IJMTST is UGC Approved Journal with Journal Id: 43137

International Journal for Modern Trends in Science and Technology, 8(S08):28-32, 2022

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST08S0805
Available online at: https://www.ijmtst.com/vol8si08.html

IoT-Enabled Smart Agriculture

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To Cite this Article
Lakshmeswari Chennagiri and Chennagiri Venkata Veera Brahmam. IoT-Enabled Smart Agriculture. International Journal for Modern Trends in Science and Technology 2022, 8(S08), pp. 28-32. https://doi.org/10.46501/IJMTST08S0805

Article Info
Received: 26 May 2022; Accepted: 24 June 2022; Published: 28 June 2022.

ABSTRACT

With the support of technology, the agriculture industry has advanced significantly, becoming more data-driven and intelligent.. Many industries, including agriculture, have been changed by the rapid expansion of Internet of Things-based technologies. Existing farming practices are dismantled, and new opportunities, as well as challenges, are created.In this article, the potential of wireless sensors and IoT in agriculture is discussed, as well as some of the problems that will need to be overcome when combining new technology with traditional farming methods.The Internet of Things (IoT) devices and techniques used in agriculture applications are thoroughly explained. We can recognise contemporary IoT trends in agriculture based on this article.

KEYWORDS: Internet of things (IOT), smart agriculture, sensors, farm fields, and irrigation are some of the termsused.

1. INTRODUCTION

The Internet of Things is a collection of devices with software, sensors, and networking that allow objects to communicate and share data. Farmers are reaping endless benefits from implementing the IoT programme. It has aided farmers in lowering costs while increasing agricultural yields.

One of the main goals of the irrigation system is to supply and maintain the appropriate environment for crop growth in terms of temperature and soil moisture. Users can access data saved in the cloud using their cellphones and PCs.

In the user interface's control panel, the user may keep track of the crops and control the water, pumps, and fans. The fundamental goal of a smart irrigation system is to produce and maintain optimal crop conditionsPlant development can be promoted by cultivating in an environment with appropriate water supply and ideal temperature, and therefore agriculture field productivity can be increased.as well as a rise .

We can boost productivity and feed more people in the future by utilizing this technology.
higher crop output, sustainability, and cost effectiveness. [1]

2. SOIL MOISTURE SENSOR

It detects moisture in the soil. The sensor has both analogue and digital output inputs and works on the open short circuit theory. This system's output is roughly indicated by the LED output. When the earth is dry, the electricity stops flowing and the circuit becomes open. If the ground is moist, current flows, the circuit shorts, and the output is zero. Levels are used to represent sensor data. It is corrosion resistant, thus the sensor can handle the farmer's costs for a long period at a low cost. [4]

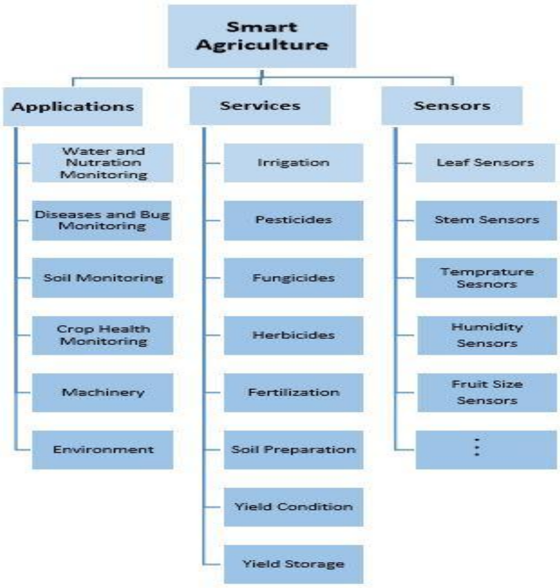

Figure 1: General Hierarchy of Applications, Services and Sensors for Smart farming. [2]

3.TEMPERATURE AND HUMIDITY SENSOR

It is used to determine the temperature and humidity levels. This system displays data on how well it performed. If the threshold is surpassed, the LED will blink, and the values will be posted on the web page for the farmer to inspect.

4.ACOUSTIC SENSORS

These have a variety of applications in agricultural management, including soil cultivation, weeding, and harvesting. The key benefit of employing this sensor is its quick reaction and low cost, especially when considering portable equipment. These sensors work by detecting changes in the noise level.These sensors are mostly used for pest detection and monitoring, but they can also be used to classify a variety of seeds. [4], [5], [6], [7], [8, 9], [10]

5. OPTICAL SENSORS

Optical sensors analyse organic components in soil, moisture, minerals, colour and composition, among other things, using a phenomenon known as light reflectance. The ability of soil to reflect light is determined by the sensors' testing of various regions of the electromagnetic spectrum. The change in the reflection of waves indicates a change in the density of the soil.

2. APPLICATIONS

Implementing the latest sensors and IoT techniques in agricultural processes can result in a major change in all aspects of farming practises. Smart farming can now achieve unprecedented heights because to the seamless integration of wireless sensors and the Internet of Things. The internet may help enhance answers to many traditional agricultural problems like as yield optimization, drought response, soil aptitude, irrigation, and pest management by using smart farming approaches. The hierarchy of important applications, services, and wireless sensors utilised in smart farming applications is depicted in Figure 3. The following are some key examples of how advanced tactics might help enhance overall efficiency at various stages. [2]

1.SOIL SAMPLING AND MAPPING

Soil analysis is critical for extracting field-specific information that is useful for making decisions at various stages. The primary goal of soil analysis is to determine the nutrient status of farmland, and certain measures are done depending on the field's insufficiency. Type of soil, crop history, fertilisers, irrigation level, and other parameters all aid in the analysis of soil nutrients. Many firms offer sensors and instruments for soil testing, and these kits assist farmers in determining the quality of their soil. Depending on the information presented, measures to boost crop growth can be made.

Drought is a major factor in crop production productivity being limited. This problem can be remedied by employing remote sensors to receive soil moisture data on a regular basis by SMS, e-mail, or a website check. We can let the water pump to run depending on the data we receive; if it reaches a certain range, we will receive an alarm and be able to turn off the water.(Muhammad Ayaz1 (Senior Member, 2019

2.IRRIGATION

Several irrigation technologies, such as drip irrigation and sprinkler irrigation, can address difficulties such as water waste, which are also present in older irrigation methods such as flood irrigation and furrow irrigation. Water scarcity can impair the quality and quantity of crops, as well as contribute to nutrient deficiencies in the soil and the development of illnesses that are damaging to the plants.It's difficult to predict how much water crops will use.It takes into account things like irrigation method, crop kind, soil type, and soil moisture level. Taking this into account, the soil and moisture control system employs wireless sensors to assist the crop in making the most efficient use of water, resulting in improved crop health. Agricultural water stress index irrigation management, for example, is one of the IoT approaches used to improve crop efficiency.To measure the conditions and communicate the data, wireless field sensors are placed. (Other data, including as meteorological information and satellite imagery, are utilised to calculate the crop water stress index (CWSI), which improves water usage efficiency.).

3.FERTILIZERS

Smart farming makes use of fertilisation, which aids in the estimate of nutrient dose requirements, reducing the negative impact on the environment. The application ofsmart agriculture allows for the estimation of nutrientdosage, which lowers the negative influence on the environment.. Fertilization requirements include soil type, crop variety, and absorption capacity, yield, fertility type, and weather, among others. Satellite photos assist us indetermining the state of crop nutrients, as well as assessing the quantity of soil nutrients, both of which can improve fertiliser efficiency. Smart fertilising benefits from GPS accuracy and autonomous vehicles. Pests are detected using IoT-based sensors, smart robots, and drones, and pesticides are sprayed to control them.

3. ADVANCED PRACTICES IN AGRICULTURE

Previously, the quality of seed and fertilisers were aspects that were considered while increasing agricultural productivity. However, these traditional methods are insufficient to meet the need. Scientists have proposed several alternatives, such as bioengineered and genetically modified foods, which are generated by inducing changes in their DNA using genetic engineering techniques. Because people prefer organic food, only a few technologies gain popular adoption. Years of research have been performed to see if technology like IoT may be leveraged to encourage the usage of conservative agriculture approaches. In order to improve urban farming, the use of cutting-edge technology is critical.

1. GREENHOUSE FARMING

It is considered as one of the method of smart agriculture. However, growing crops in the controlled environment is not a new idea, as it has roots from 19th century. But this kind of setup is used in countries which experience drastic changes in climatic conditions. The day's crops grow in indoors are not much affected by varied environmental conditions and also we can grow any kind of crops. In these times the support of sensors and other devices are important for communication. There are a number of factors that can influence crop productivity, including:

ventilation, monitoring, and wind control, among other things The most important task in modern greenhouse farming is environmental monitoring. Where we must verify the several measuring points that regulate the indoor environment. [4]

2.VERTICAL FARMING

Farming areas are in greater demand as a result of rising food demand. However, pollution and soil erosion have resulted in significant land loss. The quality of soil has been harmed as a result of contemporary farming methods focused on industrial farming. Taking the challenges with arable land into account, there will be a significant loss in food production in the following days. Fresh water is essential for agricultural, which puts a strain on already scarce water resources. Vertical farming can help overcome these obstacles. This type of farming is more likely to be seen in urban agriculture, where crops are grown in a controlled environment. We can save resources by employing this method of farming. The following are crucial parameters in this type of farming:

To control the climatic conditions in vertical farming, we employ NDIR (non-dispersive infrared) sensors to measure carbon dioxide. Gasbox sensors are used to ensure that plants develop to their full potential by allowing for specific conditions. Pseudo dual beam NDIR measurement is used to improve stability and reduce optical complexity. Touching the crops with hands at each stage is not required to see the growth in the IoT connected farm. Mint controls are used in a variety of vertical farming applications to solve issues like wastage and sensing. [5]

Smart farming technology includes trucks with GPS trackers and wireless sensors that are put in the fields to monitor moisture and other parameters. Watering, planting, picking, and fertilising are all tasks that robots assist farmers with. Acoustic sensors are used to monitor and control pests as well as distinguish between different types of seeds.

1.DATA BASE

All crop data is safely maintained in the database, and users can access it anytime they need it.
Cellular communication: It is used to receive updates from the field, and the user's ability to get updates is dependent on bandwidth and other factors. The cost of this transmission is inexpensive; but, employing satellites to transmit data is a more expensive option for small farms.

2. ZIGBEE

It is used to communicate across a short distance. Depending on the applications, network topologies such as star are used. GSM or Bluetooth can be utilised depending on the distance between the farm and the user. [2]

3.BLUETOOTH
This communication is wireless and takes place across a shorter distance between devices. It is the most preferred alternative to adopt because of its perks such as low power consumption and low cost. It can exchange data such as parameter readings. Unlike WiFi, which requires a LAN connection to operate, it is available on every smart phone. WiFi, on the other hand, may be used to operate big farms because many devices are connected, making it simple to operate. Technology fluctuates dependingonthesize of the farmland.[4][8]

4. COMMUNICATION

Data must be updated on a regular basis, and information must be reported at regular intervals in smart agriculture. To accomplish this,
Telecom network operators play a critical role in communication reliability. The type of communication used differs depending on the farm's applications. Bluetooth and other wireless gadgets are used to connect peers and share data

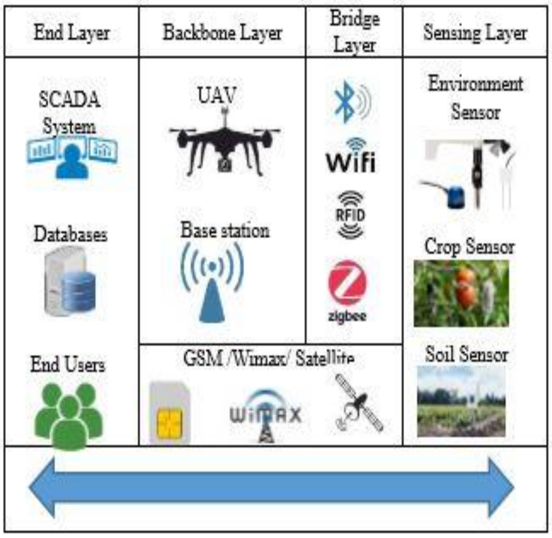

Figure 2. Communication in smart farming. [2]

. Wi-Fi is used to connect devices over a short distance and share data with a server, from which we may get the information and examine the specifics whenever we want. Smart phones are used to monitor agricultural conditions since they are freely accessible to everybody and because they all have built-in GPS that allows farmers to know where they are. [2]

5.ARGUMENTS

Smart agriculture yields higher agricultural yields while reducing water and resource waste in the farming process. The technique aids in improving crop condition and controlling the moisture and temperature levels of the crops based on weather conditions
The author Muhammad Ayaz addressed many of the technology that aid smart farming, however he did not go into great detail on data security or how to store up data for future use
When the parameters in the field are less than required, System Embedded sends an SMS alert message, which is a very simple way to know the status of the water level. It is not mentioned in the paper by author Muhammad Ayaz.

According to my opinion, technology should be approached with caution; a data base including all crop-related information could crash owing to a lack of security. In the case of vast fields, the complexity will be enhanced; yet, in real farming, a modest setting in the fertilisation device might damage the crop due to the incorrect amount of pesticides cutting.

6. ADVANTAGES

1. A small group of farmers can cover a huge farm.
2. It saves time by allowing for easy monitoring and provision of the conditions that plants demand.
3. There are several drawbacks with conventional farming that this technique may be able to address. Excessive watering can harm plant growth, thus the irrigation system ensures that the right amount of water is delivered to the plants. However, rainfall water may not be sufficient for the plants.
4. Using fans and pumps, we may balance the parameters to the desired levels based on the moisture and temperature data received by the cloud.
5. Getting alerts from sensor data makes it simple to monitor moisture and temperature levels. Temperature and humidity sensors are used to operate it automatically. When the soil is dry, the water motor will automatically pump water to the field. When the soil becomes too moist, we receive an alarm that the soil is wet, and we move to the next step. [3]

7. DISADVANTAGES

1. Weather conditions may have been misinterpreted.
2. Devices will be modified in accordance with the needs of the farmers; this will necessitate the purchase of pricey equipment.
3. If there is malfunctioning data processing equipment or sensors, this will result in incorrect decisions being made. [1]

8. CONCLUSION

Food demand has risen in recent years as a result of population growth, hence farming methods are critical in meeting public demand. It is critical to concentrate on more intelligent and effective methods of cultivation.With the advancement of innovative techniques for enhancing agricultural productivity and handling, more young people are becoming interested in agriculture and pursuing it as a career. Technology such as the Internet of Things (IoT) enables them to simplify the process of cultivating and monitoring crops by allowing them to access information via mobile phones and the internet. Taking these aspects into account, this study emphasis the critical role of technologies, particularly the Internet of Things (IoT), in making farming smarter in order to meet future expectations. As previously mentioned, we use wireless sensors, the cloud, Bluetooth, and other devices. Various farming practices are discussed, as well as how good they are in conserving resources. To summarise, monitoring farmland is critical; IoT technology is required for better farming and less resource waste.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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