Ecosystem Framework For Agriculture Using Iot And Cloud Technology

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Abstract- *The flood in worldwide population is convincing a shift toward smart agriculture practices. This combined with the lessening normal resources, restricted accessibility of arable land, expansion in unpredictable climate conditions makes food security a significant worry for most nations. Subsequently, the utilization of Internet of Things (IoT) and Data Analytics (DA) are utilized to improve the operational effectiveness and productivity in the agriculture area. There is a change in perspective from utilization of WSN's as a significant driver of smart agriculture to the utilization of IoT and DA. The IoT coordinates a few existing technology, like WSN, RFID, distributed computing, middleware frameworks, and end-user applications. In this paper, a few advantages and difficulties of IoT have been Identified. We present the IoT ecosystem system and how the blend of IoT and DA is empowering smart agriculture. Besides, we give future patterns and openings which are classified into innovative advancements, application situations, business, and attractiveness*

Keywords- Internet of Things, Cloud Computing, IoT in Agriculture, Smart Agriculture, Internet of Things, Wireless Sensors.

I. INTRODUCTION

The Internet of Things (IoT) has found its application in several areas, such as connected industry, smart city[1], [2], smart-home [3] smart-energy, connected car [4], smart-agriculture [5], connected building and campus , health care, logistics, among other domains. IoT aims to integrate the physical world with the virtual world by using the Internet as the medium to communicate and exchange information. IoT has been defined as a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A keyarea of interest in this paper is the application of IoT in agriculture. The world population is estimated to be about 9.7 billion in 2050, as such there will be great demand for food. This coupled with the diminishing natural resources, arable land; unpredictable weather conditions make food security a major concern for most countries. The world is turning to the use of IoT combined with data analytics (DA) to meet the world's food demands in the coming years. It is predicted that IoT device installations in the agriculture sector will increase from 30 million in 2015 to 75 million by 2020. The use of IoT and DA will enable smart agriculture which is expected to deliver high operational efficiency and high yield.

Throughout the long term, WSNs has been conveyed for smart agribusiness and food creation with an attention on ecological checking, accuracy agriculture, machine and interaction control mechanization and discernibility. The capacity of WSN to self-coordinate, self-design, self-analysis, and self-recuperate has made it a decent decision for brilliant farming and the food business. The WSN is a framework that contains radio frequency (RF) transceivers, sensors, microcontrollers and power sources. Be that as it may, with the crisis of IoT there has been a change in perspective from the utilization of WSN for smart agriculture to IoT as the significant driver of brilliant farming. The IoT coordinates a few advancements that as of now exist, like WSN, RF distinguishing proof, distributed computing, middleware frameworks and end-client applications.

The application of IoT in agriculture is about empowering farmers with the decision tools and automation technologies that seamlessly integrate products, knowledge and services for better productivity, quality, and profit. Recent surveys on the IoT in agriculture have focused on the challenges and constraints for large-scale pilots in entire supply chain in theagrifood sector [5]. Some of the key issues addressed are the need for new business models, security and privacy, and data governance and ownership solution. While this survey papers deal with the application of sensor technology and challenges in the application of IoT to the food supply chain, the communication technology were limited to conventional methods which employs low range communication technologies.

II. IoT ECO SYSTEM

In this chapter, an overview of Deploying Iot in agriculture has been presented and it consists of IoT components, communication technology, data storage and analysis process and the internet. In this paper, an extensive review of IoT in agricultureis carried out. The review includes a survey of published articles, white paper and existing solutions. The IoT ecosystem for agriculture is discussed in detail based on four major components which are IoT devices, communication technology, Internet, data storage, and processing. The application of IoT and DA and how it is enabling smart agriculture is presented.

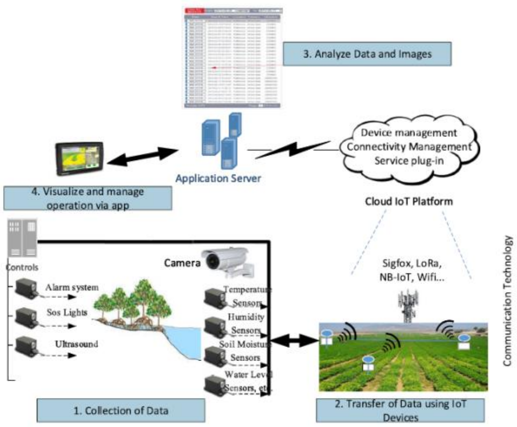

Fig.1. Illustration of IoT ecosystem for agriculture

Fig. 1 illustrates the IoT ecosystem. The four major components are essential for any IoT application. The description of the IoT components as it relates to agriculture is provided as follows.

IoT Devices: Iot devices are consists of embedded system which helps to interact with sensors and collect the data. The IoT devices are connected remotely and those are controlled by the Microcontroller System. The components are connected through the internet technology. Here, network is communication medium for the IoT devices. IoT helps in agriculture which consists of various components and sensors such as pH sensor, temperature sensor etc which are completely involved in monitoring agriculture. The sensors can be classified into location sensors, optical sensors, mechanical sensors, electrochemical sensors, and airflow sensors. These sensors are used to gather information, such as air temperature, soil temperature at various depths, rainfall, leaf wetness, chlorophyll, wind speed, dew point temperature, wind direction, relative humidity, solar radiation, and atmospheric pressure.

Communication technology: The correspondence innovation assumes a vital part in the deploying of IoT frameworks. The current communication technology can be arranged dependent on guidelines, range, and application situations. The correspondence standard can be gathered into short-range communication standard also, long-range communication standard. The communication range can be gathered into authorized and unlicensed range. The IoT gadgets application situations can be founded on sensors, and arrangement situations.

Internet: The advancement in the field of wireless communication systems, mobile devices, and ubiquitous services has paved way for massive connectivity to the Internet. According to Machine research report, the number of connected agricultural devices is expected to grow from 13 million at the end of 2014 to 225 million by 2024. The Internet forms the core network layer, where paths are provided to carry and exchange data and network information between multiple sub networks. The connection of IoT devices to the Internet enables data to be available anywhere and anytime. However, the transfer of data via the Internet requires adequate security, support of real time data and ease of accessibility. The Internet has paved way for cloud computing, where large data are gathered for storage and processing. Cloud computing involves the management of user interface, services, organizing and coordinating of network nodes, computing, and processing data. To achieve the connectivity of heterogeneous systems and devices over the Internet, IoT middleware and connectivity protocols are being developed. Examples of the IoT middleware is the service-oriented architecture (SOA), cloud-based IoT middleware and actor-based IoT middleware which have been applied to support IoT.

Data Storage and Processing Units:Data driven agriculture involves the collection of enormous, dynamic, complex, and spatial data, which requires storage and processing. The complexity of the data can range from structured to non-structured data which can be in the form of text, images, audio, and video. The data can range from historical data, sensor data, live streamed data, business, and market related data. The use of cloud IoT platforms allow for big data collected from sensors to be stored in the cloud. This includes hosting of application that is critical in providing services and to manage end-to-end IoT architecture. Recently, edge orfog computing is advocated, where IoT devices and gateways carry out computation and analysis in order to reduce latency for critical applications, reduce cost and promote QoS. There are several agriculture management information systems that have been developed to manage the various forms of data.

III. SYSTEM ARCHITECTURE

The System architecture illustrates that the complete overview of ecosystem on agriculture using IoTand how to accomplish smart agriculture. The architecture is also presents how the IoT devices are connected and interacted with its operational behaviours and also how it is useful to the farmers. Fig. 2 represents the connection between IoT devices and various components used.

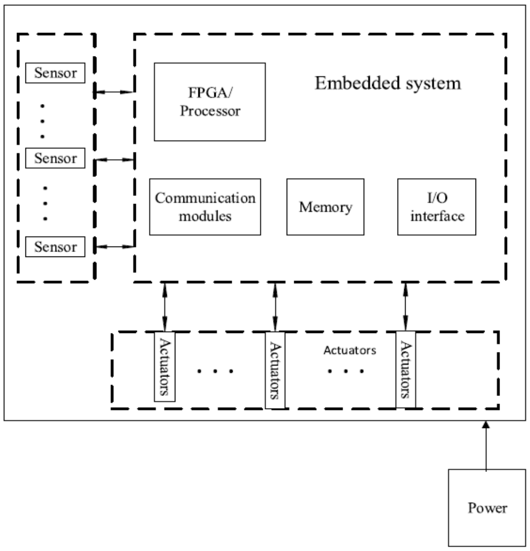

Fig.2. Architecture of IoT device

The Ecosystem framework consists of various functional components such as Collection of Data, Transferring of Data using IoT devices, Storage and analysis and Visualization and maintenance. The cloud technology is used here as a storage resources while implementing the remote connection system. The proposed eco system helps to collect the data from different peers such as sensors. It collects the information such as water pH level, temperature level, weather conditions etc. where these data helps to the farmer to monitor and maintain the agriculture and to yield fine crops.

This ecosystem framework helps in the field of indoor forming as well as open farming. The indoor farming system includes greenhouse plantation, ploy house plantation etc. The framework also helps to automate drip irrigation system and the famer can operate it remotely by using mobile device. The automatic drip system is implemented towards open forming in the field of agriculture. The system is formed with a water tank to the drip pipes is connected through the smart solenoid valve where the solenoid valve is connected to the control system. The microcontroller/arduino is placed, which is connected with various components such as sensors, GSM module, IOT module, solenoid valve, power supply etc. The soil moisturing sensor is placed in the area of land or a farm. This sensor basically would be placed in soil and it detects moisturing level. The PH sensor is used here for detecting hydrogen levels in the form for effective maintenance. The GSM module is connected with subscribe identification module for the mobile communication with the user. The LCD display is connected to display the information to the user which helps to understand the progress of system to establish the remote communication.[6]

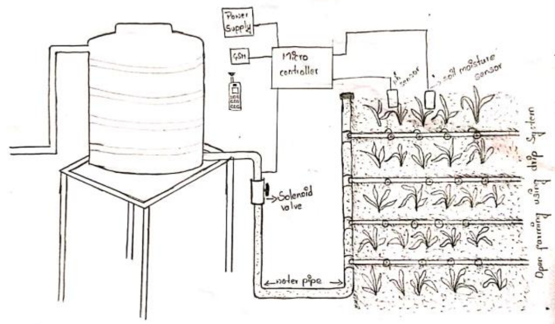

Fig.3 Automation drip system

Fig. 3 demonstrates the setup of automation drip irrigation system using IoT which is the best example the proposed system. That system operates automatically in absence of the farmer which often reduces the man power and it accomplishes the smart agriculture. The ecosystem benefits towards villages and to yield fine crops.

IV. USES OF IOT IN AGRICULTURE

1. Crop Farming:In crop farming, there are several environmental factors that affect farm produce. Acquiring such data help to understand the patterns and process of the farm. Such data includes the amount of rainfall, leaf wetness, temperature, humidity, soil moisture, salinity, climate, dry circle, solar radiation, pest movement, human activities, etc. The acquisition of such detailed record enables optimal decision making to improve the quality of the farm produce.

2. Forestry: Forestry plays an important role in the carbon cycle, and also harbours over two-thirds of world known species. The factors to be monitored in a forest includes; soil and air temperatures and humidity, and the different levels of gases, such as carbon monoxide, carbon dioxide, toluene, oxygen, hydrogen, methane, isobutene, ammonia, ethanol, hydrogen sulphide, and nitrogen dioxide. These parameters can provide early warning and alert systems against veld fire in the forest and also help to monitor against diseases. [7]

3. Livestock Farming: The factors to be monitored in livestock depend on the types of animals under consideration. For example, the conductivity of milk from buffaloes and cows can give information about the health state of the animals. Other factors are temperature, humidity, yield, pest attack, and water quality. The deployment and implementation solution also allow farmers to track and query the location of their livestock by tagging individual animal with RFID device, thereby preventing animal theft. [7]

4. Greenhouse Production: Green house also known as glasshouse technology is a technique, where plants are grown under controlled environment. It offers the benefit of growing any plant in any place at anytime by providing suitable environmental conditions. Several studies have been carried out on the application of WSNs in greenhouse to monitor environmental conditions.

Recent works have shown how IoT can be applied to greenhouse in order to reduce human resource, save energy, increase efficiency in greenhouse-site monitoring, and direct connection of greenhouse farmers to customers.

5. Agricultural Machinery : IoT-based agricultural machinery can help improve crop productivity and reduce grain losses. By proper mapping, use of GPS and global navigation satellite systems (GNSSs) the machinery can be operated in autopilot mode. The machines which include vehicles, unmanned aerial vehicles (UAVs) and robots can be remotely controlled based on the available information collected via the IoT system for precise and efficient application of resources to required farm areas. The machinery can also collect data and such data can help farmers in mapping their field for planning programs, such as fertilizing, irrigation, and nutrition. For example, CLAAS, an agricultural machinery manufacturer has implemented IoT on their equipment, enabling their machinery to be operated in auto pilot mode. Another solution is the Precisionhawk's UAV sensors, which can provide farmers information, such as wind speed, air pressure, among other parameters. The solution can also be used for imagery and mapping of agricultural plots. [7]

V. IOT AND DATA ANALYTICS IN AGRICULTURE

Accurate data analysis in farming plays a major role in improving the operational efficiency and increasing productivity. DA has been categorized into types based on requirement of IoT applications. This includes real-time analytics, off-line analytics, memory-level analytics, business intelligence level analytics, and massive analytics. The data consist of sensor data, audio, images, and video. Image processing has been extensively used in agriculture for various purposes ranging from detection of disease in leaf, stem, and fruit, quality of fruits, and weed detection and irrigation. Recently, the combination of image processing and IoT in agriculture is being carried out to achieve higher quality produce and reduce crop failure. This involves the use of drones to capture aerial images at regular interval as well as monitoring of environmental factors using the IoT devices. There are several DA methods which have been discussed in detail in. The methods are categorized into classification, clustering, prediction, and association rule. The discussion of these methods is outside the scope of this paper. We discuss the importance of DA in agriculture and how DA can help in insurance, prediction, storage management, decision making, farm management, and precision farming.

VI. CONCLUSION

Ecosystem framework on agriculture using IoT and Cloud technology has been presented in this paper. Several areas are related to deploy IoT and Cloud technology towards agriculture and to accomplish smart agriculture system towards villages. This paper also shows that there are lots of works on-going in development of IoT technology that can be used to increase operational efficiency and productivity of plants. The proposed system helps to the farmers to yield fine crops.

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