

IoT and Cloud Computing for Agriculture: An Overview

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Abstract

The Internet of Things (IoT) is a disruptive technology that will shape communications and computers in the future. It describes an object-based network, often a wireless network configuring itself. Global food security will need a single digital market, the Internet of the future, knowledge sharing, social networks, data protection, and open access to wisdom. The Internet of Things, which includes sensor technologies, WSN, RFID, cloud computing, geomatics, or 3S (RS, GIS, and GPS), must be the primary emphasis of developing wisdom-based systems for the agricultural industry. While preserving the financial stability of agricultural operations, the growing use of geomatics in agriculture contributes to greener farming practices and enhanced environmental stewardship. In contemporary agriculture, satellite and aerial photography is crucial. Food production zones may now be identified and delineated more rapidly, accurately, and at much higher resolutions thanks to advancements in image sensors and Wireless Sensor Networks (WSN). These sensors are supported by image processing software, which offers more analytical power and better knowledge than was previously achievable. Food traceability is becoming increasingly prevalent in the industrialized world, and RFID technology is pretty established. A growing number of agribusiness companies are using social media. Among agribusiness firms' most prominent social media sites, LinkedIn, Twitter, and YouTube, at least 43% of input suppliers to the farming industry are engaged on these platforms. "A new style of computing in which dynamically scalable and frequently

virtualized resources are provided as a service over the Internet” is what cloud computing refers to. Even with recent technological advancements, applying IOT to agriculture is still challenging because managing complex agroecosystems and integrating multiple domains for online supply chain monitoring require organized, coordinated efforts.

Keywords: precision agriculture, agro-informatics, internet of things, and ICTs in agriculture.

Introduction

The global recession’s reappearance has impacted both developed and emerging economies. The agriculture industry must become more robust and efficient to guarantee worldwide food security. Regarding commerce, government policy, farm size, technology, and other factors, Indian farmers are severely disadvantaged. Technology for information and communication (ICT) may help farmers with a few of their issues. We are now entering the third and perhaps most “disruptive” phase of the Internet revolution – the “Internet of Things” (IoT), also known as “Ubiquitous Computing” – after the World Wide Web (of the 1990s) and the mobile Internet (of the 2000s). Applications for IOT are found in many fields, such as supply chain management, infrastructure monitoring, retail, transportation, healthcare, and agriculture. Applications in agriculture include monitoring soil and plants, control systems and tracking of greenhouse environments, food supply chain monitoring, animal monitoring, and so on. With the help of wireless connections to data gathered from satellites and ground sensors, precision farming equipment can analyze crop conditions and modify the way that each section of a field is farmed. For example, it can apply more fertilizer to areas that require more nutrients (Chui et al., 2010). For the Internet of Things (IoT) to be widely accepted, networking physical devices must be affordable and beneficial to end users. The following are some of the potential advantages of IOT, according to the Global ICT Standardization Forum for India: (i) Better performance, visibility, and scalability; (ii) Better and more affordable services; (iii) Transparency of physical flows and detailed status information; and (iv) Increased efficiency, accuracy, mobility, and automation (Nabati & Taheri, 2016).

2. Related Works

A global network of devices that communicate with one another is called the Internet of Things (IoT). It combines ambient intelligence, pervasive computing, and ubiquitous communications. IoT envisions a world in which all “things,” particularly commonplace items like furniture, clothing, cars, roads, and intelligent materials, are readable, identifiable, and able to be found, contacted, and managed online. Numerous other applications, including energy monitoring, transportation safety systems, and building security, will be built on top of this. Over time, this picture will undoubtedly shift, mainly as sophisticated applications are made possible by the synergies between identification technologies, wireless sensor networks, intelligent devices, and nanotechnology. Innovative uses of technologies like Bluetooth, RFID, NFC, and ZigBee are helping provide stakeholders with an IOT value proposition. Through the combination of technological advancements in item identification (“tagging things”), sensors and wireless sensor networks (“feeling things”), embedded systems (“thinking things”), and nanotechnology (“shrinking things”), the Internet of Things will connect the world’s objects in a way that is both sensory and intelligent. 2005 saw Wal-Mart and the U.S. The Department of Defense mandated that its leading vendors and contractors tag their shipments with RFID for inventory management. The idea of the Internet of Things first gained traction in 2005 with the rise of the RFID industry (Mazhar et al., 2023; Wang et al., 2023).

The following are the Internet of Things technologies, according to SRI Consulting Business Intelligence:

- **Enabling Building Blocks:** Microcontrollers, wireless communication, RFID technology, energy harvesting technologies, sensors, actuators, location technology (GPS), software, and machine-to-machine interfaces and electronic communication protocols all directly contribute to the development of the Internet of Things (Wang et al., 2023).
- **Synergistic Technologies:** Biometrics, machine vision, robotics, augmented reality, mirror worlds, telepresence,

and adjustable autonomy, biometrics, tagging/geocaching, tangible user interfaces, and clean technologies are some of the technologies that could enhance the Internet of Things(Wang et al., 2023).

2.1 Conditions for IOT Uses in Agriculture

A platform for sharing information about traditional sustainable agricultural methods, techniques, tools, tips, and so on would be made available by the accessible, affordable, interactive crowd-sourcing platform for sustainable agriculture. It would also enable offline data entry and interaction to upload consolidated information. To address the issues of food security and water security with sustainable agriculture, the solution must provide farmers with additional resources like microfinance services and third-party agricultural information. It must also enable interactive farming, give users easy access across various devices, including computers, kiosks, IVRs, mobile phones, and other devices, and support traditional practices with contemporary value in multiple languages. Other requirements include providing a centralized repository for information about crop diseases, traditional sustainable farming techniques, and other topics from various sources. The system has to fulfill the following specifications(Wang et al., 2023):

1. **Sturdy Models:** When creating the appropriate goods and services, the agricultural sector's unique characteristics, including variety, complexity, spatiotemporal variability, and uncertainty, must be considered.
2. **Scalability:** Since farms come in various sizes, the solutions must also be scalable. Since testing and deployment take place in phases, the architecture needs to be able to grow gradually with fewer overheads.
3. **Affordability:** The secret to success is affordability. Significant advantages must be available at a reasonable cost. Standardized platforms, tools, goods, and services may reduce costs with higher quantities.
4. **Sustainability:** Sustainability is essential due to the severe economic strain and intensive international competitiveness.

3. Iot Functions

The growth of the Internet of Things, a technological revolution that will shape computers and communications in the future, relies on rapid technological advancement in several critical areas, including nanotechnology and wireless sensors. First, an easy, discrete, and affordable item identification system is essential for connecting commonplace items and gadgets to enormous databases, networks, and the internet. Only then can information be gathered and handled. This feature is provided via radiofrequency identification (RPID). Second, the capacity to use sensor technologies to detect changes in an object's physical state will be beneficial to data collecting. By shifting information processing capabilities to the network's edges, embedded intelligence may increase the system's power. Lastly, as downsizing and nanotechnology progress, ever-tinier objects can communicate and interact. Combining all these advancements will create an Internet of Things that links items throughout the planet in a sensory and intellectual way.

3.1 Internet of Things Architecture for Agriculture (Datang Mobile, China)

Datang Mobile offers the Internet of Things for Agriculture Wisdom Agriculture system. The three levels of the system are the application layer, the transport layer, and the sensor layer. They serve the following purposes:

1. Sensor/Information Collection Layer: This layer's primary goal is to automatically and instantly convert physical agricultural production data into digital data that can be used in a virtual environment in various ways. The following categories of information are gathered via the Internet of Things for Agriculture:

- Data from agricultural sensors, such as vital signs, temperature, humidity, pressure, and gas concentrations.
- Details on the attributes of agricultural goods, such as name, model, feature, and cost.
- Details on the operational state of agricultural machinery, gear, etc.

- Product locations and other agricultural location data.

The primary function of the information collecting layer is to identify the different types of information, gather information that has been tagged, gather physical details from the actual world using sensing methods, and convert the physical information into digital form for processing. The mechanisms used in the information collecting layer include cable networks, sensor networks, wireless networks, cameras, GPS sensors, terminals, RFID tags, and readers, as well as two-dimensional code labels and readers and terminals.

2. Transport/Network Layer: This layer's primary responsibility is to gather and compile the agricultural data obtained from the Sensor Layer for processing. The Internet of Things for Agriculture's brain and central nervous system is the Transport Layer, which processes and transmits data. The network layer includes integration of the Internet and telephony, network administration, information, and intelligent processing centers.

3. Application Layer: This layer's primary responsibility is to process and evaluate the data gathered to foster a digital awareness of the real world. It combines agricultural market information with IoT.

4. Use Of Iot

IoT has several uses in various industries, including supply chain management, retail, transportation, healthcare, agriculture, and infrastructure monitoring. Following is a list of a few of them:

- **Agriculture:** Agricultural IOT will undermine conventional claims that the "physical world" and the "ICT world" are distinct. Farmland, agricultural machinery, and fresh produce are combined with chips, broadband networks, and database systems to create a new "agricultural infrastructure" in rural IoT. Food traceability (RFID), soil and plant monitoring, precision agriculture, greenhouse environment monitoring, control systems, food supply chain monitoring, animal monitoring, and other IoT applications are used in agriculture.

- **Retail Management:** The retail industry has several business-related applications. These include vending machines, automated checkout, context-based advertising, product promotions, shelf stock, consumer behavior and preferences monitoring, and theft prevention.
- **Healthcare:** One of the primary uses for identifying fake medications is in this field. Additional application domains include assisted living, telemedicine, and personal health monitoring.
- **Homeland security, smart homes** (lighting, entertainment, energy management, assistance), access control, restricted materials, banknotes, passports, and counterfeit goods detection are security measures.
- **Government and public sector:** disaster management, forest monitoring, tourism support, homeland security, and pollution monitoring
- **Sports:** Safety, user performance tracking, sporting goods, etc.

4.1 IOT's Advantages for Agriculture

The advantages of IOT applications in agriculture are as follows:

- 1.Enhancement in input utilization efficiency (Soil, Water, Fertilizers, Pesticides, etc.)
- 2.lower manufacturing costs
- 3.A rise in profitability
- 4.Durability
- 5.food security
- 6.preservation of the natural world.

4.2 China's Agricultural IoT

Even after Chinese Premier Wen Jiabao introduced the "To Feel China" idea in August 2009, the "Government Work Report" named the Internet of Things one of the five new vital sectors. China is a country where the Internet of Things is considerably more prevalent than in the US, EU, and other

nations. Built by scale, the first Chinese agricultural IOT application service platform links the first set of The 64 IOT locations in China are engaged in manufacturing, distribution, and processing. With information input from sensing and agricultural knowledge integrated, they may make analyses and judgments. Currently, they are employed in the production of agricultural products (in the cities of Beijing, Shouguan, and Shanghai), on fruit farms (in Chongqing), on precise husbandry farms (in Beijing), and in the processes of storing, transporting, and tracking agricultural products, among other uses.

5. Computing In The Cloud

In the world of IT, cloud computing is the newest buzzword. The best way to describe cloud computing is as “a new style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet,” according to Borko Furht of Florida Atlantic University. This is why it is so important to integrate cloud computing with IoT. The tremendous processing, storage, and service capabilities of cloud computing and the information-gathering capabilities of the Internet of Things create a valid network between people and things and the objects themselves.

Even though different people have different definitions of cloud computing, everyone agrees that there is a tiered architecture. There is no set number of layers, and the hardware basis is adaptable. The hardware is the lowest layer, followed by the software platform, the software layer, and the hardware. Each level provides functionality as a service to the layer above through well-defined APIs. These tiers are referred to as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS), beginning with the lowest layer. One of the most crucial elements of this stack is data, and offering data as a service has enormous promise, particularly for the geospatial industry. Comparatively speaking to the layers stated above, Data as a Service (DaaS) is not as well discussed. The research community is eager to use the cloud’s possibilities, and many companies are now providing cloud-based services at one or more of these levels.

Data availability as a service is very relevant, particularly for geographic data. The idea behind DaaS is to provide valuable data as a service over the internet, charging for use.

5.1 Cloud Processing in Indian Rural Areas

Dealing with service providers one-on-one is not economically feasible for farmers in remote locations. They need a variety of services from thorough and affordable service providers. MBR Services for Customers Pvt. Ltd. One such business was established in 2005 by Rama Krishna to satisfy the demands of the rural market. Initially, it was a massive market headquartered in Eluru, Andhra Pradesh. It started with only ten communities and included 55 settlements over time. It makes it possible for customers to deal with the business daily. It is putting up ground-breaking microfranchising efforts to introduce a revolutionary super bazaar model in rural regions and have a broad beneficial influence in bringing about a qualitative shift. It illustrates how a corporation may support the growth of retail establishments by creating consumer-friendly, long-term business strategies and keeping vast databases of rural customers.

They are using small-scale data on rural customers to provide specialized services. MBR is establishing a network of centers to enhance the profitability and productivity of rural Indian customers by offering comprehensive ground-level assistance. By keeping sizable databases of rural customers with microdata to provide specialized services, the centers enable rural customers and offer comprehensive solutions under one roof. The following services are to be rendered: sales and promotion of FMCG (fast-moving consumer goods) products; education; financial; healthcare; insurance; mobile phone; rail and bus ticket; marriage; courier and cargo; agriculture allied services; crop finance; testing of soil and water; supply of agricultural inputs and animal feeds; information services; procurement of fresh fruits and vegetables and their handling, storage, and processing; and other services as required by the client. These centers would be efficient and provide rural customers with independence and respect, which they need so much.

Conclusion

Single farmers may be able to distribute their produce directly to customers via the Internet of Things, not only in a limited area such as stores or direct marketing but also in a larger one. This will alter the whole supply chain, which is now primarily controlled by big businesses, and perhaps create a shorter, more direct link between producers and consumers. Thanks to cloud computing, the business sector could provide farmers in rural regions with all the services they need at a reasonable cost.

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