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IOT for precision Agriculture: A Review

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Abstract

People may use the internet of things to live and work smarter and achieve total control over their life. In order to increase crop productivity with fewer manual interventions, IoT is important in farming. IoT solutions are a type of system that uses various sensors (light, humidity, temperature, soil moisture, crop health etc) to monitor and automate different operations in an agricultural field. Farmers can monitor their fields from anywhere.They can also choose between manual and automated solutions for taking appropriate data-driven actions. When compared to traditional farming, smart farming is significantly more efficient. IoT allows automating operations and saving money on manpower. It also reduces waste and enhances service delivery by lowering the cost of manufacturing and delivering items and providing transparency into consumer transactions.

Keywords: Cloud,IOT,Sensors, LoRa

Introduction

Agriculture plays vital role to build country economy as it provides food for the whole population. In this way, it connects and communicates with all of the country's important businesses. If a country's agricultural foundation is quite vast, it is considered socially and economically wealthy. As a result, the agro-industry must implement IoT in order to feed this huge population. Major problems, such as rising food demand, climate change, extreme weather conditions, and environmental effects, must be overcome.

The Internet was once controlled solely by the user. Further Machine-to-machine (M2M) technology based on wired and wireless Internet was then created, together with smart communication technology [12].

The Internet of Things (IoT) is a network of physical objects—"things"—embedded with sensors, software, and other technologies for connecting and sharing data with other devices and systems over the internet. There are several Internet of Things (IoT) uses in farming, including data collection on temperature, rainfall, humidity, wind speed, pest infestation, and soil composition. This information may be utilized to automate agricultural processes, make accurate decisions to increase quality and quantity, decrease risk and waste, and simplify crop management work. For example, farmers may now remotely monitor soil temperature and moisture, and can use IoT data for precise water and fertilization operation. Data received from sensors helps to understand about his or her farm, can help increase farm productivity, and simultaneously lowering expenses.

IoT functions include data gathering and processing, planning and decision-making, and prescriptions and services [13].IoT in agriculture consists of a series of processes that collect data from crops, livestock, agricultural machinery, and farms; create a database based on the collected data; make an appropriate prescription based on expert analysis of key data; and deliver prescriptions to consumers via text message

Some of the most outstanding technologies that are combined with IoT to develop agricultural solutions are wireless sensor networks, cloud computing, middleware systems, and mobile applications [1,2]. LoRa is a widely used network radio in India because of its advantages such as long range, low power consumption, and its low-cost investment [3, 4].

In agriculture, IoT is used for a wide range of activities, and applications can be broadly divided into four categories as (a) management systems, (b) monitoring systems, (c) control systems, and (d) unmanned machinery.

This article gives systematic literature review of IoT-based tools and its application for agriculture

Components of IOT

The architecture of IoT was composed of three layers. The front end layer collects weather parameters generated by different agricultural operations. The intermediate layer works as a gateway layer, connecting the front end layer to the Internet. The back end layer collects all of the front end data [14].

I. Sensors/Devices

Devices and sensors are the components of the device connectivity layer. These smart sensors are continuously collecting data from the environment and transmit the information to the next layer.

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Some of the most common devices used in IOT are optical sensors to measure soil properties, photodiodes and photo detectors to determine soil, organic matter, and soil moisture, moisture sensors to measure the amount of water in the soil, and geo-positioning devices to determine latitude, length, and altitude It's important to keep in mind that geolocation devices are a crucial component of precision agriculture[10].

Common sensors are:

- Temperature sensors and thermostats
- Pressure sensors
- Humidity / Moisture level
- Light intensity detectors
- Soil nutrient sensors
- Proximity detection
- RFID tags

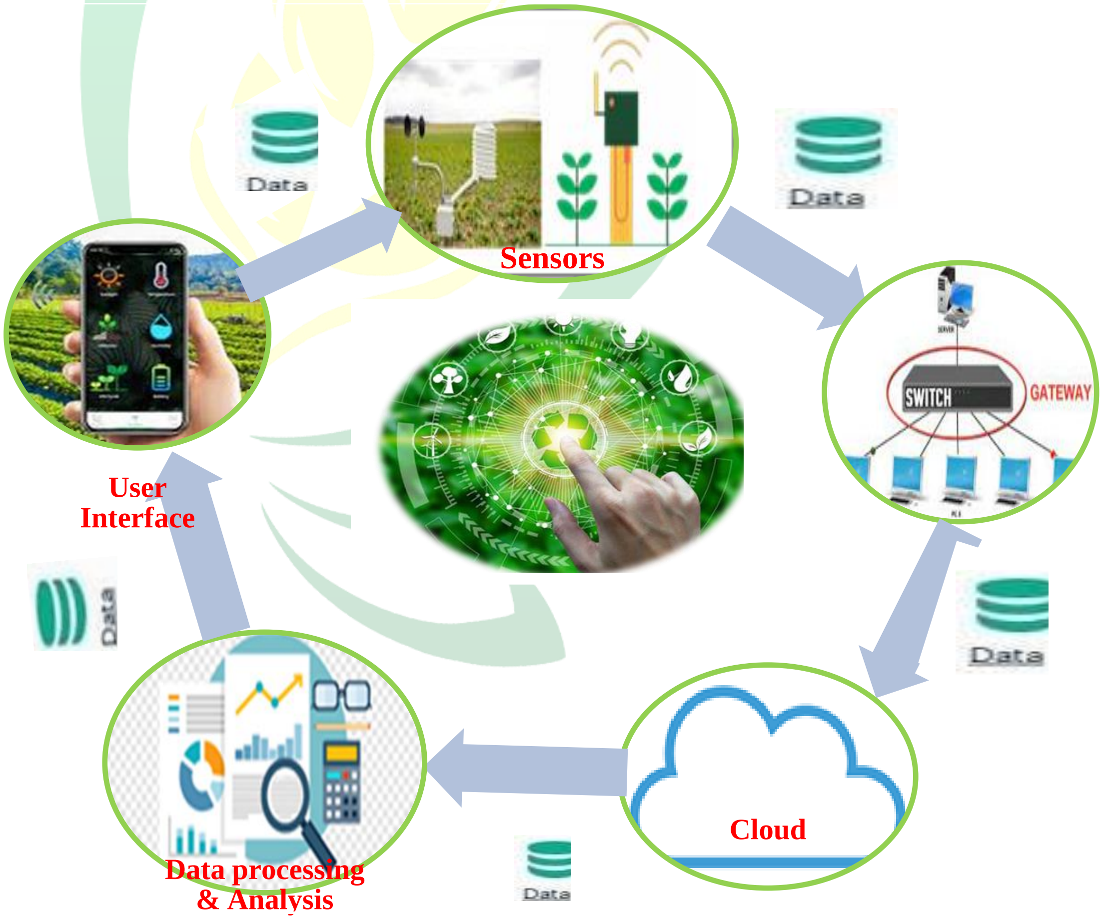

Figure 1.Components of IOT

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II. Connectivity

Data from sensors is transferred to a cloud infrastructure, but it requires a medium for transit. Sensors can be linked to the cloud using a variety of communication and transport mediums, including cellular networks, satellite networks, Wi-Fi, wide-area networks (WAN), low power wide area network LoRAWAN, ZigBee, Bluetooth, Z-wave, and others.

The advancement of wireless communication technology results in lower costs, lower power consumption, and small-scale multifunctional sensors that allow for short-range communication.[9]

Figure 2.Connectivity Icon

III. Gateway

The IoT Gateway handles bidirectional data flow between various networks and protocols. Another role of a gateway is to translate various network protocols and ensure the compatibility of linked devices and sensors. Gateways can be set to do local pre-processing of data obtained through various sensors before sending it to the next step. It protects the system from harmful threats and unauthorized access by acting as an intermediate layer between devices and the cloud.

IV. Cloud

The Internet of Things generates vast amounts of data from devices, apps, and users, which must be managed efficiently. IoT cloud provides capabilities for collecting, processing, managing, and storing vast amounts of data in real time. These data may be easily accessed remotely by industries and services, allowing them to make vital choices as needed.

V. Data Processing and analytics

Once the data has been gathered then sent to the cloud, the software processes it. This might range from something as easy as ensuring that the temperature reading on equipment like thermometer is within an acceptable range. It may also be highly complicated, such as employing computer vision on video to detect pests. Each alternative has its own set of characteristics and exchange between energy consumed, range, and bandwidth. As a result, selecting the optimum connectivity choice in the IOT system is essential. The process of converting analog output from various smart devices and sensors into usable insights that can be analyzed and used for deep analysis is known as analytics. Smart analytics solutions are necessary for IoT systems in order to manage and enhance system.

VI. User Interface

Next, the information made available to the end-user in some way. This can achieve by triggering alarms on their phones or notifying through texts or emails. User interfaces are the visible, physical components of an IoT system that users may access. Designers will need to provide a well-designed user interface that requires the least amount of work from users and encourages more interactions.

Applications of IoT in Agriculture

The Internet of Things has made smart farming possible. Smart farming based on IoT refers to a system designed to monitor crop fields using sensors. These sensors monitor every crop-related nutrient. Smart farming based on IoT not only modernizes traditional farming methods, but also targets other agriculture methods such as organic farming, family farming (complex or small spaces, specific cattle and/or cultures, preservation of specific or high-quality varieties, and so on), and enhances highly transparent farming. There are various applications of IOT in agriculture.

1. Precision Farming

Precision agriculture is defined as anything that improves the accuracy and control of the farming process when it comes to producing animals and cultivating crops. Precision farming is distinguished by manufacturers' utilization of high-speed internet, mobile devices, and dependable, low-cost satellites (for images and location).Precision farming is one of the most well-known IoT applications in the agriculture industry, and it is being used by a number of organizations across the world.

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2. Agricultural Drones

Unmanned aerial vehicles (UAVs) driven by IoT have facilitated in the conversion of agriculture from traditional farming techniques to a new level of intelligence in precision agriculture.[11]

In the agriculture industry, drones are being utilized to improve a variety of farming operations. Drones are used in agriculture for crop health evaluation, crop monitoring, pesticide spraying, irrigation, planting, and field analysis. There are two types of drones: ground-based and aerial-based drones.

During their flight, these drones collect multispectral, thermal, and visual data.Drones provide several advantages, including crop health imaging, integrated GIS mapping, time savings, simplicity of usage, and increased agricultural yields. We can give the agriculture industry a high-tech makeover by combining drone technology with effective strategy and planning based on real-time data collecting.

3. Livestock Monitoring

Large farm owners use wireless IoT apps to monitor the location, health, and well-being of their livestock. This knowledge enables them to identify sick animals and, from then on, segregate them from the herd, care for them, and prevent the sickness from spreading to other animals. It is also effective for reducing labour expenses since owners may locate their animals using IoT-based sensors.

4. Smart Greenhouses

Intelligent greenhouses are increasingly common in urban areas because they allow monitoring several parameters of nutrient solutions [5], as well as to improve the growth, yield, and quality of plants. Greenhouse farming is concerned with boosting the yields of vegetables, crops, and fruits, among many other things. IoT can be used to build a smart greenhouse. These smart greenhouses autonomously monitor and manage the environment even without manual intervention. In a smart greenhouse, several sensors are employed to evaluate environmental conditions and analyze their appropriateness for plants. By using IoT to interconnect the system to the cloud, a remote access is created. This reduces the need for continuous manual inspection. The cloud server manages data processing and executes a control action within the greenhouse.

5. Monitor Climate Conditions

Crop productivity is affected by the weather. Different crops require different climate conditions to grow, and even a rudimentary understanding of climate has a significant impact on crop quantity and quality. Farmers can use IoT technologies to get real-time weather updates. IoT technology-based systems with NPK sensors using light dependent resistors (LDRs) and light emitting diodes(LEDs) system provides guidance on the amount of fertilizer required for farmers at regular intervals by monitoring and analyzing nutrients present in the soil [15]

6. Remote sensing

Sensors installed around the farms, such as weather stations, are used in IoT-based remote sensing to collect data that is then sent to analytical tools for analysis. Farmers may monitor their field remotely.

7. Soil quality

The examination of soil quality assists in determining nutritional value and dehydrated farm parts, as well as soil draining capacity or acidity, which allows for the adjustment of irrigation water requirements and the selection of an efficient kind of cultivation.

8. Computer imaging

This type of photography mostly comprises using sensor cameras located across the farm to provide photos that are then processed digitally.These images are useful for getting accurate information regarding

- **Quality control**

Image processing coupled with machine learning compares photographs from the database to images of crops to determine size, shape, color, and growth, and adjusts the quality as an outcome.

- **Sorting and grading**

Sorting and grading product based on color, shape, and size can be simplified with computer imaging. Multiple agricultural machines are connected to each other by exchanging data through communication. Agricultural machinery companies that are global leaders have developed a tractor with auto guidance technology using GPS to improve working efficiency and reduce labor requirements [7].Tractor companies such as John Deere and Case IH are conducting ongoing research on autonomous tractors [8]. Tractors with automatic steering

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have several advantages, such as repeatable path tracking, reducing overlap and facilitating operations under low visibility conditions, taking complete control over the quality operations.

Conclusion

According to FAO forecasts, the world would need to produce 70% more food in 2050 as the human population grows rapidly. As a result, agricultural fields would shrink and scarce natural resources will be depleted. So agricultural yields must be increased urgently to fulfil demand, Internet of Things (IoT) may play a significant role in this process. Farmers and ranchers may now practice smart farming with the help of IoT. Farmers may spend less time in the field while still increasing crop yields thanks to smart farming. In the agriculture industry, the IoT-based ecosystem offers a variety of uses. To summarize, IoT applications enable farmers to collect valuable data that can be used to improve efficiency. Landholders and small farmers must realize the benefits of IoT-based smart farming and should effectively implement IoT solutions.

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