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IoT and Cloud Computing for Smart Agriculture Using DS18B20 & Arduino

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Abstract—The Internet of Things (IoT) is the most sophisticated notion in today's internet era. It most likely supports all domains on the planet. Agriculture is one of these domains that uses IoT to make agriculture smarter. Several IoT applications are visible in the sphere of agriculture for unimaginable benefits to farmers and, as a result, for the successful development of the nation. This research examines prospective uses of IoT in agriculture for the fundamental improvement of farmers to better crop production.
Keywords: *Smart Agriculture, Internet of Things(IOT)*

INTRODUCTION

Farming is the backbone of the nation's progress. Because of its exceptional agricultural lands and other resources, India is known as an agricultural country. Temperature and soil moisture factors have recently influenced agricultural growth, such as productivity, disease, and yield production. Agriculture-related difficulties have been a hurdle to the nation's progress. There is a need to modernize the current agricultural standard procedures. In order to manage crops in a regulated setting, new agricultural trends are required. Greenhouses, for example. The Internet of Things is a recent innovation in the world of the Internet. The concepts enable the interconnection of physical items equipped with sensing, actuating, and processing capacity by giving them the ability to collaborate on a job while keeping linked to the internet, referred to as the "Internet of things" IoT. The goal of constructing a good object is achieved with the use of detectors, actuators, and embedded microcontrollers. These useful objects gather knowledge from the development environment, process it, and take suitable actions. As a result, the Internet of Things can provide invaluable assistance and assist people in leading wise and intelligent agriculture. The significance of those technologies, and hence their application in agriculture, has been investigated and analyzed in this paper. Farmers will easily receive a timely cultivating guideline relating to aspects such as pesticide consumption, seasonal plant illnesses, as well as natural disasters and recovery procedures, thanks to IoT. The removal of human-to-human and human-to-computer contact is the primary benefit of integrating agriculture and IoT. Connecting agriculture to the internet is one of the most critical aspects of IoT device operation. It is assumed that the connection is wireless, and wireless connections are classed based on energy consumption, uplink and downlink data rates, packet size, device per access point, topology, frequency band range, and channel width. The proposed paper outlines the challenges encountered in agriculture and gives a survey of many authors in the sector. It also demonstrates how to apply IoT in agriculture.

LITERATURE REVIEW

Smart agriculture technology help farmers to obtain access to GPS, soil scanning, and better monitor producing crops. Percision Agriculture is a notion presented by Miguel A. Zamora-Izquierdo. He proposed an IoT framework for using soilless culture with saline water. He proposed three separate planes for interacting with the crops, processing the collected data, and acting on the data. Miguel A.Zamora-Izquierdo employed IoT protocols for communication and determined that this strategy keeps farmers connected to the farming environment at all times. P.Viswanathan and Mahammad Shareef Mekala have presented a Cloud-Enabled Clay-Mist Measurement Index. They took two crucial soil characteristics, temperature and humidity, which are directly related to plant growth. The results have been demonstrated to be 94 percent accurate despite the slower execution pace.

Sutanni Bhowmick's paper goes into great length about the concept of vertical farming. Vertical farming is a new tool for assessing soil environmental parameters that promote crop development. He created sensor arrays to collect data, which he then forwarded to the cloud system module to analyse the environmental conditions. He also used the app to notify farmers when the threshold was reached. K.S. Patil has proposed a concept that combines internet and cellular communications. He gave the system the moniker Remote Monitoring System (RMS). The system captures real-time data from the production environment and sends it to the farmer via SMS, as well as general advise on weather patterns, crops to cultivate on the soil, and so on. As a result, this strategy was successful in providing farmers with convenient access to agricultural infrastructure. He proposed the network model,

which involved connecting sensors and actuators across the farming area. The proposed system monitored soil nutrients and pH in order to improve soil humidity.

Sowmya B. J. suggested an automated prediction method that analyses the enormous information units of existing agricultural records. Large data analytics is the process of inspecting enormous amounts of data from many sources such as sensors, weather forecasting, and social media data. Based on existing information about a relevant case, the algorithm makes superior decisions.

ENABLING TECHNOLOGIES FOR THE INTERNET OF THINGS

The following technologies are part of the Internet of Things:

Sensor Networks that are Wireless (WSN)

A wireless sensor network is made up of dispersed devices that include sensors and are used to monitor environmental and physical variables. A WSN is made up of end-nodes, routers, and a coordinator. End Nodes have a number of sensors attached to them, and they can also function as routers. Routers are in charge of directing data packets from end-nodes to the coordinator. The coordinator gathers data from all nodes. The coordinator also serves as a gateway, connecting the WSN to the internet.

The following are some instances of WSNs used in IoT systems:

1. A weather monitoring system employs WSNs, in which nodes gather temperature, humidity, and other data, which is then aggregated and evaluated.

2. Interior air quality monitoring systems gather data on the indoor air quality and gas concentrations using WSNs.

3. WSNs are used in soil moisture monitoring systems to measure soil moisture at various sites.

4. Surveillance systems acquire surveillance data using WSNs (such as motion detection data)

5. WSNs are used in smart grids to monitor the grid at various locations.

Computing in the Cloud (CC)

Cloud computing is a paradigm shift in computing that entails offering programmes and services via the Internet. Cloud computing entails the supply of computing, networking, and storage resources on demand and delivering these resources to customers as metered services in a "pay as you go" paradigm. Users can provision cloud computing resources on demand without interacting with the cloud service Provider. The supply of resources is a fully automated procedure. Cloud computing resources may be accessible through the network using conventional access mechanisms that offer platform-independent access across heterogeneous client platforms such as workstations, laptops, tablets, and smartphones.

It is referred to as on-demand computing because it distributes system resources and data to the users who require them. It can be represented in a variety of ways, including IaaS, PaaS, and SaaS.

Analytics for Big Data

Big Data analytics is the process of gathering, organizing, and analyzing huge amounts of data (referred to as Big Data) in order to uncover patterns and other relevant information. Big Data analytics may assist companies in better understanding the information contained within the data and in identifying the data that is most relevant to the business and future business choices. Analysts working with Big Data generally seek information derived from data analysis.

The following are some instances of large data created by IoT systems:

1. Sensor data collected by IoT systems such as weather stations.

2. Machine sensor data gathered from sensors integrated in industrial and energy systems in order to monitor their health and detect failures.

3. Data on health and fitness collected by IoT devices such as wearable fitness bands.

4. Data generated by IoT technologies for vehicle location and tracking.

5. Information derived from store inventory monitoring systems.

Protocol for Communication

Communication protocols are the correct definitions of digital message formats as well as rules. These protocols' primary role is to transfer messages from one computer system to another. These are important in telecommunications systems since they deliver and receive messages on a regular basis. Error detection and correction, signaling, and authentication are all covered by these protocols. They can also explain semantics and syntax, as well as connect analogue and digital communications.

Communication protocols, which enable network connectivity and application coupling, are the backbone of IoT systems. Communication protocols enable devices to communicate information via a network. Several protocols

are frequently used to describe various parts of a single connection. A protocol suite is a collection of protocols designed to function together; when implemented in software, it is referred to as a protocol stack.

The Internet Engineering Task Force publishes Internet communication standards (IETF). The IEEE is in charge of wired and wireless networking, whereas the International Organization for Standardization (ISO) is in charge of all other forms. The International Telecommunication Union-T is in charge of telecommunication protocols and formats for the public switched telephone network (PSTN). Standards are being pushed towards convergence as the PSTN and the Internet merge.

Systems Embedded (ES)

Embedded, as the name implies, refers to something that is linked to another item. An embedded system is a computer hardware system that has software integrated in it. An embedded system can be a stand-alone system or a component of a larger system. An embedded system is a controller with a specialized purpose that is programmed and operated by a real-time operating system (RTOS) within a larger mechanical or electrical system, typically with real-time processing limitations. It is frequently integrated as part of a larger device that includes hardware and mechanical components. Many gadgets in general usage today are controlled by embedded systems.

An embedded system is a computer hardware system with a microprocessor that is programmed to perform a specific purpose, either as a standalone system or as part of a larger system. An integrated circuit is at the heart of the system, doing calculation for real-time activities.

An embedded system is made up of three parts.

1. It is equipped with hardware.

2. It comes with application software.

3. It includes a Real Time Operating System (RTOS) that supervises the application software and offers a method for the processor to complete tasks on time while adhering to a latency control approach. The RTOS controls how the system operates. It defines the rules for the execution of the application programme.

IoT APPLICATIONS IN SMART AGRICULTURE

Although smart agriculture is not widely used in India, it demonstrates dynamic capabilities for agricultural support. It aids plant growth and development in a variety of ways. Some of these applications for enhancing plant development are given below:

Climate Conditions Monitoring

Climate and weather conditions are the most important things to consider when farming. IoT-enabled smart agriculture employs a variety of sensors to monitor the climate conditions of the surrounding environment. The sensor's job is to collect data from the field and transfer it to the cloud. The cloud is pre-loaded with some basic measures that will be compared to the detected data. We will be able to map the climatic conditions and select the appropriate crop for cultivation based on the comparison. METEO, Smart Elements, and Pycno are a few examples of agricultural IoT devices.

Drones for Agriculture

Agricultural drones are a prime illustration of how technology has evolved through time. Agriculture is becoming one of the most important industries to use drones. Drones are being utilised in agriculture to improve a variety of agricultural techniques. Crop health evaluation, irrigation, crop monitoring, crop spraying, planting, and soil and field analysis are some of the ways ground-based and aerial-based drones are utilised in agriculture.

Drones have several advantages, including crop health imaging, integrated GIS mapping, ease of usage, time savings, and the potential to enhance yields.

PrecisionHawk is a company that employs drones to collect useful data using a variety of sensors used for photographing, mapping, and surveying agricultural land. These drones conduct monitoring and observations while in flight. Farmers provide information about the field to be surveyed and choose an altitude or ground resolution.

Drone data may be used to calculate plant health indices, plant counting and yield prediction, plant height measurement, canopy cover mapping, field water ponding mapping, scouting reports, stockpile measurements, chlorophyll measurements, wheat nitrogen content, drainage mapping, and so on..

During the flight, the drone captures multispectral, thermal, and visual imagery before landing in the same place from where it took off.

Livestock Observation

Livestock monitoring is a method of keeping track of the health of the herds. The health of the animals is checked for indicators of sickness using an IoT gadget. The sensors attached to the animals will collect information about the animals' whereabouts and well-being. The sensors can also track the status of cattle pregnancies and alert the owner when a cow is close to give birth.

Large farm owners may use wireless IoT apps to collect data

on their cattle's whereabouts, well-being, and health. This information assists them in identifying ill animals so that they may be removed from the herd, preventing disease transmission. It also reduces labour expenses since ranchers may use IoT-based sensors to find their animals.

JMB North America is a company that provides cattle farmers with cow monitoring systems. One of the options assists cattle owners in observing pregnant cows on the verge of giving birth. When the heifer's water breaks, a sensor powered by a battery is ejected. This provides data to the herd manager or rancher. The sensor allows farmers to be more attentive while they are with heifers who are giving birth.

Greenhouses with Intelligence

Greenhouse farming is a way of increasing the output of vegetables, fruits, and harvests, among other things. The environmental factors in greenhouses are controlled by either personal intervention or a proportional control mechanism. These approaches are less successful since manual intervention leads in output loss, energy loss, and labour expenses. A smart greenhouse may be built using IoT; this design autonomously monitors and changes the environment, eliminating the need for manual intervention.

Different sensors that monitor environmental factors based on plant requirements are utilised to regulate the environment in a smart greenhouse. When the system is connected via IoT, we may establish a cloud server to provide remote access.

This reduces the need for ongoing manual supervision. Inside the greenhouse, the cloud server also processes data and performs a control action. With minimum manual involvement, its design provides farmers with cost-effective and optimum solutions.

Illuminum Greenhouses is a drip installation and Agri-Tech greenhouse company that provides services using cutting-edge technology. It employs solar-powered IoT sensors to construct contemporary and inexpensive greenhouses. The greenhouse condition and water usage may be monitored using these sensors via SMS notifications to the farmer via an internet site. In these greenhouses, automatic irrigation is used.

The greenhouse's IoT sensors offer data on light levels, pressure, humidity, and temperature. These sensors may automatically operate actuators to open a window, switch on lights, regulate a heater, turn on a mister, or turn on a fan, all via a WiFi connection.

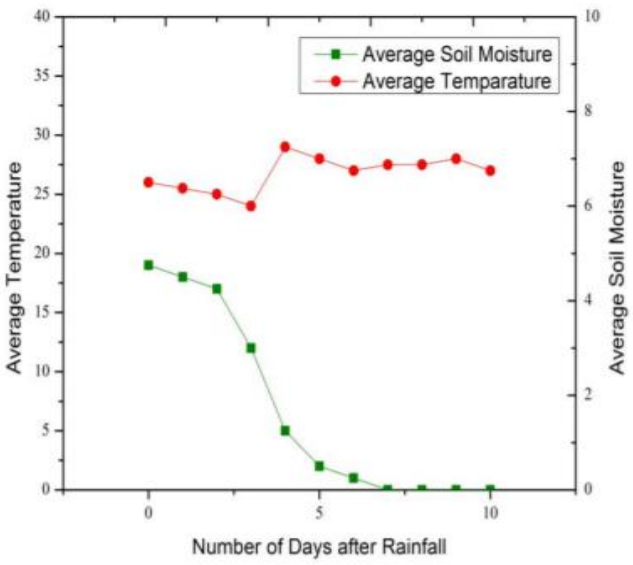
Management of Crop Water

Water is a necessary resource for agricultural production. All agricultural activities rely on a steady supply of water. As a result, the farmer must guarantee that the crops receive an adequate supply of water. To ensure enough water supply for agriculture irrigation, this approach employs the Web Map Service (WMS) and the Sensor Observation Service (SOS). As a result, this IoT lowers water waste.

RESULTS

The graph below depicts the change in temperature and soil moisture as the number of days of rainfall increases. In the study, an Arduino mega 2560 is employed. The soil temperature is measured using a DS18B20 sensor. A soil moisture sensor is also used to measure soil moisture. According to the results of the analysis, when the temperature rises, the soil moisture drops.

DS18B20 sensor



IOT SENSORS FOR SMART AGRICULTURE:

- GPS satellite signals are used by location sensors to determine latitude, longitude, and altitude to within a few feet. It is necessary to install three location sensors in order to triangulate the position.
- The clay, organic matter, and moisture content of the soil are measured using optical sensors. These sensors are typically attached to drones.
- Electrochemical sensors give critical information regarding soil pH and nutrient levels.
- To determine the mechanical resistances of the soil, mechanical sensors are utilized.
- Temperature, moisture, and soil salinity are all monitored by parrot sensors. The data is sent to the farmers' cell phones.
- Spruce is a sensor gadget that is used to regulate irrigation. The data is kept on a cloud server, and the user may access it at any time and from any location.
- Koubachi is a tool for watering plants in the garden. It functions as a node that collects data from various sensors such as air temperature, soil moisture, sunlight, and so on.
- The dielectric constant is used by a dielectric soil moisture sensor to determine the moisture level of the soil.

IMPORTANCE OF IOT IN SMART AGRICULTURE

The use of the Internet of Things in agriculture, as in other industries, offers hitherto unattainable efficiency, resource and expense reduction, automation, and data-driven operations. However, in agriculture, these advantages do not operate as enhancements, but rather as remedies for the entire business, which is confronted with a variety of severe challenges.

- Exceptional efficiency: Agriculture is a race these days. Farmers must produce more commodities in the face of failing soil, less land availability, and increased weather unpredictability. Farmers may use IoT-enabled agriculture to monitor their products and conditions in real time. They get insights fast, can anticipate issues before they emerge, and make intelligent decisions on how to avoid them. Furthermore, IoT technology in agriculture allows for automation such as demand-based watering, fertilisation, and robotic harvesting.
- Expansion: By the year 9 billion, cities will house 70% of the world's population. IoT-based greenhouses and hydroponic systems provide short food supply chains that should be able to feed the world. Smart closed-cycle agricultural systems enable food to be grown virtually anywhere—in supermarkets, on building walls and rooftops, in shipping containers, and, of course, in everyone's home.
- Reduced resources: Many ag IoT solutions are focused on optimising resource use—water, energy, and land. Precision farming with IoT is based on data received from various sensors in the field, which allows farmers to precisely distribute exactly enough resources to within one plant.
- Cleaner process: IoT-based precision farming solutions not only help farmers save water and energy, making farming greener, but they also dramatically reduce the usage of pesticides and fertiliser. When compared to typical farming practises, this strategy yields a cleaner and more organic end product.
- Agility: One of the advantages of adopting IoT in agriculture is that processes become more agile. Farmers can immediately respond to any significant change in weather, humidity, air quality, or the health of each crop or soil in the field thanks to real-time monitoring and forecast systems. In the face of significant weather fluctuations, new capabilities assist agriculture experts in saving crops.
- Product quality has improved as a result of data-driven agriculture, which enables farmers to grow more and better products. Farmers may better grasp the precise connections between weather and crop quality by using soil and crop sensors, aerial drone surveillance, and farm mapping. They can reproduce the optimum circumstances and improve the nutritional content of the items by using linked systems.

CONCLUSIONS

The suggested paper has explored the role of IoT in agriculture. This article examines several IoT-supported technologies as well as IoT applications in smart agriculture. This study discusses the advantages of IoT in agriculture. IoT is a new idea in the world, and a thorough knowledge of its principles is more important than ever. This article provides farmers with quick advice in boosting agricultural

production and taking effective agricultural care. All of the apps described above have a 98 percent accuracy rate. This can assist farmers in increasing agricultural output and, as a result, improve the nation's well-being.

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