

Internet of Agriculture: Applying IoT to Improve Food and Farming Technology

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Abstract— This paper investigates the role of Internet of Things(IoT) in Agricultural Sector. Today agriculture is embedded with advance service like GPS, sensors that enable to communicate to each other analyse the data and also exchange data among them. IT provides service in the form of cloud to agriculture. Agriculture cloud and IT service provides a special skill service to farmers regarding cultivation of crops, pricing, fertilizers ,diseases detail method of cure to be used Scientist working on agriculture will provide their discoveries, suggestions regarding modern techniques for cultivation ,usage of fertilizers can obtain the history of the region. the study was based on applying a cloud based application on agriculture. This is based on agri-cloud that enhance agricultural production and availability of data related to research projects in the failed, the impact of doing this will save the cost and time make the communication easier and faster. This paper would promote a lot of research in the area of application of IoT in agriculture.

Keywords- Internet of Things, Cloud Computing, Big Data, Service Oriented Architecture, Agriculture.

I. INTRODUCTION

Cloud computing have five values like reduction in initial cost, allocation of resources without limit, maintenance and upgrades are performed in backend and they don't collaborate with other system in cloud and possibilities of global service development. Cloud computing is a tool to make information technology related services available with simple manner and hiding the difficulties in the services. The user don't really need to know who are providing the services . It reduces the cost of availing those services and offers maintenance. It provides services to user whenever and wherever they needed. Agriculture cloud is the special cloud that is composed of based on MAD cloud architecture. Most of the agriculture based developing country like India ,the agricultural sector contributes are 20% of the country's GDP and around 65%

of total population employed in the sector. the main objective of our work is to define land potential explicitly and dynamically for unique and constantly changing soil and climatic condition .the cloud application helps the farmer to increase their agricultural yield .this work will also facilitate more rapid and complete integration and disseminate of local and scientific knowledge. This application provides high quality service and efficient data to user in anywhere anytime. It provides width coverage area. The scope of this paper to concern the characterization and analysis of agricultural data with varying climatic and soil condition.

Cloud support various services to farmers to interact with cloud by using any cheaper ways like sensors, mobile devices ,scanners etc., the query to the users can be asked via internet connection. The research application is completely based on MAD-cloud architecture ,data are stored according to the co-ordinate and physical and chemical requirements of the crop. The data are stored in methodological form and they are updated by admin and data are collected by sensor, GPS. the data also defines soil texture, humidity, wind speed, rain amount. The user can obtain detain information about related crop which is require to increase the production .the user can select the co-ordinate location and define personal detail like name, place, etc. It also describes crop disease and method to cure. Cloud provides objective way like required quality, reliability and security by using the cloud in agriculture helps the farmers and also used to increase our economic level.

The rest of the paper is organized as follows: section 2 describes smart farming applying IoT. Section 3 gives a broad overview of IoT and agriculture. Section 4 gives a detailed view on application of IoT system for advanced agriculture in India. Section 5 portrays application of cloud computing in agricultural information system. Role of sensors in precision agriculture is depicted in Section 6. Section 7 speaks agricultural virtualized information database. Section 8 speaks about role of

bigdata in food and agriculture. Section 9 concludes the paper giving the future research direction.

II. SMART FARMING APPLYING IoT

Isabella M. carbonell says that prediction of future of agriculture is done through many agribusinesses such as Monsanto or John Deere which have the high investment in bigdata. It has the capacity to produce an extraordinary predictive business model on different sectors of farming. Bigdata accumulated from many source are only to interpret post events but also for the future events to come in to settle a matter. The author says about the unfiltered data collection that means prediction of future needs through future needs. Bigdata has commercialized because large part of data resources comes under industrial agriculture formally called as "data driven agriculture" or "smart farming".

Some of the research cases for Bigdata are as follows

- Deep undersatndability of information.
- It gives link and authority to the people.
- Decisions can be made based on the proofs.
- It provides complete solutions for the difficult problems.
- All unified agencies that award grants must make the data available and ability to access data can help develop informed policies.
- Data security for research done on farm will need to be addressed.

The author explained about the technique of Monsanto that with t5he help of the wireless sensors placed on the modern tractors supervising every verdict of the farmers. It tells the farmer, when to plant crop and irrigates them, quantity and timing of spraying pesticides and insecticides, predicts the day of harvest and also it describes about the micro climatic changes. Monasanto provides the farmers with enormous amount of data directly through a Wifi data connection, sensors and its new data analytics app called as "Climate field view pro". This wireless data collection procedure is regulated via "Technology use agreement" in which the farmers have to sign.

Bigdata that acts a tool providing hidden procedures, requires large technologies, efficient functioning, masteries which too much difficult for an individual farmers. In order to avoid these difficulties it constructs hierarchies around research. Large agribusiness gives the control over only who gets to have access over the data but not to all others. Big agriculture which means bigdata analytics on customary industrial farms which deals exclusively on inputs and production .Even though the smaller farms uses the agriculture methods such as no-till and drip irrigation provides more output than farms, an industrialized farm

considered as great success and efficiency. Satellites provides the "field level weather" which says about the present temperature, weather and soil humidity at the field level which help us determining the day tom plant or harvest based on the weather data of past 30 years.

In accurate agriculture a huge amount of information has been available and new advent for development are now required. so survey on bigdata are conducted to find the ideas as a means to analyse enormous amount data set. This survey is done through computed tomography images, which presents bigdata environment for agriculture soil analysis. It is arranged in three layers : Source, environment and applications in the 2nd layer Hadoop framework is used to process CT images and discuss 3D structures. Another application in the structure is the statistical investigation of soil samples. Bigdata environment is evolved as a soil analysis system understand the issues on the agricultural lands

Agribusinesses has the high values in bigdata, as it provides the unpredictable future business model in the field of agriculture. This will provide the great change among the public and private sector agribusiness. Bigdata obtained from various sources are gathered not only to know past events but also to predict the future needs. Angwin says about 'Dragnets' or unfiltered data collection which means "increasingly future-oriented and concerned about the predictive power of the information it gathers". In spite of many problems with data-driven farming, it is not negative and could be used efficiently by the farmers. There are some examples that make use of technology and the ideas of farmers to openly access the analytic tools with the stored data such as "ISOBlue", an open_source project. The other examples are "FarmLogs" and "Open age data Alliance". the open data is also provide by small group such as Global Open Data for Agriculture and Nutrition initiative (GODAN).These open source technology will provide the farmers with the available data for the future needs. These data tools are also for small non industrial farmers, user friendly softwares and public funded research, could pave the way for the creative use of Bigdata for small farms.

III. INTERNET OF THINGS AND CLOUD COMPUTING

IoT is a revolutionary technology that represents the future for computing and communication. It refers to a network of object and self configuring wireless network. The resurfacing of global recession has caused ripples across both the developed and developing economies. Agriculture sector will have much more efficient to ensure global food security. After WWW(world wide web) and the mobile internet are more potentially 'disruptive' phase of Internet revolution. The internet of things which is also known as ubiquitous computing. IOT applications encompass diverse areas including agriculture, healthcare, retail, transport,

environment, supply chain management, infrastructure monitoring etc., Applications in agriculture include soil and plant monitoring, green house environment monitoring and control system monitoring of food chain supply. The networking of things must be cost effective and useful to the end users for acceptance and wide scale adoption of IOT. The IOT is a worldwide network of intercommunicating devices. It integrates pervasive computing and ambient intelligence. IOT is a vision where things especially everyday objects such as all home appliances furniture, cloths, vehicles, roads and smart materials are purchased via internet. This will provide the basic for many new applications such as energy monitoring, transport safety systems. IOT will connect the world's objects in both a sensory and intelligent manner through combining technological developments like sensors and wireless sensor networks, embedded systems and with nanotechnology. The following technologies directly contribute to development of IOT: Machine to machine interface, Protocols of electronic communication, Energy harvesting technologies, sensors, actuators, GPS, Software. The following technologies may add value to the IOT: - tagging/Geo-caching, Bio metrics, Machine vision, Robotics, telepresence, Adjustable Autonomy, life recorders, Personal black boxes, clean technologies.

The accessible, affordable, interactive crowd sourcing platform for sustainable agriculture would provide a means of sharing information like tools, techniques, sustainable agriculture methods etc. It address food security, water security, the solution must provides for problems, micro finance services for farmers must also provide a centralized repository for a variety of information such as traditional sustainable farming techniques, crop disease etc.,. The features of agriculture sector such as diversity, complexity spatio temporal variability in developing the right kinds of products and devices. The size of farms varies from small to large and hence the solutions should be scalable. The IOT is a technological revolution that represents the future of computing and communication and its development depends on innovation from wireless sensors to nanotechnology. First in order to connect everyday objects and devices to large database and networks only they can data about things be collected and processed. Nanotechnology means that smaller and smaller things will have the ability to interact and connects. These developments will create an IOT then connects the world objects in both a sensory and an intelligent manner. the real world agricultural products digital information or data can be processed in virtual. Then temperature, humidity, pressure, gas, concentration and vital signs. The main task of IOT is to collect all the information in the real world by sensing techniques and then transform them to digital information. the main task of this analyze and process the information collected, so as to cultivate digital awareness to the real world. It is a combination of IOT and agricultural mark intelligence. Agricultural IOT will completely subvert

the traditional assertions that physical world are separated. In agricultural IOT, farmland, agricultural machines and fresh agricultural products are integrated with chips and broadband network.

Benefits of applying IoT in Agriculture include

- Improvement in use efficiency of inputs (soil, water, fertilizers, pesticides, etc.)
- Reduced cost of production.
- Increased profits.
- Sustainability.
- Food safety.
- Protection of the environment.
- with the IOT, single farmers may be able to deliver the crops directly to the consumers not only in small region like in direct marketing or shops but in a wider area.

IV. APPLICATIONS OF IOT BASED SYSTEM

IOT has emerged as a core of IT industry in this new generation .The Prime Minister Narendra Modi gave the idea of "Digital India" in 2015. It is mainly based on development of IOT and strategic new industries. India is basically an agricultural based country. IOT based sensor network will be useful in the development of agriculture in future. Sensors are kept in electricity grid, railway, bridge, tunnel, road, buildings, dam, oil and gas pipes ,etc., and connect the internet ,which operates programs and realize remote control. Some of the IOT techniques includes RF identification, new sensors technology, sensor network technology and internet work communication. IOT is an intelligent technology of identifying ,sensing and intelligence. IOT is defined as the combination of cloud computing ,intelligent sensing network and ubiquitous network. some of the ubiquitous networks are 3G, LTE, GSM, WLAN, WPAN , wimax , RFID ,zigbee ,NFC ,bluetooth and other wireless communication protocol technology.

Now a days agriculture has become industrialized .so it is to be developed. The agricultural development is promoted only by the idea of agricultural informationization and it is a corner stone for transforming and maintaining sound and sustaining economic development .In the past five years agricultural infrastructure has given the remarkable result in the field of agriculture. It provides the basement for the agricultural information service. In terms of modern forms IoT produce the many technologies like soilless culture, culture solution control technology ,the artificial photosynthesis technology, growing environment control technology, intelligent irrigation technology ,etc.,. IoT technology is used in the farms for the production of plant factory technology. this is highly efficient in agricultural system for continuous production of crops around the year through highly accurate to control environment. It is controlled by the computer to automatic control the temperature ,humidity, CO₂ concentration and culture solution of crops in farms. The smart agriculture control platform and database. The

platform further consist of subsystem as agro ecological environment control ,agricultural resource control, production process control ,farm products ,food safety, agricultural equipments and facility. Data centre is set of complex facilities. It includes not only a computer system but also other facilities go with it and redundant data communication links ,environment control facility, monitor facility and various kind of security devices.

Large amount of data obtained by using radio frequency identification, wireless communication, automatic control, information sensing techniques of IOT, truly realizing smart agriculture.

V. APPLICATIONS OF CLOUD COMPUTING IN AGRICULTURAL INFORMATION SYSTEM

Miao tion,Qingli xia and Hao yuan (2012) says that the problem in agricultural information management ,it is very urgency to implement the cloud computing in this field. The author says that the recent years due to development in the technology the agricultural field were declared and construction were increased in rural areas. The agricultural information resource and service provides the information about the farmers they actually need, that is changes in climate, soil dependency. In first stage they transform information by face to face ,second stage by media and printed materials, the third stage is telephone and social networks. The fourth stage is cloud computing. It is a business computing and storage made to detect the contents. The cloud computing can be developed in the agricultural sector, it gives the information and the crops that are suited for that condition.

Under the condition of cloud computing ,the different agencies can use the common space to store message and share the infrastructure provide by the cloud providers. The machine are not need to purchase but the resources of agricultural information are stored in cloud server. It provides the farmers with efficient information and more accurate billings. As the farmers are poor in literacy, the cloud computing provides the integrated methods rather than traditional methods. If the farmers put forward some queries to the system the client directly sent to the cloud and collect all data require for the queries and send the result to the user. The cloud can develop the new integrated method for the user need to attract them. Once the farmers put forward their request on the cloud service, it will analyze the problem and gives the solution based on the different agricultural information service agencies. The platform of cloud consulting could seen as a black box between the farmer and the services. The cloud platform will give the relevant award for answering the questions with encouragement. The advantage of this model are the agencies of agricultural information services don't need to develop their own information consulting centre. This can solve the cost of purchasing the equipments. The impact of doing this will save the cost and time make the communication easier and faster.

Cloud computing have five values like reduction in initial cost, allocation of resources without limit, maintenance and upgrades are performed in backend and they don't collaborate with other system in cloud and possibilities of global service development. Cloud computing is a tool to make IT related services available with simple manner and hiding the difficulties in the services. The user don't really need to know who are providing the services. It reduces the cost of availing those services and offers maintenance to those services. The cloud computing provide service to the user wherever and whenever they needed. Agriculture cloud is the special cloud that are composed of different services based of MAD-cloud agriculture.

Most of the agriculture based developing country like India, the agricultural sector contributes are 20% of the country's GDP and around 65% of total population employed in the sector. The main objective of our work is to define land potential and explicitly and dynamically for unique and constantly changing soil and climatic conditions. The cloud application helps the farmers to increase their agricultural field. This work will also facilitate more rapid and complete integration and disseminate of local and scientific knowledge.

This application provides high quality service and efficient data to user in anywhere anytime. It provides wider coverage area. The scope of this paper to concern the characterization and analysis of agricultural data with varying climatic and soil condition. Cloud supports various services to farmers to interact with cloud by using any cheaper ways like, sensors, mobile devices,scanners etc., The query to the user can be asked via internet connection. The research application is completely based on MAD-cloud architecture, the data are stored according to co-ordinate and physical ,chemical requirement of crop. The data are stored in methodological form and they are updated by admin and data are collected by sensors, GPS. The data also define soil texture ,humidity, wind speed and rain amount. The user can obtain detailed information about related crop which is required to increase the production. The user can select the co-ordinate location and define personal detail like name, place etc.,It also describes crop disease and method to cure. cloud provides objective way like required quantity, reliability and security. By using the cloud in agriculture helps the farmer and also used to increase our economic level. Agriculture is the major source for the largest population in India to earn money and to carry out their livelihood. precision agriculture is adopted in some countries, but there is need to involve cloud computing in agriculture to increase crop production and also to develop our economy. Cloud computing is expected to increase significantly in near future due to improved hastening facilities and faster internet speed. They will be able to get the information like reduction in cost which are beneficial to farmers.

The food and agriculture organization of the united nation predicts the population will increase 8 billion by 2025 and 9.6 billion in 2050. so we need to increase the

food production by 70% comparing with other countries. India is the large agricultural country, it has large farm land but the production value is low. Cloud computing technology tends to connect with various object in the world by internet. It involves the use of wireless sensors which will monitor the status. This can be efficiently used to increase the crop production to meet the growing needs of increasing population. Cloud computing along with IOT is helpful to charge pay per usage and reduction in cast. This can be developed to increase the quality, quantity, sustainability and cost effectiveness in agricultural production.

Indian farmers have already started taking help of the modern agriculture tools and machine. Indian farmers are just at the introductory level as compared to other countries. Cloud computing is required in agriculture and it is not possible for farmers to deal the service providers as a individual basis. Cloud computing provides the sharing of resources at low cost. Considering the Asian countries, India is a part of Asian country, China and Japan are also in advanced stages. use of cloud computing storage server is proposed to reduce the cost of data service and to overcome drawbacks of high cost of data service. Cloud computing is used for virtual storage purpose. By using this cost is reduced, and the user is provided with the extra facilities to request only the required services at a time.

VI. ROLE OF SENSORS IN THE PRECISION AGRICULTURE

India is one of the rapidly developing economies. All over the world 58.4% are ingenuous agricultural assemblage. But in India it provides only 30% to 60% for the agriculture. Today, India ranks second worldwide in farm output. Agriculture and their related sectors for 13% of the total GDP in 2014; about 50% of the total workforce. Agriculture gives the support to our economy among various sectors of the nation. But, the present report says that the agriculture sector continue to trail.

Precision agriculture (PA) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. Crop variability involves both spatial and temporal component. Some agriculture experts have noticed the demand for sensor data incorporation in agricultural system and analysed how to overcome the realistic propositions involving the government and its policies. Using this techniques the data analysts, agricultural professionals and others give forward how to bring about better process at lower costs.

The evolution of data over the past decade has started a unique thought in the domain of information technology and data science called Big Data. This technology is acquiring deep consideration as an idea to develop the performance of agricultural systems by combining different systems data and communications platform to reduce redundant crop failures, enhance agricultural governing and agricultural services. It gathers all crop information generated through electronic smart devices (like moisture

sensors, electromagnetic sensors, and optical sensors) for a detailed area. These smart devices will generate impressive amounts of data, impelled by record keeping, agreement and regulatory requirements, which are considered as big data. The e-Agriculture service data can be considered as a Big Data because of its variety of data with huge volumes flowing with high velocity. Some of the solutions to the e-Agriculture service big data include the predominant current technologies like HDFS, Map Reduce, Hadoop, STORM etc.

The following are the points that make the performance of agricultural systems better and increase productivity:

1. Measure, store and analyze the data to improve yield quality.
2. Manage revenue costs by reducing crop failure's probability.
3. Improve preventive care and increase producer-consumer satisfaction.

Big data describes about the structured, semi-structured and unstructured data that has the potential to be mined for information. Big data is a set of techniques and technologies that require new forms of integration to uncover large hidden values from large datasets that are diverse, complex, and a large scale. The processing of such data using common database management tools is a very serious task. Everything around us is contributing to the generation of Big data at every time instance. The vast Indian agricultural system is ought to harness agriculture's "big data" by interpreting a complex set of data, including electronic farm records and sensor data.

VII. AGRICULTURE VIRTUALIZED INFORMATION DATABASE

Agriculture information resource such as multimedia files remote sensing images and monitoring data streams are characterized with distributed and massive storage. The development of the modern agriculture information techniques and the generation and the utilization of agriculture information resources and the sharing of the data is urging problems. By taking remote sensing image data which is widely used for pest control, disease, yield forecast crop quality analysis etc. and the dynamic monitoring of the crop growth also been realized.

There are different agriculture applications data, farmland monitoring data, climate data and soil investigation data to the isolated organization, cloud computing, distributed computing and grid computing which features for virtualization, highly reliable, common ability and serve to the demand. Hadoop, as an open source framework, is suitable for the distributed data storage and management in cheap computers. The cloud storage platform is constituted by the central server the cloud storage platform provides the interface like resource access platform management and status monitor etc. after submitted to the

cloud platform, it provides information like remote sensing images, videos, text can be stored in resource server.

Information service realizes the management of underlying services like registration information, legal validation and status monitor. Normal user also can register, retrieve and access to the agriculture information. The admin user can dynamically monitor the node of resource server monitoring. Cloud storage is a kind of virtualized resource storage pool. Combined with one or more software or hardware, it has an ability of dynamic allocation, smooth extension storage and communication. Cloud storage deals with the integration of resources distributed separately. The resource of storage cloud is stored in different resource node. The high efficient data transmission is achieved by distributed storage algorithm. When users add agriculture information, whose schema has been registered, the category should be specified.

A distributed node of dynamic monitoring platform based on Hadoop cloud storage was developed by open source software ganglia. At present, the agriculture virtualized information database on efficiently developed and implement in many countries. It solve the problem of blocking of massive agriculture information and multi-copy storage and concurrency transmission of agriculture resource information. The server monitoring was done dynamically and agriculture resource security in each research institution should be considered.

VIII. BIG DATA IN FOOD AND AGRICULTURE

Now-a-days the farming has become digitalized. Even the small scale farmers uses the information gathered from the precision agricultural equipment and from large datasets and precision analytics. John Deere fits all of its tractors with sensors that is helpful in collecting information about the soil and crop conditions. This information helps the farmers to decide where to plant crops. The information collected from the John Deere tractors are not openly accessible by farmers.

The use of large information sets and the digital tools for collecting, separating and analyzing them-together referred to as Big-data. In olden days farming was empirical but the information collected are not digital. But now-a-days logging data using the application can be done more efficiently and farmer can access the information is profound. Integrated Field Systems (IFS), is a platform under which Monsanto corporation has a suite of digital tools for collecting and analyzing farm data. It helps to collect data on soil conditions, weeds and weather. In the case of weed I.D., which helps the farmers to identify the weeds and measure the weed pressure using digital mapping tools. These shows that there are corporate benefits attached to this.

In 2013, Monsanto has bought the digital tool developer climate corporation which focuses on tools for collecting farm-level data. Canada's National Agricultural Information Services (NAIS) on Agriculture and Agrifood has built an application called Agroclimate Impact Reporter/AIR). Climate data from all farmers and volunteers is gathered and supplied to the farmers using this tool

Authors predict the particular agricultural systems may be used not only in design of Big data but also in the marketing of Big data technologies. innovation of hybrid seeds ,agronomy, data analysis, precision agriculture will provide the farmers with the hybrid matches and increase the production of yield opportunities. bigdata tools are said to be 'revolutionizing' the farmers livelihood. It is the technology's connection with the social ecology and human conflicts.

IX. CONCLUSION AND FUTURE WORK

This paper investigates the role of Internet of Things(IoT) in Agricultural Sector. Today agriculture is embedded with advance service like GPS, sensors that enable to communicate to each other analyse the data and also exchange data among them. IT provides service in the form of cloud to agriculture. Agriculture cloud and IT service provides a special skill service to farmers regarding cultivation of crops, pricing, fertilizers ,diseases detail method of cure to be used Scientist working on agriculture will provide their discoveries, suggestions regarding modern techniques for cultivation ,usage of fertilizers can obtain the history of the region. the study was based on applying a cloud based application on agriculture. This is based on agri-cloud that enhance agricultural production and availability of data related to research projects in the failed, the impact of doing this will save the cost and time make the communication easier and faster. This paper would promote a lot of research in the area of application of IoT in agriculture.

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