Cloud-based Architecture Integrated with IoT Framework for Smart Agriculture Applications for Increased Productivity

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Abstract: In recent decades, advances in computer technology have become more important in all areas, including transportation, healthcare, smart online purchases, smart education, and warehouses. Computing technology makes it simpler for man to adobe data in every industry and business. The goal of these innovations in every area is to give real-time, dependable, efficient, and secure data when it is required. Furthermore, computer technology creates a user-friendly environment for everyone involved in it to readily utilize the technology. The major objective of technology, on the contrary hand, is to improve communication in all areas since information and communication have always been vital components of the human race. This article investigates cloud-based architecture linked with an IoT framework for smart agricultural applications with the goal of increasing crop production.

Keywords: *Cloud-based Architecture, IoT Framework, Smart Agriculture.*

1. Introduction

The adoption of technological advances will not only give great information but will also provide better communication, therefore shortening the world's distance. The goal of this research is to highlight another technological device in a different industry that really plays an essential role in human society [1-8]. The two technologies that this paper discusses are Cloud computing platforms and the Internet of Things (IoT) in the segment and emergence of cultivation, because agribusiness is the main component of the nation that describes the financial conditions of the country, and there is a need to improve this same agricultural production sectors of them as mentioned [9].

In recent years, technological advancements have become more important in all areas, including transport, health care, smart online shopping, e-education, and warehousing. Computing technology makes it simpler for man to adobe information in every industry and business. The goal of these technologies in every area is to give real-time, dependable, efficient, and secure data when it is required. Moreover, computer technology creates a user-friendly atmosphere for everyone involved in it to readily utilize the platform. The major goal of technology, on the other hand, is to improve communication in many areas, since information and communication have always been vital aspects of the human race, as previously described.

2. Background of the Study

Precision agriculture is the use of auxiliary technology in agricultural production systems to reduce waste and increase output. Smart farms respond by using scientific skills to assist with plant observation, soil conservation, insect control, watering, order tracking, and other areas of the production cycle. Temperature, brightness, moisture, pressure, soil chemical content, autonomous aircraft equipment, camcorders, and crop radar are examples of these resources. The Internet of Things (IoT) is a network of linked smart devices that may communicate with one another and give meaningful outcomes in their operating environment. As a consequence, almost any equipment that can link to the Internet, such as gadgets, electronic goods, furniture, and agro technologies, may be called a "thing" in the IoT [10-11].

While the idea of the Web as the Internet of Things is not new, its adoption has grown in recent years as a result of advancements in technology that enable it, such as breakthroughs in hardware—resulting in relatively small and decrease power usage in interconnectivity with the World wide web and among devices, for example via wireless links, cloud services, intelligent systems, and enormous information. The sensing phase focuses on the approach's hardware components and how they interact with one another and with the internet protocol suite [12-14]. These gadgets are in charge of gathering data and allowing "things" to communicate with one another. Monitoring systems and transmission portals may be built using networks and software such as UAV systems, sensor systems, or unique systems made utilizing hardware including detectors and surveillance systems such as Arduino or Raspberry Pi. Sensors are used to detect plant ailments, change greenhouse ambient conditions, and monitor outside plants.

The transport layer moderates communication among interpretation layer devices and processing stack services, which could also take numerous forms, such as communicating directly among a sensor network and an algorithmic framework (such as FIWARE, Smart Farm Net, and Thinger.io) or an entry point that, in addition to helping to facilitate interactions among a sensor network and the internet, also functions as a data aggregator. The layer of transport refers to the transport and application capabilities, such as networking and development platforms. Data sources are used in IOT technologies to bridge the perceptual and computing levels. These technologies are being used to build wireless sensor networks that enable sensors and applications to communicate wirelessly [15-17]. Each protocol's essential qualities are data exchange rate, range, and energy consumption. These qualities may be used to categorize short-range, mobile networks, and long-range approaches. Small-range protocol stacks (such as Bluetooth, ZigBee, and Wi-Fi) enable communication across short distances. Such protocols are said to offer high data transmission frequencies and low energy usage.

Topologies like tree, star, and mesh may be used to connect multiple devices. A star network consists of a central node and many outlying nodes. In this design, the transmission operates as follows: The primary server immediately gets information from the periphery nodes. Using various network services, the centralized router may combine signal forwarding and communication features. Tree systems are made up of router connections and leaf networks. Similar networks may be described using clustering of star topology. Throughout each network, leaf networks relay signals to their parent networks. Any item in a network may potentially operate as a router with customizable capabilities. Mesh networks transport messages sequentially until they get to their final location.

3. Cloud Computing for Smart Agriculture

Cloud computing is synonymous with a cloud, and that cloud refers to a framework that includes a variety of items and techniques such as data processing, interfaces, computer technology, servers, programs, and software. Cloud technology is the manipulation, acquiring, customizing, and spreading of these techniques, as well as their connection to the Internet. It is also known as the technological paradigm since it provides several advantages to all industries. The allure of cloud applications is that services may be accessed at any time they are required. It is essentially a collection of systems that are linked to public or private networks.

The technology behind cloud computing is a current hot technology that is very comparable to computing services and grid computation; it is regarded as a combined solution with information technology including grid computing, utility computing, distributed systems, storage servers, bandwidth allocation, and networking technologies. Cloud technology is making our enterprise applications mobile and collaborative, as well as providing a user-friendly platform that makes the technical infrastructure easier to utilize. This technology has also piqued the interest of government entities in various countries and territories, including the United States, the United Kingdom, Japan, and other developed countries, and all of them have begun to use nationwide cloud computing platforms for the future growth and betterment of their agricultural industry.

3.1. Cloud computing's part in agriculture

Cloud-based technologies are becoming a popular alternative for improved agricultural process management. As mentioned in the previous section, cloud technology involves the collaborative use of technologies over the internet to make it easier for gardeners to try to influence and analyze data. Cloud services in agriculture provide storage of data about relevant things such as weather conditions, waterlogging, pest disease, agricultural production data, crop prototype databases, and strategic decision databases. To facilitate agricultural growth, a cloud computing platform demands less man labor. Cloud computing data may be accessible from anywhere and by many investigators, laborers, and farmers. By implementing cloud technologies in farming, farmers, and laborers did not need to master technological skills or additional technologies. It is essentially the ease of services that relates to providing ease of strategic planning, ease of information management, and knowledge of the information that is offered to farmers. Cloud services may be offered whenever and wherever they are required. Because both developed and emerging countries are utilizing services offered by cloud computing in agricultural areas.Cloud computing is made up of several cloud models that are advantageous to end consumers and easily accessible anywhere.

(a) Software as a Service (SaaS) Model

This concept entails offering software services to end customers on request. Many end users may access the application from the cloud via the internet. Another advantage of this strategy is that it can be applied to software, Google apps, LinkedIn, and other online applications on a per-user basis.

(b) Platform as a Service (PaaS) Model

This concept entails offering a computer system for designing and developing a specific software application. It also offers tools for non-developers to construct online applications, with the platform essentially consisting of a computer system, a database, and web servers.

(c) Infrastructure as a Service (IaaS) Model

This concept entails supplying the element via which cloud computing services may be accessed and utilized. Machines, virtual computers, database management systems, and servers are all included in this architecture. Figure 1 depicts cloud computing models.

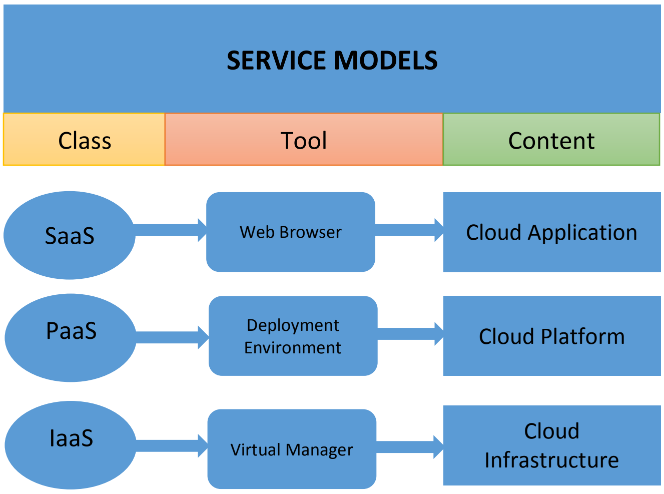

Figure 1. Layers in a Cloud Computing Framework

3.2.Agricultural Cloud Computing Applications

As addressed in the section on agricultural difficulties, these difficulties are caused by a lack of adequate mechanisms, a shortage of crop intelligence, a lack of information about climate and crop infections, and a lack of understanding about farming on the part of the farmer and labor. The use of cloud-based solutions is beneficial in addressing these issues. The cloud may function as a sort of bank, storing all agricultural-related data. This information is accessible to farmers and other agricultural sector users at any point in time and from any place, making it easier for them to gather data. The use of clouds gives a platform for laborers, farmers, and investigators to work on without the expense of investing in software and hardware. The client does not have to understand the calculating principle or procedure for this calculation; just enter the payment quantity. These growers, laborers, and researchers may also use cropping methods, pest control, disease management methods, and monitoring crop and livestock issues, i.e. the agricultural era.

3.2.1. Weather-related information database

Weather forecasting provides data regarding specific weather conditions and weather environments for different vegetation types.

3.2.2. Disease-related information database

It is useful to be aware of pest diseases that target crops and ruin them since agriculture suffers from the greatest assault of locusts on crops, which destroys them.

3.2.3. Database for innovative crop production techniques

It is beneficial to learn about new crop production mechanisms and approaches using diverse technologies. It also maintains information on individual crops cultivated in a certain area.

3.2.4. Information sharing on agriculture

Another beneficial use of cloud applications is that cloud computing has strong network connectivity and so plays a vital and simple function in delivering and sharing information about agricultural difficulties to users.

3.2.5. Quality control of agricultural products

Cloud services have allowed for scientific research, supplies of raw materials, agricultural production, storage and shipment, marketing, quality tracking, information services, product quality assurance, and so on.

3.2.6. Crop monitoring in real time

One use of cloud computing in agriculture is that it gives real-time monitoring information and circumstances regarding crop development, such as leaf perimeter, stem height, leaf diameter, and root height. It also checks the amount of fertilizer and water in the soil.

3.2.7. Agricultural science and technology provision

Cloud computing technology, which serves as an essential supporting technology of digital agriculture, provides sophisticated technological support and achieves digitizing and visualizing expressing, controlling, designing, and administration of all agricultural involved items and the whole process. In the cloud computing environment, extension services, education, and academic research reach trinity. Furthermore, cloud-based technology can be used to create precision agricultural technologies and device systems that use advanced agricultural production data and professional spatial database software to establish organic links between agricultural output and operating procedures. Figure 2 depicts the linked fields in agriculture where cloud computing may be applied.

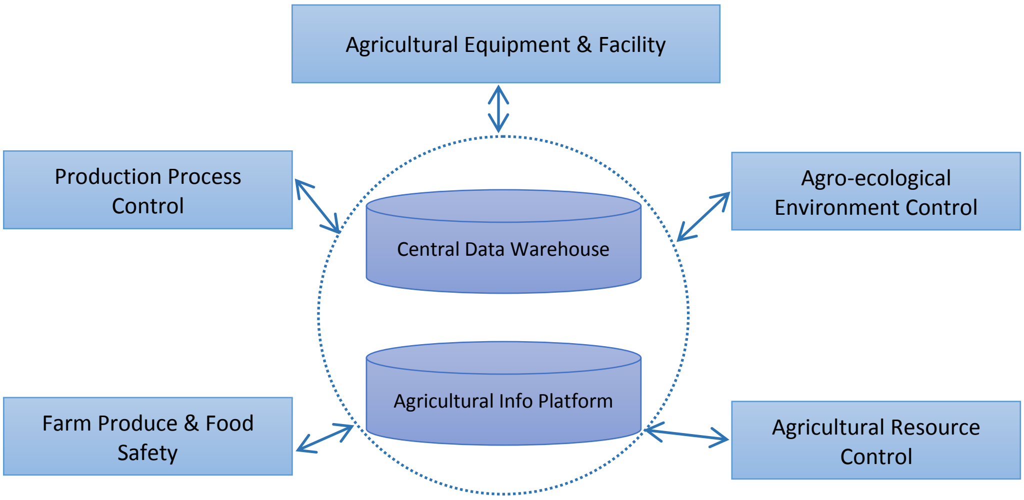

Figure 2. Cloud computing in Agriculture

4. Agricultural Sensors

GPS satellite signals are used by geolocation sensors to calculate latitude, longitude, and altitude almost within a few feet. A minimum of three satellites are required to pinpoint a place. Optical sensors utilize light to assess soil qualities. The detectors assess distinct light reflectance wavelengths in the near-infrared, mid-infrared, and filtered light spectral bands. Sensors may be mounted on vehicles or aerial platforms such as drones or satellites. Electrochemical biosensors give important agricultural data such as pH and soil nutrient levels. The detector's probes work by sensing distinct soil ions. Pneumatic sensors evaluate soil compaction, or "mechanical resistance," by penetrating the soil and measuring stress and strain using load cells or pressure gauges. Air-flow sensors detect the permeability of soil air. Computation in motion may be done in single or liquid places. Since the data is not intended to be transferred to the server, all of the aforementioned data is captured and then instantly analyzed at the source, which decreases dependability and is also incredibly time-efficient.

5. System Architecture

Advanced analytics encompasses archiving software and hardware, data preprocessing, supervised learning, and analysis algorithms, in addition to smart sensing for data collecting and linked devices. There must be choices made in each of these domains about data gathering, data preprocessing, methodology selection, continual training of techniques, prototype deployment or redeployment, and so forth. Storage energy management at the periphery is also important. Edge computing enables reduced latency, economical bandwidth, and robust end users. Those who utilize this service benefit from lower latency than those who are not near data centers. Edge computing extends the capability for deploying applications in typical data center edge networks. Smart, precise farming may solve difficulties for big and small farms alike, as well as assist farmers in meeting ever-increasing food needs. Figure 3 depicts the system architecture.

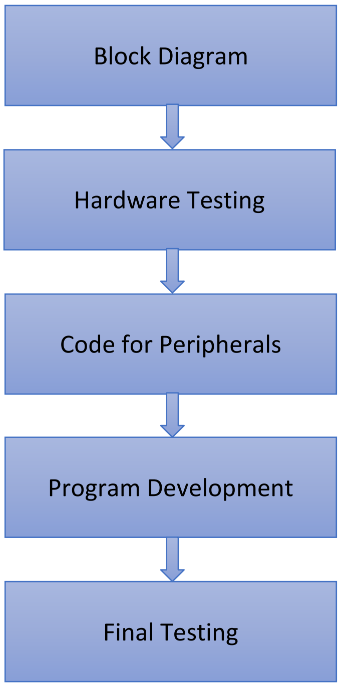

Figure 3. System Architecture

6. Conclusion

Technological improvements have been more significant in all fields in recent years, including transportation, health care, smart online shopping, e-education, and warehousing. Computer technology makes it easier for humans to access information in all industries and businesses. In every case, the purpose of these technologies is to provide real-time, trustworthy, efficient, and secure data when it is needed. Moreover, computer technology offers a user-friendly environment in which everyone engaged may easily use the platform.This paper investigates a cloud-based infrastructure combined with an IoT framework for smart agricultural applications with the goal of increasing crop output.

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