Original Article

ECO-FRIENDLY GREEN CLOUD STRUCTURE WITH INTERNET OF THINGS FOR ASTUTE AGRICULTURE

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Abstract

Astute agriculture has been altered by the Internet of Things (IoT), which has increased efficiency and reduced production costs while improving productivity and optimizing resource utilization. This article discusses the future of automation and the use of sensors and IoT in greenhouse farming. Various factors such as humidity, the potential of hydrogen (pH) and electrochemical value, temperature, ultraviolet (UV) light intensity, and carbon dioxide (CO2) level are recorded using a range of sensors to offer important insight into early defect identification and diagnosis. Fog computing is an emerging computing technology for enhancing and supporting cloud computing. Fog computing platforms include a variety of properties that allow them to offer services to users more rapidly and enhance the Quality of Service (QoS) of IoT devices, such as proximity to edge users, openness, and mobility support. Consequently, it's becoming an important approach for user-centered IoT-based apps. A Decision Support System (DSS) in the Fog layer described in this article is the entire operating system that supervises and oversees all activities. We offer an energy-aware allocation technique for deploying application modules (tasks) on Fog devices and an appropriate Green home management system based on Machine learning. The suggested method's simulation is assessed using several performance measures. The results reveal that the suggested machine learning approach in the Fog IoT environment is more efficient than the other energy conservation and greenhouse gas management methods.

Index Terms: IoT, Fog Computing, Astute Farming, greenhouse.

1. Introduction

Agriculture has seen various revolutions throughout the years, whether it be the growth of modern agriculture or an improvement in agricultural practices. Agriculture technical improvements have driven the green revolution movement. Farmers have had the opportunity to learn about and use scientific agricultural methods, minimizing the demand for human labour and embracing technology due to the Green Revolution [2]. Greenhouse farming has emerged as the key to Astute and sustainable agriculture because of its dependence on data. Data-centric farming has changed agriculture by making it more precise and accurate, consolidating the whole agricultural process. A variety of little agricultural techniques endanger the growth and nourishment of plants. Farmers encounter challenges throughout the production process, such as labour availability, disease diagnostic accuracy, irrigation interval decision-making, and feeding the plants the appropriate quantity of nutrients and pesticides. Environmental elements such as humidity, soil moisture, CO2 level, and so on significantly impact plant development [1].

It isn't easy to monitor and modify all variables in an open environment. On the other hand, greenhouse farming is an effective alternative strategy for increasing crop yield and balancing the factors. This protected cultivation technique starts with seedlings, saplings, plantations, etc. Plants grow nearly twice as fast under greenhouse cultivation as they do in the field. Plants grown in greenhouses have a variety of challenges, including the optimal balance of nutrients available to the plant, variable temperatures and humidity, adequate soil and moisture monitoring, disease detection and prevention, and frequent data collecting.

With the help of distributed architectures, IoT provides an effective approach to linking many Astute and embedded devices, offering new alternatives to construct new applications without limits. One well-known concern in the agricultural business is providing farmers with accurate information timely so they may make better-informed decisions about their investments. Fog computing is a distributed platform that delivers execution, storage, and communication services to IoT devices and the Cloud computing storage area. The fog layer is now recognized as a major extension of the cloud since it provides several supportive and helpful properties, such as edge position, position awareness, and small reaction latency. The Fog's major aim was to give services to end-user devices such as real-time apps. This article suggests an IoT Fog-based infrastructure as a viable solution to the problems. The idea aims to lessen the demand for labour while increasing agricultural automation.

Fog devices are inefficient in energy consumption compared to cloud data centers. This is cause for worry, particularly for prospective battery-powered fog nodes like automobiles, portable laptops, and mobile phones. As a node operates faster, the battery drains faster. When a fog node's battery level approaches zero, it can no longer deliver services and is termed a failure. Failure of a node reduces total fog availability and may cause further delays, ultimately violating the service-level agreement (SLA) of extremely low-latency applications. The energy usage in access and edge network segments will surely increase as the need for fog computing grows. This motivated us to propose a DSS-enabled fog computing platform in this study. Our objective in creating a fully automated Astute agriculture system for greenhouse farming is to enhance output while reducing the need for manual labour. Appropriate criteria such as application kinds, user mobility, and energy efficiency should be addressed to accomplish optimal scheduling and resource allocation in a Fog-enabled IoT system. As a result, the scheduling strategy should specify whether apps or tasks are offloaded to the Fog or the Cloud. It also decides the priority of application execution at a certain Fog instance based on the latency limitations. Furthermore, the scheduling strategy should consider diverse circumstances of application task execution while keeping the key goals in mind [4].

2. Related work

Crop yield forecasting is a binding obligation for decision-makers at the national and regional levels (including the EU) to make rapid judgments. An accurate crop production projection model may help farmers decide what to plant and when to sow it. Crop yield may be predicted in several ways. This review article investigated the literature on agricultural yield prediction using machine learning.

Review research on the application of machine learning to assess nitrogen status[5] concludes that fast advances in ML and sensing technologies will lead to cost-effective agricultural solutions.[6] offers an overview of IoT-based irrigation solutions for agricultural systems. Their review study looks at the most often observed factors that describe water quality for irrigation, soil, and weather conditions, as well as wireless technologies, sensor nodes, and IoT systems.[7] suggests evaluating monitoring and control options for precision irrigation systems. The authors provide fresh insights into how current monitoring and sophisticated control systems might be enhanced to achieve precision irrigation for better food safety and water saving.[8] identifies and debates IoT technologies, methodologies, and future research for Astute agriculture and key agricultural applications. These studies included a detailed examination of Astute agricultural monitoring in both simulated and real-world settings.

Using three wireless technologies—IEEE 802.11g (Wi-Fi 2.4 GHz), IEEE 802.15.4 (ZigBee), and Long Range Wireless Area Network (LoRaWAN) [9], an experimental evaluation of IoT devices with energy harvesting capabilities will be carried out. They emphasize that the study's findings may be used to inform the selection of a wireless technology to be implemented into an energy-harvesting agricultural monitoring system. Their study does not mention the IoT software used for Astute agricultural monitoring. In contrast to countless research on intelligent agriculture, few studies on corn crops have been published in the literature.[10] developed a 3D mathematical model for corn tempering drying by considering the thermo-physical variability of different components in maize kernels. There is no indication of an integrated architecture.

To implement Astute irrigation systems, a LoRaWAN plus fog computing architectural model [11] has been proposed. To decide when to irrigate, the suggested system incorporates IoT nodes that connect with adjacent fog computing nodes and a distant cloud. A mechanism for local data storage and tracking has not been proposed. Cloud computing, according to their research, is more expensive. The research in the literature also identified applications for graphical monitoring.

On Windows platforms, a graphical user interface programme for multiracial analysis of soil and plant structures is available [12]. For fertilization scheduling in olive orchards using reclaimed water, Alcaide developed a user-friendly mobile application called REUTIVAR-App [13]. Their research monitors a daily real-time irrigation and fertilization plan suggestion at the farm size. The study, however, made no mention of IoT applications. A framework for gathering, assessing, and displaying sensor data in Astute agricultural applications has been designed[14]. Create a low-cost hardware and software idea to monitor environmental factors in chicken farms [15]. Numerous tests are also performed to compare the proposed prototype to everyday items.

[16] describes an adaptive network strategy for an Astute farm system that uses the LoRaWAN and IEEE 802.11ac protocols. The LoRaWAN protocol is used to transmit sensor data that is tiny in size and low in energy. The video data in their investigation is communicated via the IEEE 802.11ac protocol, which offers a faster data rate than LoRaWAN.To accomplish long-term and inexpensive monitoring [17], a model for soil environment monitoring systems based on RFID sensors and LoRa has been created. The temperature, moisture content, and chloride ion concentration of the soil are all measured by this device. The research in the literature also recommended new algorithms for intelligent farm monitoring.

The Optimized Method of Sensor Node Deployment for Agricultural (OASNDFA) is an agricultural intelligence monitoring algorithm developed in [18]. It is based on an optimal hypothesis for sensor nodes in agricultural areas that are not essential. Environmental concerns like those seen in hilly areas make selecting node sites difficult. A mathematical model for node location selection is offered, and the suggested approach assists in discovering the optimal placements of the nodes.

The dynamic converge cast tree method (DCTA), based on tree topology, was developed in[19] as a novel approach for monitoring agricultural goods and addressing complex dynamic topology issues. DCTA is used in the monitoring system with the help of wireless sensor network (WSN) technology. Thanks to DCTA, which also provides high data transfer between nodes, better data for monitoring plant development is available.

[20] A strategy for distributed Bayesian localization based on RSSI (Received Signal Strength Indicator) was suggested. Their method minimizes computer complexity while reducing transmission overhead.[21] proposed a technique for automating irrigation using interconnected systems. The software employs the energy-efficient

Equalized Cluster Head Election Routing Protocol (ECHERP) for sensor mobility. An IoT-based Astute irrigation solution was developed, consisting of environmental sensors, online services, and IoT devices. The recommended method for the sensor network produced good results. The purpose of fog computing is to allow mobile devices to do computationally intensive tasks at the network edge. The benefits of fog computing include closeness to end users, location awareness, low latency, and mobility assistance.

[22] proposes a multimodal generative adversarial network improve cloud classification accuracy and IoT energy efficiency. The findings are confirmed using the multimodal cloud dataset. [23] describes how to offload transmission to prolong battery life by constructing a spectrum energy-efficient transmission system with efficient processing in cloud IoT. It increases the performance of power amplifier offloading in IoT networks.

End-to-end energy models for edge cloud-based IoT systems are offered in [24], where the energy consumption of IoT platforms is analyzed. This model is validated by analyzing the video stream from car cameras. Network architecture for the Internet of Things that solves the problem of congestion in wireless networks. Network resiliency is improved in tandem with ubiquitous, low-cost mobile device connection.

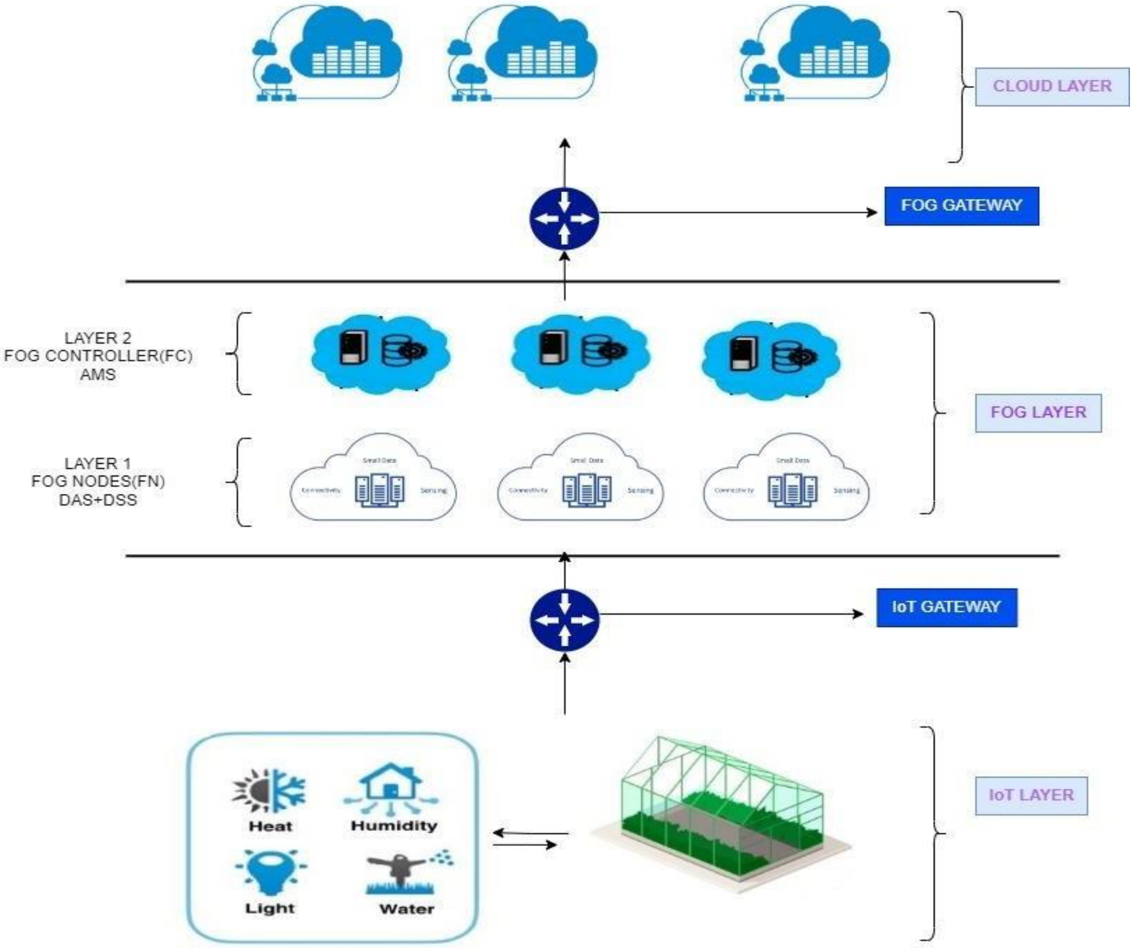
[26] proposes a method for enhancing energy efficiency in real-time for enterprises engaged in energy-intensive manufacturing. A workshop case study is used to demonstrate the practicality of a developed model. This idea might be expanded upon in a real-world workshop. ENZYME is proposed to increase the energy efficiency of self-propelled IoT edge devices. Experiment results show that a regular handler may help you save 8.8% of your energy. Furthermore, ENZYME may spend 35.71% more energy with a frequency modulator by including a router handler.

The resource allocation of the hierarchical Fog-cloud computing paradigm was described in [24]. The objective is to maximize experience quality (QoE). A strategy for achieving equilibrium is proposed. In addition, a near-optimal resource allocation system is suggested.

Researchers suggested a paradigm for energy-efficient fog computing in homogeneous fog networks. The energy-efficient task scheduling (MEETS) method is proposed as a solution to a problem aimed at optimizing energy efficiency for job scheduling. The results demonstrate that the proposed scheduling technique works. QoS-aware resource management technique ROUTER to use a cloud computing environment helped by fog. The proposed approach is tested using the iFogSim toolbox. Proper regulation of environmental temperature, humidity, soil and environmental wetness, CO2 level, water level, and UV light density are the essential parameters that influence how effectively plants and flowers flourish in a greenhouse. Along with these aspects, the proper distribution of nutrients, fertilizers, and treatments, as well as the visual evaluation of the health of the leaf and flower, are critical to the plant's wellness and production. Some of the challenges involved with monitoring and maintaining these parameters include the right computation of temperature and humidity values, precise monitoring of the soil and its moisture, information collecting at regular intervals, and so on. These operations must be automated to the greatest extent possible to address the difficulties mentioned above. To accomplish this, we propose an IoT fog-based architecture as a tool for automated greenhouse farming. The proposed framework may help plants grow in a pleasant environment by allowing soil monitoring, automated environment optimization, appropriate watering, real-time issue detection, reduced harvest failure, remote controlling and management, and a reduction in operating expenses. The suggested framework is conceptually separated into three elements: Layer of IoT: IoT sensors create massive volumes of heterogeneous data for gateways by using several sensors put in various agricultural areas. This layer may also receive a decision from a control actuator, such as turning on or off the irrigation system [14]. In Astute agriculture, several IoT sensor nodes detect a wide range of phenomena in urban settings, including but not limited to soil pH, temperature, moisture, electrical conductivity, and ambient temperature [15]. This layer collects millions of data points from many sources. Thanks to the Internet of Things, people and objects can connect globally across space and time. Several IoT-layer sensors are used to collect data about greenhouse farming. These data are then shared with the next layer, the Fog layer, for effective data processing and resource management. Fog layer: To minimize latency for agricultural applications and services, the fog layer must process and evaluate IoT sensor data. This stratum has three different systems. Data Acquisition System (DAS): collects real-time data from sensors in the IoT layer. 2) Decision Support System (DSS): A decision support system manages and monitors resources. 3)

Central Actuator Manager (CAM): A collection of tools used in the greenhouse to carry out different operations controlled by a set of actuators. The cloud computing sector is critical to the development of IoT agricultural applications. Scalable on-demand computing resources and services, such as storage, networking, and computing, are available. When agricultural data is received from the sensor or fog layers, it is processed, analyzed, and stored in the cloud by the cloud layer. Cloud computing can handle and analyze massive volumes of data.

Fig. 1 Architecture of IoT based on fog Skillful greenhouse agriculture



In the DAS, an automated system must handle every deviation instantly. For example, if the CO2 level exceeds the higher limit (900 ppm), the ventilators must be opened, and if the CO2 level falls below the lower limit (800 ppm), the CO2 cylinder must be turned on. Similarly, when the light intensity is not within the range of 440lx - 670lx, the greenhouse's rooftop cover can be uncovered or covered, and the dehumidifier can be set on / off when the ground humidity is not within the range of 55% - 65%, the warm air is activated when the temperature falls below 17C. The air cooler may be activated when the temperature rises above 28C. If an abnormality is recognized in a greenhouse plant, relevant measures will be handled using various machine-learning approaches. A classifier based on the Support Vector Machine (SVM) method detects any variation in greenhouse plants. Thirty percent of the data is utilized for testing, while 70% is used for training. Based on the training data,

Overall classification accuracy was 91%, and on test data, it was 85%. As a consequence, different greenhouse farming equipment will be activated on time. After collecting data from sensors and using machine learning algorithms, the DSS advises the optimal course of action. The DSS will respond appropriately. After receiving the data, the DAS sends it to the DSS. In addition, the DSS employs an actuator management system to analyze data and take appropriate action.The DSS is the primary platform for our proposed IoT Fog-based Astute greenhouse farming paradigm. The proposed model consists of six major components, all of which are regulated by the DSS: the rule-based engine, the CAM, the machine learning models, the experts or agronomists, greenhouse employees, and the data repository. In this case, the DSS functions as both a resource optimizer and a resource allocator. The rule-based engine receives data from the data server regularly. If the data received is routine data for which the DSS has established rules, the DSS will deliver the CAM instructions by those rules. For example, starting the dehumidifier when the humidity level exceeds the threshold or starting the water pump when the water level falls below the set range. A temperature change, a diseased flower or leaf, or any other irregular condition for which no established preset standards may be instances of non-regular data. These data are given to a machine learning module to get the required response. However, the machine learning module may not always be able to deliver a solution (for a new disease or climate change). In this case, the data is immediately provided to an expert or agronomist who utilizes the data from the repository and the DSS information to determine the best course of action. The DSS is a service provider in this scenario. After receiving the command, the CAM activates the appropriate actuator to act. Furthermore, using data from optical sensors, the DSS analyses and prescribes the right quantity and interval of providing water, nutrients, and pesticides to greenhouse plants. The expert or agronomist establishes the right nutrient ratio by considering the plant's health, environment, quality of the soil, temperature, humidity, and any plant illnesses (if any). The settings in the greenhouse may be manually set using the dashboard depending on the user's needs. It should be emphasized that the medications will not be sprayed over all of the plants; rather, they will only be sprayed over the plant diagnosed with the illness and the plants within a radial radius of 1m. The following approach alleviates the conventional difficulty of covering all plants and aids in administering medications at the required intervals. The DSS also offers an interface for communication and engagement with human actors such as greenhouse employees, supervisors, and specialists as needed through Astutephone notifications and SMS. The supervisor also uses the optical CMOS magnifier to examine the present state of a plant or surrounding plants. The row and column values of the plant are entered into the magnifier, which assists in viewing and monitoring the plant's state. The supervisor monitors the status of all sensors and actuators in real-time using an interactive interface to a dashboard on a screen. The supervisor may need to make decisions such as changing the status of certain actuators or determining how much insecticide or pesticide to dispense on occasion. However, certain ground activities, such as planting, weeding grass, bending, cleaning, de-budding, loosening the soil, and so on, need human participation, even if greenhouse farming automation requires less human labor. Greenhouse employees do these tasks. Some of these tasks must be completed regularly. In contrast, others are triggered by an occurrence (such as unwanted grass being observed by a visual sensor and grass cutting task needing to be activated). The DSS controls, schedules, and actively monitors the duties of greenhouse personnel. The DSS provides the remainder, and the greenhouse supervisor updates the DSS regularly. The DSS also acts as a communication and engagement interface with human actors such as greenhouse employees, supervisors, and specialists.To automate the equipment, received parameters such as water level, CO2, mister, humidity, temperature, and UV light are linked to individual actuators for each activity. In addition, all actuators are linked to a Central Actuator Manager (CAM) (Refer to Fig. 3). The CAM receives DSS instructions and acts on them by activating, deactivating, or managing the actuators. If a disease is diagnosed, action is performed promptly. This action might be a previously established rule-based action, ii) an action proposed by machine learning models, or iii) expert advice (expert advice is recorded in the repository). In rule-based action, the CAM automatically activates or deactivates the actuator depending on the rules established by the DSS or the agronomist. In the event of expert guidance, the choice of which actuators to activate is made after examining DSS recommendations, prior results in comparable scenarios, and the manager's expertise. This dashboard also allows you to manage the mister and dehumidifier (start/stop). The dashboard also displays the number of nutrients and water recommended by DSS. Using the optical CMOS magnifier also aids in evaluating the present state of a plant or surrounding plants. The magnifier takes the values of the plant's row and column as input and visualizes the plant's state. The dashboard accepts various inputs and, upon clicking the submit button, performs the appropriate adjustments and sends the data to the repository for future use. Once there is enough labeled data, the agronomist will use a machine learning method to improve the accuracy of the findings. This section proposes a novel framework for effectively monitoring and supervising Farming in a greenhouse. Sensors, Internet of Things (IoT) devices, mobile apps, machine learning, and fog computing technologies have all been implemented in large numbers. We aim to create an automated greenhouse farming system to reduce human labour while increasing total productivity. In this examination, Astute, sustainable, and data-centric techniques are contrasted with the traditional approach. We used a variety of sensors to gather data from the greenhouse, as described in section 2's recommended method parts. The proposed IoT-based system covers resource allocation, resource optimization, operational coordination, time management, human effort management, data gathering, and data-driven decision-making.

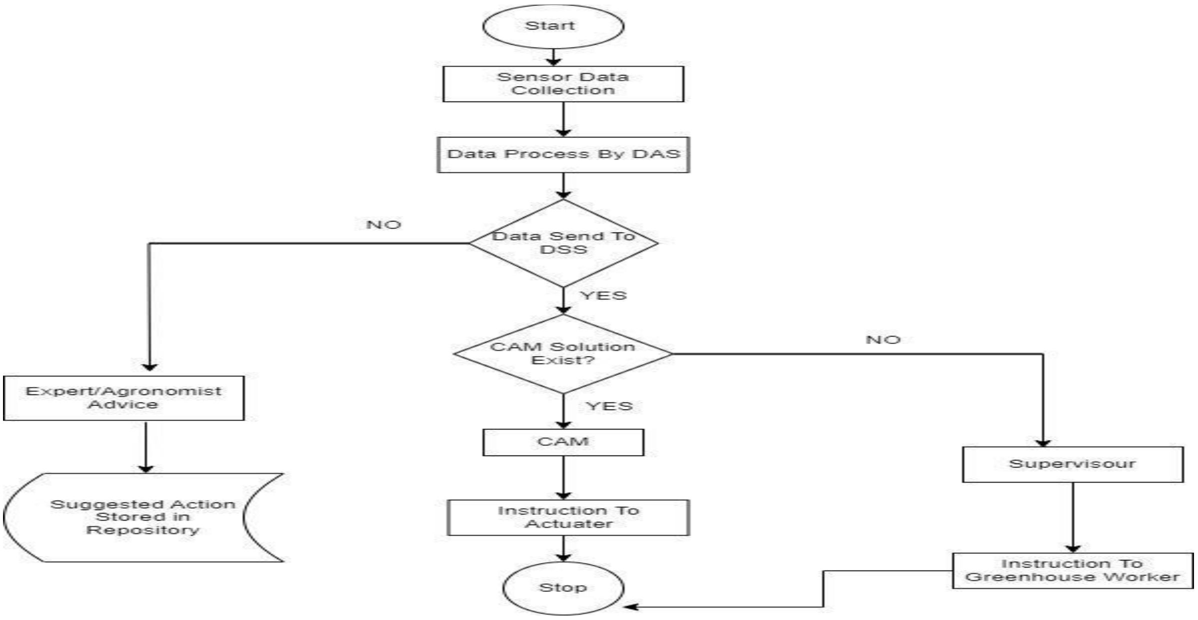
1. Uno Arduino: This board [24] features Wi-Fi, Ethernet, a USB port, micro-SD card capacity, and three reset catches in addition to an MCU ATMega 32u4 with Arduino compatibility. By connecting to an Atheros AR9331, this board can also run Linux.

2. Humidity sensor DHT11/DHT22: It is a sensor for moisture and humidity. It is used to monitor the amounts of moisture and humidity on land continually. The Arduino Uno is utilized to save the data collected in the cloud [25].

3. The YL-69 soil moisture sensor monitors the quantity of water in the soil. It is commonly used in agriculture, water management, greenhouses, and other research institutions that need precise estimates of soil water content. It is divided into two sections: an electrical board containing the hardware and a test that detects how humid the soil is. For the e-sensor to operate, a potential distinction directly related to the dielectric permittivity of water is created. Voltage fluctuations may be read as dielectric permittivity changes, hence water level changes [26].

4. Camera: A cropped photo is taken and sent to cloud storage using an IoT Arduino Uno device. [28]. The fog devices will be assigned to the application. The primary goal is installing the program on fog devices that use the least energy.

Fig 2 IoT fog-based astute greenhouse farming flow chart



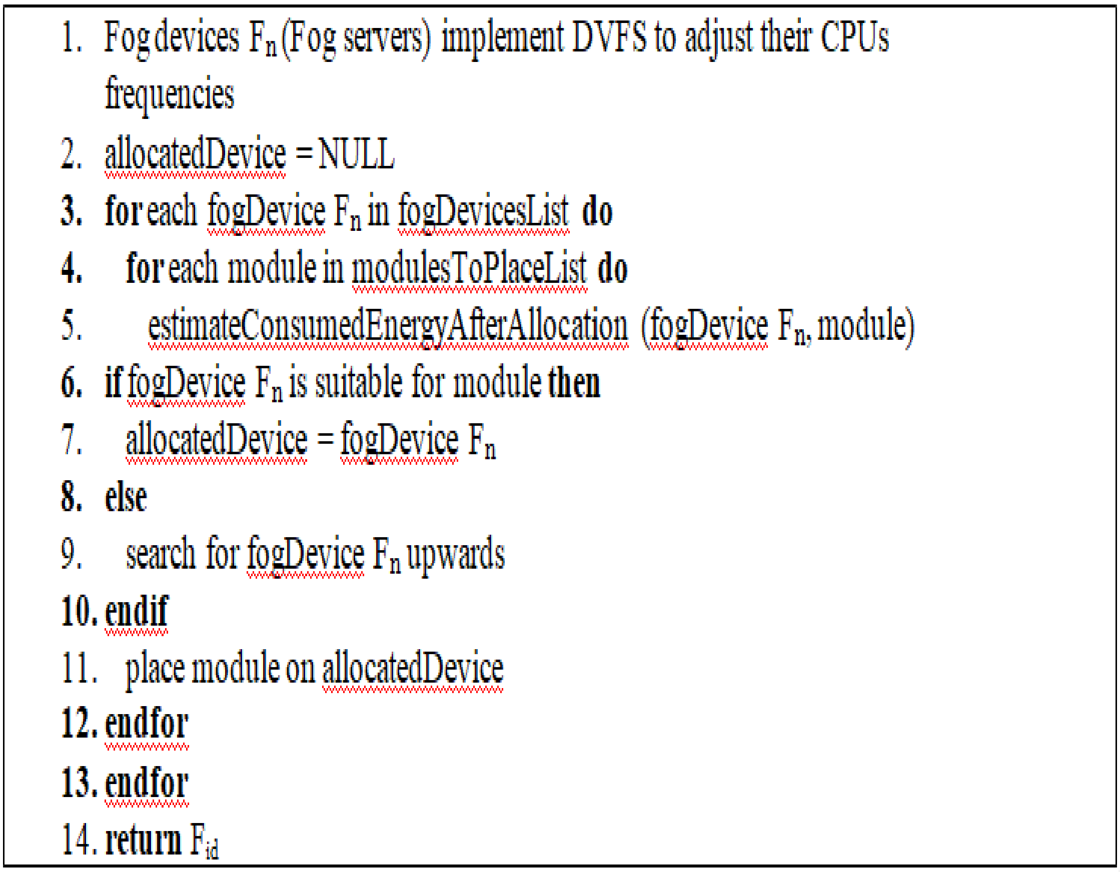
5. Cloud storage: All crop-related photos are uploaded to the cloud and analyzed using an SVM classifier. Furthermore, soil data is being kept in the cloud for future K-means classifier research. Crop diseases are identified using the SVM classification approach. Crop-related photos are collected and uploaded to the cloud using cameras and an Arduino Uno. Following that, feature extraction and image preparation are performed. Following that, the SVM algorithm is employed to categorize these images. Because the system also possesses soil information for a certain form, the sickness is projected using a previously accessible training data set. Based on the damage

observed and the soil condition, the algorithm then advises the kind and dose of pesticides that may be used to avoid harm.

6. Mobile application: Farmers may access the findings through a mobile application. Farmers will sign up for an Astutephone application to provide information about their property and crops. We have also presented energy-aware allocation approaches using an effective crop monitoring system. This section will provide an efficient way to convert energy in fog nodes. Assume there is Fn number of fog nodes present, where n=1,2,...f. Sensors in greenhouse settings generate an Al number of applications where l=1,2,...a. The green home application will be allocated using our suggested strategy depending on the remaining CPU capacity and energy use. DVFs method may be used to calculate energy

4.1 Result and analysis

The suggested automation system was prototyped in a 1000-square-foot area of the original 2.5-acre greenhouse. A whole year's worth of results is analyzed. The numerous costs (c) associated with a greenhouse rose plantation may be divided into labour costs, hardware installation costs for automation, recurring costs for maintenance, and continuing expenditures for periodic check-ups. This leads us to the following conclusion: The proposed IoT-based fog computing system dramatically reduces labour expenses by automating multiple operational units. ii) In contrast to the conventional method, the hardware installation costs for the proposed IoT-based fog computing framework are almost nonexistent. However, this expenditure is simply one-time in nature.



```
Fog devices $F_n$ (Fog servers) implement DVFS to adjust their CPUs frequencies
allocatedDevice = NULL
for each fogDevice $F_n$ in fogDevicesList do
  for each module in modulesToPlaceList do
    estimateConsumedEnergyAfterAllocation (fogDevice $F_n$, module)
if fogDevice $F_n$ is suitable for module then
  allocatedDevice = fogDevice $F_n$
else
  search for fogDevice $F_n$ upwards
endif
  place module on allocatedDevice
endfor
endfor
return $F_{id}$
```

iii) The proposed IoT-based fog computing technology has substantially lower costs than its alternative for the last three expenditures, such as regular periodic inspection, maintenance, and recurring costs. As a consequence, compared to the cost of a straightforward solution, the recommended IoT-based fog computing architecture is much cheaper over time. Even though it periodically requires maintenance, the recommended IoT-based fog computing system's total cost is far lower than the current strategy, which depends on human labour. Results of predictions

The following is the concept and procedure for forecasting accuracy:

As TP (true positive) is found, the pattern intensifies and is seen as intensifying (fruit production increased). The rate falls and is categorized as declining when it is found to be TN (true negative) (fruit production decreased). False positives (FP) are situations in which a trend is dropping but is seen to be increasing, while false negatives (FN) are situations in which a trend is rising but is perceived to be decreasing [39].

Recall = (TP) (TP) + (FN)

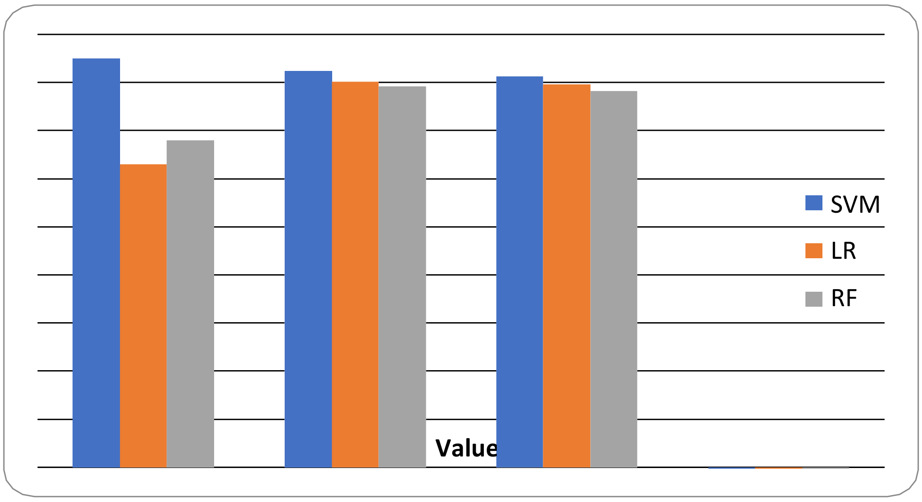
Precision = (TP) (TP) + (FP)

Accuracy = (TP) + (TN) (TP) + (FP) + (FN) + (TN)

F1 Score = 2 ∗ (Precision ∗ Recall) (Precision + Recall)

Algorithm	Accuracy (%)	Recall	F-Measure	Precision (%)
SVM	96	92.48	94.65	94.69±3%
RF	78	91.57	89.39	92.77 ±2%
LR	73	92.27	91.68	92.87 ±4%

Figure 3. Predicted values of several models.



The F-measure, recall, precision, and anticipated accuracy of several techniques are shown in Figure 3. SVM, among them, offers decent accuracy.

Comparative Chart

This section compares the current trivial technique with the fog-enabled greenhouse framework. In this comparison matrix, factors including energy use, price, network BW, and accuracy are taken into account.

Comparison Graph

This section compares the current trivial technique with the fog-enabled greenhouse framework. In this comparison matrix, factors including energy use, price, network BW, and accuracy are taken into account.

Figure 4 Energy consumption values of different models.

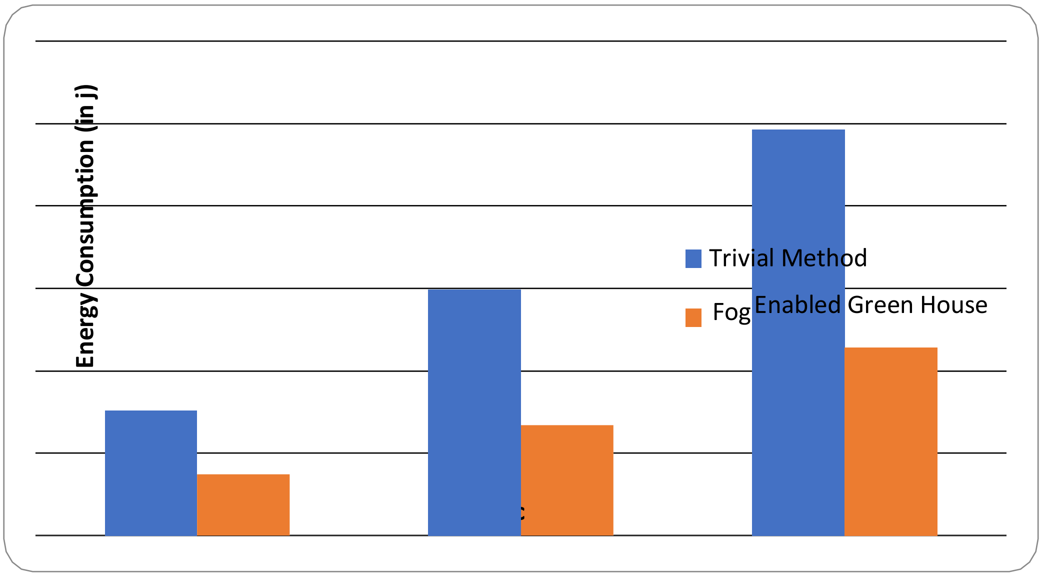
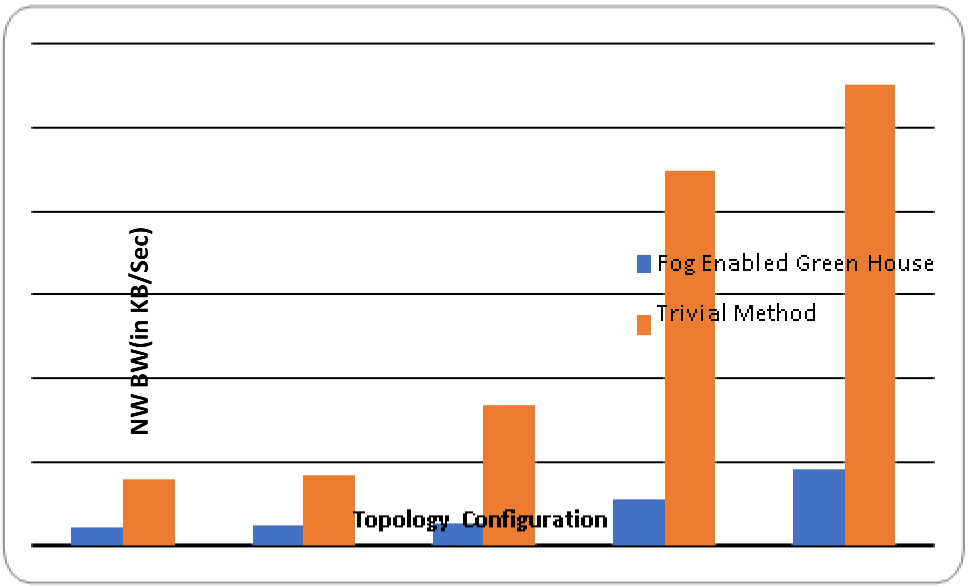


Figure 4 depicts the energy consumption value of the previously utilized simple approach in conjunction with a fog-enabled greenhouse. It demonstrates that the SVM machine learning approach reduces total energy usage in the Fog-enabled green home framework.

Figure 5 Network Bandwidth uses values of different models.



In general, fog computing leads to fewer data being carried over the network. This reduction is due to relocating the bulk of application modules to the network edge, which removes the need for a cloud connection. Consequently, a Fog-enabled application scenario consumes fewer network resources than a straightforward method. Figure 5 depicts network usage, which shows that for various configurations, the Fog-enabled greenhouse framework produces superior results in terms of network BW.

Figure 6 Estimated Costs

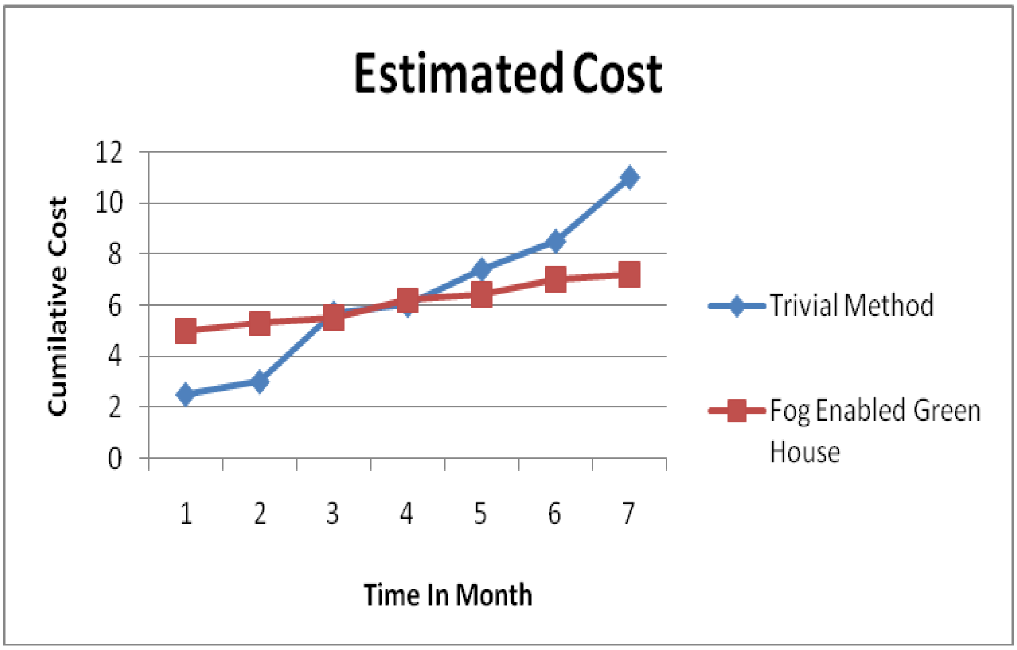


Figure 6 depicts the total cost and the cost of a basic and fog-enabled approach. It illustrates that the proposed IoT-based architecture is much less expensive than the basic alternative. Even though the suggested IoT-based approach occasionally requires maintenance, the total cost is substantially cheaper than the ineffectual alternative employing human labour.

Figure 7 Accuracy comparison

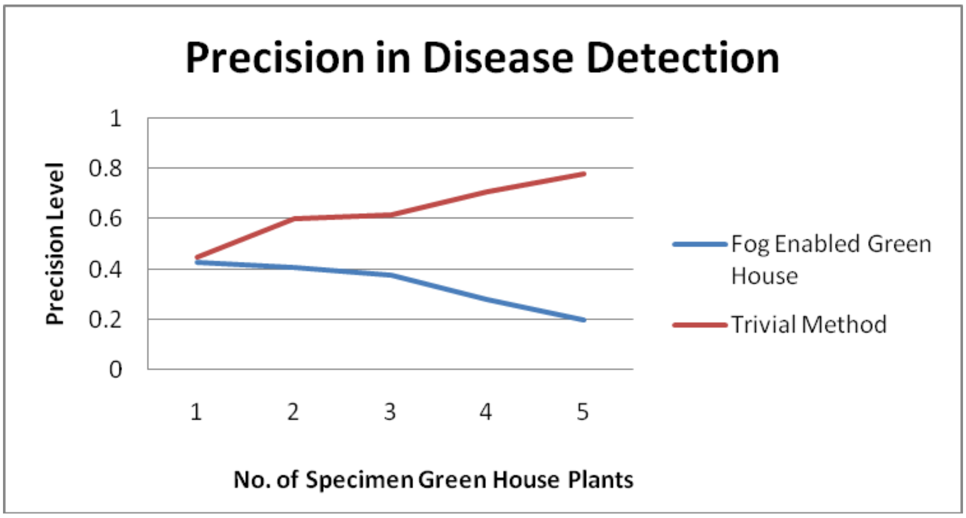


Figure 7 shows the accuracy of the Trivial and fog-enabled frameworks. The recommended IoT infrastructure provides improved accuracy with more samples. This is because when samples are added to the collection, the dataset becomes richer, and learning rates increase, boosting the accuracy and predictability of disease detection in greenhouse plants.

6 CONCLUSION AND FUTURE SCOPE

The main barriers to agricultural output are making choices, selecting crops, and installing supporting systems to increase agricultural productivity. Weather, soil fertility, water volume, water quality, seasons, and crop prices impact agricultural forecasting. Growing advances in agricultural automation have resulted in a massive growth in the production of instruments and software for rapid knowledge acquisition. Growers, like everyone else, are increasingly reliant on mobile devices. This study introduces a mechanism for tracking and monitoring Astute crops. A framework for agricultural disease detection is proposed. This is based on SVM classification. It diagnoses crop sickness and offers appropriate herbicides based on previously known soil data for a given spot. This research investigated the relevance of the interaction between the trivial method paradigm and fog computing to minimize latency and energy consumption. It also proposed an energy-conscious allocation technique for application module placement (tasks). The proposed solution consumes more energy and network traffic than the cloud layer.Furthermore, the suggested fog-enabled greenhouse offers greater forecast accuracy and lower total expenses than a straightforward method. The study's automated IoT-enabled system boosts greenhouse production for rose plants while minimizing wasted expenditures. The investment in these IoT devices is also not very considerable compared to the costs involved with employing manual operations. Through automation, the IoT-enabled process offers reliable information and decreases the amount of human labour necessary. It reduces the time and effort required to gather, analyze, and calculate accuracy percentages. With today's technology, new approaches for establishing a sustainable field or greenhouse are considerably better and more readily accessible. MyGreen may be linked to other eco-friendly Internet of Things (IoT) technologies to help build Astute cities and Astute villages.

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