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# A Review on IoT Applications in Smart Agriculture

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**Abstract.** Farming plays an important role in the survival of human civilization. As our forefathers have taught us, agriculture has a long-evolutionary history that one can learn from. The Internet of Things (IoT]) is used to improve crop yields. IoT enables internet-connected equipment with sensing devices to exchange information with others. The sensor in the land can collect data remotely and send it to the producer in timely manner. Among the devices that can be wirelessly managed and maintained in live time are pumps, garages, vehicles, weather forecasting, and PC. This paper provides a detailed study about the various methods such as drip, greenhouse, IoT based monitoring system, wireless network, smart and precision agriculture. Remote sensing method provides high accuracy and better yield than the existing methods. Thus, agriculture system provides greater yield and the farming lands are protected with the help of technology.

**Keywords.** greenhouse, internet of things, precision agriculture, smart agriculture, wireless network

## 1. Introduction

The Internet of Things (IoT) technology is being utilized in many sectors across the world. These sectors are agriculture, home automation, automobiles, and the medical industry. The IoT uses elements like sensors and other elements to sense data like heat, temperature, and other important factors from the outside world. This IoT in agriculture can read the data from the outside world and send an alert message to the farmers. Crop yields can be increased by using information recorded and inferred in the farm field, as well as weather information from online repositories [1] [2]. Agriculture production needs to be improved with advanced technology to help the entire ecosystem. In order to improve the production system, the most important things to measure are temperature, humidity, and soil signals [3, 4]. This data will be transmitted by the wireless networks through an M2M (machine to machine) support platform. The IoT uses both wired and wireless technology [5] to communicate between the sensors, microcontrollers, and actuators.

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Based on the problem noticed in agriculture, the IoT technology was selected to overcome the problem. Different IoT techniques use sensors to transmit the data from a ground point to a destination point, called a "farmer communication point." When a farmer receives an alert message, he performs the alternative task to avoid damage to his field. IoT in agriculture can also change many developing countries into developed countries [6]. Smart agriculture has recently been advocated as a way to improve agricultural modernization and considerably increase food output. In particular, smart agriculture systems incorporate numerous modern computer and information technologies such as the Web of Things, machine intelligence, and cloud technology. IoT is mostly used to gather agricultural data and transfer it to data centers, while artificial intelligence methods are utilized to evaluate the data for smart decision-making. One example is looking at the data on the agricultural ecosystem to figure out how much water is needed for irrigation.

## 2. Related Work

IoT techniques make use of the cloud by collecting data from the fields and utilizing machine learning to predict future instances to overcome upcoming disasters. Using the GSM module, the client receives the SMS or alert message [1]. In many countries, like China, Thailand, and other countries, there is a successful implementation of IoT in farming. IoT sensors are able to gather data from the agricultural field and respond to user-input via wireless networks, making them ideal for farmers [2]. The aim of the IoT in agriculture is to make fields talk to each other. It uses the sensors to grab the data, and that data can be used to analyze the situation. As a result, no output resource is utilized less efficiently, and most production resources are also more efficiently used as yield levels rise as control parameters are optimized more. [3]. An experimental setup with a large number of sensors for monitoring the farming area's status is designed. The suggested system employs an infrared camera to detect the presence of insects based on the heat they emit. To validate the pest's existence in the field, image processing is utilized to take photos of the pest [4]. A new technique for analyzing humidity, temperature, and light in a potato field using a wireless sensor network has been developed. Based on the data acquired [5], farmers may be able to find a recovery technique for increasing the fertility of the soil. The major aspect of IoT in agriculture is situational monitoring. Several kinds of farming are: crop farming, aquaponics, forestry, and livestock farming. The parameters monitored are water, fuel, and animal feed using IOT. Many countries are not able to develop this type of IoT-based application because of development costs [6]. A multi-agent system is developed with precision agriculture for intelligent systems in the industry [7]. Precision agriculture seems efficient because it is tightly matched with scientific theories of soil, crop, and pest management. Automatic irrigation systems also provide a better system because it works based on temperature, water content in the air, and humidity sensor [8].

## 3. Methodology Used

Various methodologies are implemented to achieve the highest yield, and technology plays an efficient role in the agriculture sector. The accuracy of a methodology is calculated by considering the advantages of using that methodology, response time, and many others. The different methodologies are briefly discussed in the following section.

### 3.1. Drip Irrigation using IoT Sensors

Drip irrigation is the process of watering the field or plants, and it saves 40–50% of the water that was going to be wasted. These sensors are used in agricultural lands to detect water content in the soil. Depending on the values read by the sensor, the IoT technology decides whether to send water to the crops in the field or not. It uses the Arduino board with the combination of a soil moisture sensor as shown in Figure 1. The IoT sensors continuously check the reading from the soil. With the combination of IoT and drip irrigation, water saving is increased by up to 50–60% [9] [10]. The goal of this system is to make a reliable, advanced, cost-effective, and smart drip irrigation control system gadget that can look at the land's humidity, heat, and moisture levels and deliver water close to the roots of the plants to make sure all crops get enough water for healthy growth while reducing labor-intensive tasks.

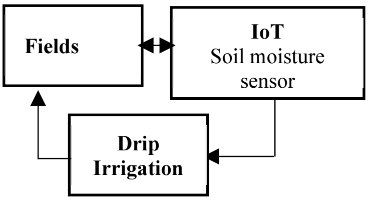


**Figure 1.** Drip irrigation

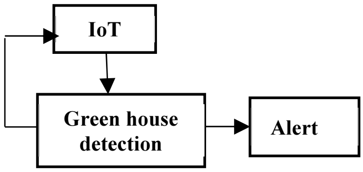


**Figure 2.** IoT based greenhouse detection

### 3.2. Greenhouse Agriculture

The goal is to provide agriculturists with field data about greenhouse factors such as carbon dioxide (CO2), soil moisture, humidity, and light. The water content of the soil is monitored in order to control how the conservatory windows and doors roll on and off. This prevents agriculturists from physically visiting the fields. Crops, farm animals, soil, moisture conditions, and the effects of current technologies are being investigated. IoT is commonly used to link devices and collect data, as shown in Figure 2. The device is meant to monitor various greenhouse characteristics such as CO2, moisture, heat, and light. Gardeners may gather this data using a cloud application and internet access. Conservatory windows and doors roll open and shut based on how much moisture is in the air [11]. By doing so, all the physical tasks can be controlled automatically.

### 3.3. IoT based Monitoring System in Agriculture

The system's core components are a microprocessor, a network processor, and an area network unit, as shown in Figure 3. It is lightweight, battery-operated, and provides a secure and quick connection. Variations in environmental circumstances will have an impact on the crop's total production. For maximum development and yield, the health of the plants needs to be maintained. Systems are used to detect the state of the crop field, which is highly important. The temperature is measured using an infrared thermostat sensor with a built-in digital control and math engine. It measures temperature in real time and uses a moisture sensor to detect the relative humidity levels in the farming field. A camera sensor is used to connect the camera to the camera booster pack via a PCB. This is used to collect up-to-date photos of a certain field. [12] [13].

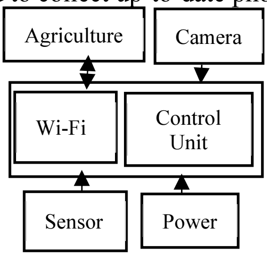


**Figure 3.** IoT monitoring in agriculture

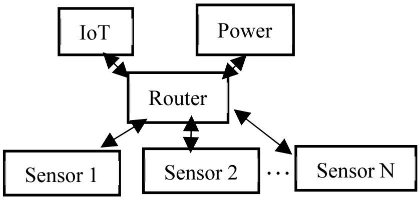


**Figure 4.** Wireless network in agriculture

*3.4. Wireless Sensor Network in Agriculture*

A wireless sensor network requires little, if any, architecture. It is made up of multiple sensor nodes that work together to observe a certain area, as shown in Figure 4. The sensors in the system may be kept unvarying for information-sensing and computation without causing any disruption. The network sensor nodes can be installed on an ad hoc basis. Because there are so many nodes in a structure with fewer wireless sensor nodes, maintaining and detecting errors is extremely tough [14] [15]. Data obtained from the sensor browser information system is managed by the command center. The geo-spatial consortium also establishes a framework for interoperable interfaces and data compression, allowing for real-time synchronization. Anyone with a website can see the most important information and the characteristics of the network.

*3.5. Poly House, Water-Volume Sensor and Soil PH Sensor in Smart Agriculture*

The Poly farm-house is the most effective method for increasing crop performance and productivity. An IoT water analyzer keeps track of how much water is flowing through a pipe. Almost every huge organization that deals primarily with fluids or chemical products must continually monitor and quantify the liquids they must manage during the automated processes. A flow sensor is a device that is widely used to monitor the flow of fluid. The flow rate and volume of fluid passing through the pipe are regulated using a microcontroller. In order to achieve a higher yield, one has to provide sufficient water. Data from this water current detector device is sent to the computer, which further takes the proper measures, such as shutting off the pump [16].

*3.6. Precision Agriculture*

Smart farming improves farmers' livelihoods by automating and optimizing all agricultural factors that can be automated in order to increase agricultural yield. IoT sensors assist in the measurement of soil quality, weather conditions, and humidity levels. It also optimizes these factors in order to maximize production. Figure 5 shows that IoT precision agriculture is made up of four parts, such as weather monitoring, soil monitoring, plant disease monitoring, and irrigation monitoring. The weather monitoring system checks for critical weather situations, and the irrigation monitoring system reduces the amount of water supplied to the field. The soil monitoring system repeatedly checks the soil mineral quantity and fertility and guides us to appropriate consequences.

Farmers can reduce the risk by doing economic analyses based on the different crop yields in a field [19].

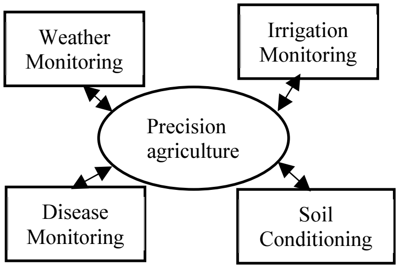


**Figure 5.** Precision agriculture

## 4. Results and Discussions

The recent techniques include smart drip irrigation, precision agriculture, poly-housing, wireless networks in agriculture, remote sensing, and smart agriculture as in Table 1. It discusses the advantages, disadvantages, tools used, operating layers, and provides a comparison of the accuracy of various methods.

**Table 1.** Comparison of various agriculture methods

| S.No | Techniques Used | Advantages | Disadvantages | Tools Used | Layer | Accuracy |
|---|---|---|---|---|---|---|
| 1 | Smart Drip irrigation [9] | Less wastage of water. | Increased power consumption. | Soil-moisture sensor and Arduino | Internet layer | 94% |
| 2 | Precision agriculture [18] | Detects data from four different domains. | Collisions of multiple domains | Hygrometer, sensor, anemometer, raspberry pi | Internet and application layer | 76% |
| 3 | Poly-housing [14] | Protects from heavy rains | Crop protection is less. | Polyethylene sheets, DTH sensor | Internet layer | 75% |
| 4 | Wireless network [11] | Transmits data to remote locations. | High radiation. | Wireless router, camera, wifi | Network layer | 85% |
| 5 | Remote sensing [10] | Remote monitoring is achieved | High radiation. | Micro controller, raspberry pi | Network layer | 95% |
| 6 | Smart agriculture [19] | Efficiently stores and organizes the data. | Highly expensive. | Cloud platform, Arduino sensors | Application and network layer | 80% |

## 5. Conclusion and Future Work

The Internet-of-Things plays an important role in smart agriculture. Many applications that are related to IoT have been implemented in smart agriculture to achieve greater yield. Farmers benefit from using smart agriculture because it increases agriculture yield rapidly, which is required for today's rising population. The existing mechanisms such as drip, greenhouse, IoT based monitoring system, wireless network, smart and precision agriculture are compared and contrasted. The study shows that the remote sensing method is efficient and provides higher accuracy than the existing methods. Thus, the agriculture system provides a greater yield and the farming lands are protected with the help of technology.

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