Smart Agricultural Practices Using IoT and Data Analytics

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***Abstract*- There is a paradigm shift taking place in agricultural sector towards smart agricultural practices. This is due to the reducing agricultural resources. So, IoT has been used started to be used as a tool to improve the productivity in the agriculture sector. The IoT is the combination of several technologies such as WSN, radio frequency identification, cloud computing, middleware systems and end-user applications. In this paper, an attempt has been made to find the ways to attain most benefits from IoT in the field of agriculture. DA has also been integrated so as to attain maximum efficiency. Also this work tries to make this combination towards smart agriculture.**

***Key Words*- IoT, Data Analytics, Smart agriculture**

I. INTRODUCTION

IoT is finding applications in many areas such as medicine, smart-home, smart city and others. IoT is a system with computing devices, digital and mechanical machines all of which have unique identifiers to transfer the data over a network. IoT makes better automation by using internet as a medium[1].The agriculture has been identified as a potential area for usage of IoT along with data analytics for increase in food production [2].It is expected that more farmers will use IoT combined with data analytics to enhance food production in the coming years.[3].

For smart agriculture purpose, the farmers have been using Wireless sensor networks till now. These sensors have been used mainly for automatic control of farming machines, onitoring the eco system[4][5].With the help of WSN it has been seen that food production has been increased manifold. However, IoT is a better choice for smart agriculture now a days because the accuracy of this technology is better than WSN. The IoT combines positive aspects of all applications such as WSN, cloud computing, middleware and others[6]. IoT has been identified for quick decision making system or smart agriculture for farmers to enhance production and to increase their profit. However certain constraints such as privacy, security, data governance have limited the use of IoT. The existing methodologies in farming have used low range of communications technologies.

In this paper, IoT for agriculture has been discussed and the usge of IoT for a farm in India. It combines all the IoT system components. Besides challenges of using IoT in agriculture has been discussed.

II. ECO SYSTEM WITH IoT

The Ecosystem with IoT has four major components as IoT devices, communication technology and data analytics. The fig.1 represents block diagram for the ecosystem with IoT.

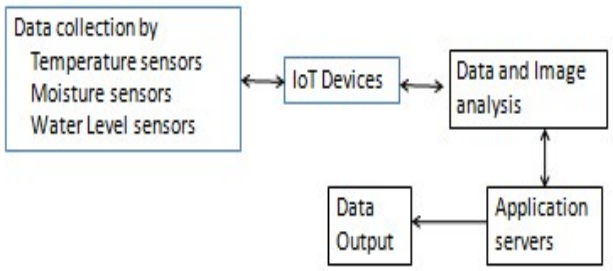

Fig.1.Block diagram of Eco system for IoT

1. IoT Sensors:

It connects the system with environment. They need wireless connection. An IoT device has sensors, embedded system with processor, communication modules, memory and interface which combined turn on or off the actuators. The processor in modern days is of v FPGA type.

Sensors measure moisture, temperature and other factors related to agriculture. The sensors are of large no, of types. They are given in Table1.The IoT devices must satisfy the following requirements:

1. Large memory
2. Fast Computation
3. Large coverage of farming methods
4. Reliable
5. Less cost.

2. Communication: Communication is based on standards, spectrum and application. The standard is either short term communication standard or long term communication standard. They sre described as follows:

(a).Standard: The standards are classified into short range and long range standards. Bluetooth, Zigbee are short range standards They cover short distance of 80-100m only. Long range communication standards cover some more distance

of a few Kilometres. Low power Wide area standard uses low power to cover wide area for communication.

(b).Spectrum: For the cost under consideration, unlicensed spectrum may be used, if information security is not a concern.But if the security is a major concern it is recommended to use licensed spectrum by sacrificing cost.

TABLE 1: SENSORS USEFUL FOR AGRICULTURE

Sensor	Functions	Applications
Air	It gives amount of air permeable into soil	Soil structure, Moisture level
Electrochemical	It gives amount of chemicals particularly ions present in the soil.	Ion sensitive FET and electrodes. They give information about the Nitrogen, Phosphorous and Pottasium in soil
Optical	It measures certain properties of soil using light	They give he content of organic matter and amount of moiusture in the soil

(c)Communication Technology: The IoT devices are used for communication. They act either as nodes, which support lesser data rates. and backup networks. Backup networks are used for large amount of data transfer over a long distance, usually bidirectional.[7].Further communication technology depends on network topology such as star or mesh, peer to peering or tree. The IoT device works as Full function device, if it is used in Personal area network. It works either as full function device(FFD) or reduced function device(RFD) if it is used at an end. For Peer to peer, Personal area network functions as Reduced Functional Device and at end devices function as Full functional Device and Reduced Functional Device. The end device as FFD can have Multiple connections. and RFD can have only one connections. They connect with Personal area network coordinator.

3. Internet:

Internet is the backbone for IoT in agriculture. With IoT, the information is available easily. For heterogeneous systems to be connected, we need middleware [8].For network security related issues and large data processing Cloud computing is used which requires storage space for large data, managing user interface and nodes

4. Processing the data:

For agricultural purpose large amount of spatial data is needed to be stored[9].The data can be picture, text, video or any other non structured data. Cloud computing needs large data to be stored and making applications for providing services and IoT architecture. Agrionline (agrionline.nic.in),a portal by Ministry of agriculture Government of India provides, various information for farmers online. Further, National Institute of Agricultural Extension Management has provided extensive data to farmers which they can find useful.

III. IoT FOR AGRICULTURE

IoT in agriculture has its own issues and constraints.

1. Types of Agriculture:

There are several types of agricultural methods used in India. The process of monitoring requires various factors to be sensed.

(a) Crop Farming: In crop faring data such as temperature, soil moisture, Solar radiation are required. They affect farm production [10].They are useful to make useful decisions to increase profits. When soil moisture content is identified the farmer can decide, whether water is required for crops/plants. Measuring solar radiation a farmer can decide about the exposure to sunlight. Weather forecast gives information about rainfall. All these help farmers to plan and execute the things accordingly. It is also useful in pest control.

(b) Forest farming: Forest requires following factors to be monitored: (i)Humidity (ii)Temperature (iii)Levels of various gases. This will further intimate about fire if anything that is going to happen.

(c) Farming with water: This is also called as aquaponics. We have to monitor water level,its quality, temperature levels, pH levels[11].The data is used to make suitable amount of fish waste to be allowed into plants.

(d) Farming with animals: It is livestock farming. Based on information abou the animals the farming is done. Amount of milk from cows give ths health of their state. Humidty, pest are other factors. RFID tags can be made attached with animals and the information can be passed to animals. Water, animal feeds can also be monitored. This farming is used at a very least amount. But IoT in livestock farming reduces cost to very large amount.

2. Asset tracking:

With the help of IoT, time, money of agricultural companies has been reduced and they are connected with related persons easily. It is done by using RFID based GPS system[12].Further tracking makes the farmer collect the data of product such as pesticides, from manufacturing place itself. Tracing makes into compare with similar other products. All these are done with the help of IoT based cloud computing. This gives several data while the product is supplied to the farmer.[13].The factors such as environment, pest factors, storage, transportation and other things can be monitored in an accurate way.

The above factors are threat to consumers. The pesticides affect the amount of farm production. Further vaccines given to fishes in water farming are also monitored easily.

The tracking system has following:(i)Information input (ii)Storage (iii)Output transfer. This gives details about the life cycle of the product. Further it requires all the data

regarding tracking to be stored for further usage. For this RFID tracking is used[14]

3. Machinery:

The machinery that are used for agriculture can be controlled by GPS of IoT is used as one of its parts.[15].Usually, for this purpose remote controlled robots are used and other machinery are auto controlled one and do not require any man power. This increases production and saves time. Further, these machinery collect data for nutrition, irrigation are collected and hence controlling of these machinery becomes easy.UAV sensors are used for measuring wind speed and air pressure. They are used for mapping the agricultural lands.[16].

4. Predictive analysis of Farm variables:

The realtime data of farm are collected to predict about the future of the data. Farm variables include soil and air quality, weather, crop maturity and others. This causes less amount of time and cost and to reduce resource wastage. It is used to make smart decisions. It optimally distributes the resources such as seeding and other services.

5. Glasshouse Technology:

The environment is controlled in this technique optimally where the crops are grown. For this, several research works have been carried out[17].This technique reduces requirement of labour and increases efficiency,

IV. IMPORTANCE OF DATA ANALYTICS

The importance of Data Analytics is elaborated in the following aspects:

1. Estimation:

IoT is used to sense the present weather conditions Using Data analytics and smart algorithm we can predict the weather conditions at future. It is used to predict the diseases or fire that may occur due to predicted weather conditions and give warning to the farmers[18].

2. Management of storage of products:

To avoid rotting of agricultural productsor in other way, the best storage conditions must be ensured. Temperature and moisture contaminate the products. The IoT improves the storage of the products. Sensors are used at storage points. It gives information to the data analytic centre about the status of food. Using smart algorithm and and other DA techniques suitable decision is made there. If necessary, alert messages is also given to farmers. In India, if applied this technique will reduce 35% to 40% of wastage of food at the time of harvest[19].A storage system has been designed for this purpose to operate the storage facility at controlled temperature. IoT improves storage facility. If security features are added to it,other losses due to theft will also be avoided.

3. Decision:

The decision made are in automatic way. It requires no human interventions. It controls temperature and water supply. It also gives information about the optimal conditions under which farming should be done to improve yield and profit.

4. Management of farming:

Wherever animals are a part of farming, using RFID tag sensors data are collected to improve productivity. Risk management, productivity and yield are the factors that are to be controlled and managed[20]. Data analytics connect various farms to be connected together, to give agricultural inputs, weather forecast and other things for the benefit of farmers to maximise profit.

5. Precision:

Data such as temperature, moisture content taken from farm are used for precise control and hence improves productivity.

V, BENEFITS

IoT give following benefits to farmers:

1. Integration of Farming lands: Al the data fro farming lands are collected at common data centre and suitable advices are issued to farmers

2. Fraud Prevention: Various fraud in food production is a serious threat to the society. So, the fraudulent production can be avoided by the usage of IoT.

3. Speedy decision and improved yields: With IoT speed of decision making is high and yield and hence profit also increases.

4. Reduction in wastage: The manual inspection of land is reduced with the help of IoT. All the data are sensed by sensors and automatically controlled. Hence farming is almost automatic.

5. Improved Efficiency: Data collection at faster manner helps the authorities such as government and other people related to agriculture to make the policy decisions quickly. So efficiency of the system iproves.

VI.CHALLENGES AHEAD

1. Technical:

(a).Loss of data: Mostly the IoT devices operate on Unlicensed spectru. So, there is a possibility of data losses due to external system interferences. This reduces reliability.

(b).Data Security: The security threats posed to IoT can cause loss of data.

(c)Choosing correct IoT technology: The IoT is the recent technique .Most of the techniques developed are in initial stage. So, choosing the correct IoT technology for a particular type of crop is difficult one. It should be reliable.

(d).Resource optimisation: The resources available with IoT for current farming are limited. So, optimal allocation is done by mathematical model based algorithms which are to be developed yet.

VII.CONCLUSION

Application of IoT in agriculture has been discussed in detail in this paper .Further benefits of IoT and Data Analytics on agriculture and how it can be used to improve production, yield and profits has also been discussed. The threats to IoT based agriculture will be overcome in the future and IoT and Data analytics will dominate it.

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