control the agricultural tools such as an automated water sprayer to be used in the field of agriculture. So this technology can reduce the human effort in agricultural sector. Following the weather report on a particular day that it may rain, our proposed system may resist the sprayer from spraying of water immediately. This decision not only reduces the wastage of ground water but also the electric consumption in irrigation. So, Smart Agriculture can be claimed as an eco-friendly technology. Again, following Smart Agriculture can track the global market and suggest farmers the best time to harvest and sell the crop to gain maximum profit. Improving economy of the farmers in countries of whose a major population depend on agriculture results in improvement in such nations. The Smart Agriculture can improve the economy of farmers and its successful implementation will improve Gross Domestic Product (GDP) of the third world countries. As the framework is new of its kind, comparison with any existing similar model is beyond the scope.

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