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The IoT and Cloud Technologies Based Smart Farming and its Applications

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***Abstract*—** Nowadays, people doing agriculture are gradually decreasing in all over the world. When agriculture turned out to be smart, people can get better result than traditional technologies followed early. Farmers using modern technologies can control their cost, maintenance and monitoring performance of their filed. IoT and cloud can be combined together and can be applied in various domains of agriculture like temperature detection, moisture sensing, controlling and monitoring irrigation and so on. Traditional methods of farming have lot of drawbacks like wasting of water resources, unaware of seeds sowing, etc. Precision agriculture can give more accurate and better result with modern technologies. In this paper, we presented some typical applications of IoT and Cloud in agriculture field and Security threads that causes obstacles in implementation of smart farming. This survey helps for the better understanding of different technologies and to build sustainable smart agriculture.

Keywords -The IoT,Cloud Computing,Big Data,Data Mining,Smart Farming, Precision Farming

I. INTRODUCTION

The smart move towards combining of cloud and (Internet of things) IOT will be a future technology. Without Cloud, development in Internet of Things is not at all possible. The devices which are connected to the internet are known to be Smart device. In IoT, "things" refers to any object on face of the earth, whether it is a communicating device or non-communicating dumb object. Device which is connected to the internet can easily share their data with each other. Cloud is place where the perceived data from IoT device in various locations are stored, processed and analysed to give knowledge to the end user. Cloud is of three types' Private cloud, Public cloud and Hybrid cloud. Large companies like Amazon, Google and Microsoft are providing space to store and access the data. Various sensors (humidity, temperature, moisture, vibration and so on) and automation techniques (RFID, ZigBee, Bluetooth, Wi-Fi and so on) better cost made IoT a possible and easy process. IoT is using in various sectors such as smart agriculture, smart acqua culture, smart health care, smart traffic control and so on.

II. RELATED WORK

Rajeswari et al [1] proposed A Smart Agricultural Model by Integrating the IoT, Mobile and Cloud-based Big Data Analytics. Big data analysis is used to analyse the data. MapReduce algorithm is used to categorization, Attribute Selection and then the prediction is performed based on data mining technique. Mahammad Shareef Mekala et al [2] proposed A Novel Technology for Smart Agriculture Based on IoT with Cloud Computing. They used LiFi technology for better performance. Temperature sensor, Soil moisture sensor, water level sensor, rain detector and cattle monitor sensor are used. First -remote controlled process to perform tasks like spraying, weeding, bird and animal scaring, keeping vigilance, moisture sensing, etc. Thomas Truong et al [3] proposed the IoT Architecture for data collection system for detecting the fungal infection in crops. The Authors proposed the Internet of Things (IoT) system capable of sending real-time environmental data to cloud storage and (SVM) Support vector Machine learning regression algorithm to predict environmental condition (Temperature, relative air humidity and wind speed) for fungal detection and prevention.

Amogh Jayaraj [4] Rau et al proposed a cost-effective automated irrigation and fertigation along LAB colour space technique based image processing for identifying the rice diseases .Here, we are focusing on two important nutrients, namely magnesium and nitrogen. The hardware consists of a Raspberry Pi, DHT11 temperature and humidity sensor and solenoid valve. Achieving data security and system efficiency in data acquisition and transmission based on Cipher Text Policy Attributes Based Encryption [7] for cloud based the IoT in smart grid. Radadiya et al discussed about three types of cloud (public, private and hybrid cloud) using in agriculture. They also discussed about the challenges, benefits and security issues using cloud computing. Hemlata Channe et al [9] proposed Agrocloud module through Mobile application for Farmers, Agro-Marketing agencies and Agro-Vendors with the combination of Internet-of-Things (The IoT), Sensors, Cloud-Computing, Mobile-Computing and Big-Data analysis. Sukhpal Singh Gill et al [11] proposed the

system that gathers data from number of users through preconfigured devices and the IoT sensors and processes it in cloud using big data analytics and provides the desired data to users automatically. The performance of the projected system has been evaluated in Cloud atmosphere and experimental results show that the projected system offers higher service and also the Quality of Service (QoS) is also higher in terms of QoS parameters. K-NN (k-Nearest Neighbour) Supervised classification mechanism has been used in this research work to identify the different Class labels of users. Major Singh Goraya et al [12] presented the brief introduction about the application of cloud computing using across the world and also some advantages of using cloud computing in agriculture. The IOT Vaishali S[13] et al proposed THE IOT based on application controlled monitoring system to control the water supply and monitor the plants. In this they used temperature sensor and soil moisture sensor to sense the status of the soil and send to the cloud. Carolus cambra et al [14] presented the design of smart the IoT communication system manager that is used as a low cost irrigation controller.

III. THE IOT IN AGRICULTURE

Smart farming supported the IoT technologies can change growers and farmers to cut back waste and enhances productivity starting from the amount of fertilizer used to the amount of journeys the farm vehicles have created. Food production must increase by 70 percent in the year 2050 in order to meet our estimated world population of 9.6 billion people [8]. Smart farming may be a capital-intensive and advanced system of growing food cleanly and property for the plenty. In the IoT-based smart farming, a system is made for watching the crop field with the assistance of sensors (light, humidity, temperature, soil wetness, etc.) and automating the irrigation system. The farmers will monitor the agriculture farm conditions from anyplace in anytime even in farmer absence. The IoT based smart farming extremely economical compared with traditional approach.

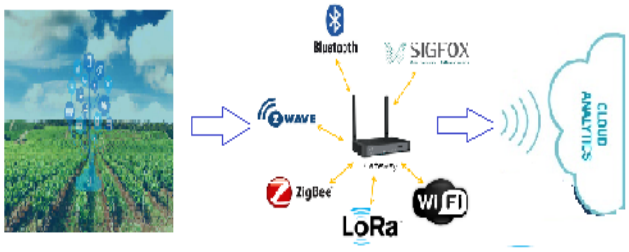

Fig 1: The IoT and Cloud Enabled Smart farming

IV. CLOUD IN AGRICULTURE

Now-a-days farmers move on to cloud storage from the IoT storage because of its lack of storage space and minimized facilities. Cloud can be use like repository to store the IoT device sensed data such as crop, weather, soil, growth progress of plants, pesticides, seeds, farmers details and experts consultation. Centralized cloud storage makes the information available to user at anywhere, anywhere. Cloud also provides integration and sharing of information with other farmers.

Table 1: benefits of cloud and the Internet of Things

S.no	Benefits in Cloud and The IoT	
	Cloud	Internet of Things
1.	Data availability	Reduces cost
2.	No Access delay	Monitoring crops, animal and human without interaction
3.	Improve economy	Avoid loss of crops
4.	Motivate farmer	Optimize water usage
5.	Better agriculture	Better planning of crops

Challenges of using cloud in agriculture: storing data in third party so, there is a lack of security, famers may unaware of using cloud technology, physical control is less; attackers can easily hack the information, need for constant internet connection, access delay and so on.

V. BENEFITS OF SMART FARMING

Data are collected by using smart agriculture sensors such as climatic conditions, soil quality, crop's growth progress or animal's health. This information will be wont to track the state of your business generally, moreover as workers performance, etc. Being able to examine any anomalies in growth of crops or farm animal's health, it also help farmer to reduce the risks of losing crop yield. By implementing smart sensible devices, you'll be able to automatize multiple processes across your production cycle, e.g. irrigation, fertilizing, or pest and pesticide management.

Table 3: Comparision between the IoT and Cloud for Smart farming

IoT platforms	**Real-time capturing**	**Cloud Service Type**	**Data Analytics**	**Developers cost**
Ubodots	yes	public	yes	free
Thing Speak	yes	public	yes	free
ThingWorx	yes	Private (Infrastructure as a service)	yes	pay
Xively	yes	Public (IoT as a service)	No	free
Plotly	yes	public	yes	free

Nimbits	yes	hybrid	yes	free
Connecterra	yes	Private (Infrastructure as a service)	yes	pay
Axeda	yes	Private (Infrastructure as a service	yes	pay
Phytech	yes	Private (Infrastructure as a service	yes	pay
Aekessa	yes	Private	yes	pay
Yaler	yes	Private	yes	pay

Some The IoT and Cloud application in cloud:

A. Climate condition monitoring

Weather sensors placed across the crop field, they collect numerous data from the atmosphere and send it to the cloud. The provided measurements are used find the condition of the climate used to map the climate conditions, select the suitable crops, and take the desired measures to enhance their capability. This type of farming is also known as Precision farming. Example of the IoT devices which is using in agriculture are allMETEO, Smart Elements, and Pycno.

B. Greenhouse Automation

The IoT devices placed within the field to gather the data relating to temperature and precipitation to leaf water potential and overall crop health, these collected data can be used by the farmer for the further improvement practices. Through this farmer can monitor their crops and any anomalies to effectively stop diseases or infestations that would damage yield of crop.

C. Cattle monitoring and management

The IoT sensors attached to the cattle in the farm to identify the activities and behaviour of the animals, health of the animals and the log performance. By using this farmer can predict the abnormal behaviour of their cattle and treat them and manage cattle without human interaction.

D. End –to-End farm management system

Farm productivity management system consists of number of The IoT devices and sensors which installed on powerful dashboard analytical and it has reporting and analytical capabilities.

VI. LAYERS OF THE IOT

First layer is a data collection or physical layer which has sensors, actuators and some other devices to collect the real time data of the field. Second layer is Network management layer used for transporting collected data from the sensor. Third layer is information management layer which do some functions like formation and classification of data, creating, monitoring, decision making, data analysing and so on. Layer four is a user interface layer because in this user can directly interact with their application and it helps the user to know about their field scenarios.

Table1: Process and Protocols Used in Different Layers of the IoT in Agriculture.

Layer	Level	Protocols Used	Process In Layer
Data Collection Layer	1	IEEE 802.11 Series, Z-wave, Wireless Hart,UWB, IrDA, PLC, LonWorks, KNX, ZigBee.	Devices, Sensors, Actuators, Cameras.
Network Management Layer	2	IPv6/IPv4, RPL, TCP/UDP, uIP, SLP, LoWPAN	Network and Transport Capabilities
Information Management Layer	3	IPv6/IPv4, RPL,TCP/UDP, uIP, SLP, LoWPAN	Data Analysis, Data Mining, & Processing, Decision Making
Application Layer	4	xHTTP, CoAP, LTP, SNMP, DNS, NTP, SSH, DNP	Various The IoT applications

VII. ISSUES IN INTEGRAING THE IOT AND CLOUD

A. Security and privacy

Security and privacy is a major concern when sensitive data to be stored in cloud. Intruders and eavesdroppers can hack data which are less secured. When comes to data security have consider about confidentiality, integrity, authentication and authorization. Data privacy refers to confidentiality of data stored on the cloud. Data integrity is that modification of original data according to intruders need. Employing Digital signature is the best way to ensure the data integrity. The IoT has major difficult problem of Denial of service, Physical damage, eaves dropping, node capture to exact information and controlling entities [6].

B. Secure network and device communication

Major challenges in integrating the IoT and cloud are to ensure the secure communication and secure data in cloud. Many the IoT devices don't do encryption before transmitting data across the network. Complex encryption and decryption is not possible with constrained devices. This device has the capacity of less encryption which is transmitted over the internet leads to many attacks in data. Use of Transport Layer Security (TLS) is the best way of securing data before transmitting data over the internet. TLS provide confidentiality and integrity between The IoT device and the cloud. Various Protocols and network security are used to gain secure end to end communication.

Table 2: Security threads in various the IoT layers

Layer	Threads	Process
Physical layer	Spoofing	Attackers sends fake broadcast message to the sensor network
	Signal Jamming	It is a type of DOS attack. Attacks happen between the nodes and hinder from communicating with each other.
	Device Tampering	Attackers get control over the node and pollute the network.
	Node Outage	Attackers stops the functionality of network components either logically or physically
	Eaves dropping	Attackers hacks the password or other data.
Network Layer	Black hole	It is a type of DOS attack.
	Worm hole	It is also a type of DOS attack. attackers relocate the bits position from its actual position in the network
	Man-In-The–Middle	It is a type of authentication attack.
	Hello flood attack	Attackers create traffic over the Internet by sending useless message from malicious nodes.
Application Layer	Sniffer	Attackers post sniffer programs to gain information like passwords, FTP files, E-mail files from the network.
	Injection	Attacker enters wrong code to the execution application to execute bad results.
	Session hijacking	Attack is based on Authentication (password and user details) and Session management.
	DOS attack	It is traditional Denial of service attack.

C. Ipv6 deployment

If IPv6 is to be used for the identification of communicating objects, then formal preparation of IPv6 would even be a problem. Unless a correct, standardized, and efficient mechanism of IPv4-IPv6 being is adopted, objects being allotted IPv6 would be of no nice profit. Studies that specialize in IPv4-IPv6 being and sleek transitioning towards IPv6 should be thought of for this problem.

D. Need for data and service Standards

In Internet of things various types of protocols are used in each layer. Some protocols are supported and some protocols are not supported in some layers based on gateway devices and also sensors being used. Solution to the present quite problem is also mapping of standardized protocols within the gateway.

Data produced by the IoT device are in various metric there is not standardized formats or units. It is necessary to have a standard protocols, architecture and protocol and APIs [15] to facilitate the interconnection among heterogeneous smart devices and to create enhanced service. At present there is not standardized way to describe the The IoT devices and its capabilities. It is difficult for Software agents to perform orchestration of data, device and service and automatic discovery. Standardization problems to be addressed in The IoT and cloud computing for allowing applications to get their own benefits from data provided by The IoT devices and from the scalability and availability promoted by cloud services [16].

E. Use of cloud resource in efficient way

Large number of The IoT devices connected to the internet produces huge amount of data, data perceived from the The IoT system should be processed on the cloud could consume significant storage resources and processing. Uploading and downloading of data in huge amount leads to network congestion and latency. Fog computing provides storage, computing and network service between the cloud and Internet of Thing's device [6,7].

F. Big data

As increase in connecting The IoT device with network produces a huge amount of data. It is very difficult for transmission, storage, accessing and processing of data from the cloud. The IoT will be a next source big data still there is no efficient way of storage management in cloud. Finding perfect management protocol to manage the massive amount of big data is a next big problem.

G. Data mining complexity

In previous era application receives data from the single sources which are of structured format. The IoT sensors perceive data of various formats which are of web document, CSV sheet and SQL sheets. The IoT data produces a new complexity in analysing and processing of stored data. Before data send to the big data analytics tool, first step has to be clean and convert into a single format. Extracting meaningful information from various temporal and spatial resolutions is a challenging method in artificial intelligence.

VIII. CONCLUSION and Future Scope

In developing countries like India, farmers are working hard to gain more profit, because of lack in proper farming methods, knowledge and much need of labours they can't get the fruit of farming. Smart farming helps the farmers to improve productivity, reduces the labour costs, predict climate condition and so on. The IoT and Cloud are the two big technologies that support as a backbone for smart farming. Important drawback for the farmer in this case is maintenance cost. So Researchers should concentrate on developing the IoT and Cloud enables architecture in cost effective way. There are many research and methods has been developed yet for smart irrigation, cattle monitoring and

Intrusion detection. Due to the lack in early detection of proper nutrients and fertilizer, early detection of disease and polluted air causes the big losses in growth of crops. There should be need in defining proper architecture for early detection of detecting all drawbacks in previous system.

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