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Smart Farming System Based On Internet of Things (IoT) For Precision Controlled Greenhouse Management

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Abstract. Smart farming with accurate greenhouses need to be implemented for better agricultural growth management, and therefore precision agriculture monitoring in diverse conditions is required. The Internet of Things (IoT) is a new era in computer communication that is gaining traction due to its vast range of applications in project development. The Internet of Things (IoT) provides individuals with smart and remote approaches, such as smart agriculture, smart environment, smart security, and smart cities. These are the new technology that are making things easier these days. The Internet of Items (IoT) has fundamentally expanded remote distance control and the diversity of networked things or devices, which is an intriguing element. The Internet of Things (IoT) comprises the hardware as well as the internet connectivity to the real-time application. Sensors, actuators, embedded systems, and an internet connection are the key components of the Internet of Things. As a result, we're interested in creating a smart farm IoT application. In greenhouse agriculture, this study presented a remote sensing of parameters and control system. The aim is to manage CO₂, soil moisture, temperature, humidity and light, with regulating actions for greenhouse windows/doors dependent on crops being carried out once a quarter throughout the year. The major goal is to properly regulate greenhouse conditions in accordance with plant requirements, in order to enhance output and provide organic farming. The outcome indicates that the greenhouse may be controlled remotely for CO₂, soil moisture, temperature, humidity and light, resulting in improved management.

Keywords: Smart Farming, Greenhouse Management, Internet of Things (IoT), Precision Farming.

1 Introduction

Plant development has proven to be an innovative test, given that the field and strength of the plants are critical parameters nowadays, whether for cash crops or food crops. One of the major difficulties in modern agriculture is the lack of knowledge about agricultural factors and information about emerging advances [1]. In the past, our ancestors avoided using a specialized development for specific plant growth, preferring instead to utilize a general wonder for all plants. Plants may be developed under unusual typical natural conditions as a result of technology advancements in agriculture, and specialized plants can be developed under specific conditions, resulting in more yield and less compost [3].

Precision agriculture in green houses for plant growth is becoming increasingly popular as a result of lower-cost technologies enabling agriculturists to re-arrive output. The greenhouse is a transparent house-like structure that can maintain a regulated temperature, needed moisture level, light infiltration, and other factors for optimal plant development. Precision agriculture is a framework for detecting, monitoring, and responding to changes in the environment. It is a technology for detecting greenhouse climate, after which the recognized data is transferred to the cloud and the agriculturist takes the necessary action based on the obtained data. This may be seen by the current breakthrough known as the Internet of Things (IoT), which is a technology that connects everything or any device to the internet via web-based approaches. In view of the novel advancement in Wireless Sensor Networks (WSN), which is nothing more than an IoT, the precise agricultural framework is moving toward improvement. Precision agriculture has recently become the most developed cultivating technology with a large framework. It includes recognizing, estimating, and communicating nursery data to ranchers in the event of a rapid shift in the greenhouse [2] [5].

A greenhouse is an arrangement with simple materials to maintain a microclimate for solid plant development, such as water stream management, directed temperature range, and so on. As a result, it avoids excessive light infiltration, extreme temperatures, diseases, and creepy crawlies, among other things. By maintaining environmental conditions, a farmer may produce any plant in any season. Going back to the areas of interest, there is the relevance of greenhouse cultivation, which demonstrates the truth of why they have become so popular. Greenhouses require a considerably smaller water supply than traditional cultivation since they trap the moisture. It shortens the editing time and broadens the types of harvests. Temperature and humidity are effectively managed in accordance with the needs of the plants. It is also possible to create slow-growing crops using nurseries. Pests may be easily managed. Harvests may be filled in a variety of environmental circumstances, making it extremely adaptable. The plants' development will be influenced by the fluctuating climatic conditions in the greenhouse, resulting in lower yield near the conclusion of the cultivation. As a result, greenhouse factors including as CO₂, soil moisture, temperature, and light must be controlled and monitored. This problem may be handled by using an Internet of Things (IoT) innovation in precision agriculture, which includes a precise application for certain greenhouse factors, such as temperature management, water flow control, light radiation, and so on, for optimal plant development [4][7][10].

2 Related work

An adaptable stage ready to adapt to soilless culture needs in full distribution nurseries utilizing tolerably saline water is proposed [1]. An exceptionally versatile perceptive framework controlling, and observing nursery temperature [2] utilizing IoT innovations is presented. Author contributes [3] towards the ongoing IoT innovations in the horticulture area, alongside the improvement of equipment and programming frameworks. An independent Fuzzy Logic Controller (FLC) with Internet of Things (IoT) abilities is created [4] for investigation and etymological dynamic about fertigation (manures + water) in a nursery. New proposition for agrarian farmland cautiousness is presented [5]. The framework utilizes Raspberry Pi board to recognize any pernicious exercises or movement in the ranch land and triggers the PiCam to take image of the scene picture. In this all-encompassing dynamic, a minimal effort, secluded, and energy-effective IoT stage for SA, indicated as VegIoT Garden, in view of Commercial-Off-The-Shelf (COTS) gadgets [6], receiving short-and long-range correspondence conventions (IEEE 802.11 and LoRa), and targeting improving the administration of vegetable nurseries through the assortment, observing, and examination of sensor information, identified with significant boundaries of developing plants (i.e., air and soil mugginess and temperature), is introduced. Contrasted with the current IoT-based horticulture and cultivating arrangements, the proposed arrangement decreases [7] network inactivity up partially. A detecting organization to assemble the field information of certain harvests (Potatoes, Tomatoes, and so on), at that point took care of these information to an AI calculation to get a notice message at long last showing both the information and the admonition message through a Graphical User Interface (GUI) [8]. The framework [9] means to build up a PC vision based mechanical weed control framework (WCS) for constant control of weeds in onion fields. An Autonomous Farming System [10] dependent on Fog processing worldview and LoRa innovation. The exploration rotates [11] around the structure and plan of a web empowered measured cultivating framework that tends to the requirement for individuals to tend vigorously on their developing harvests. RiceTalk venture [12] uses non-picture IoT gadgets to recognize rice impact. AgriTalk [13], an economical IoT stage for accuracy cultivating of soil development. They direct trials on turmeric development, which demonstrates that the turmeric quality is altogether upgraded through AgriTalk. A connection quality-arranged course (LQOR) convention [14] for versatile IoT networks is proposed. Karim et al. [15] Created and tested Cloud-IoT based late scourge choice emotionally supportive network. They introduced a choice emotionally supportive network to forestall potato sickness.

A structure that gives a framework to screen a green house, poultry and a fish tank is proposed [16]. Utilizing raspberry pi they can screen and control the climate. IoT sensors and actuators are the critical segments to screen and respond for the climate. The improvement of a portable LoRaWAN passage gadget that can be applied to expand nurseries' profitability and precision is introduced [17]. A low-power and adaptable IoT-based engineering for home ranchers and logical purposes that empowers to confirm the ecological effect on plants improvements by observing the dirt dampness and temperature is proposed [18]. Study proposed [19] a gathering frame-

work dependent on the Internet of Things innovation and keen picture acknowledgment. A MQTT convention based savvy cultivating arrangement [20] has capacity to gather information from the field atmosphere for consistent examination and furthermore to create and convey a brilliant innovation for horticulture area for improving natural and rural supportability to improve crop discernibility and to expand generally yield. The exploration work proposed has [21] the plan of a conventional IoT system for improving agribusiness yield by successfully planning water system and preparation dependent on the harvests flow necessities, natural conditions and climate figures. A sun oriented fueled brilliant farming observing framework with IoT gadgets is introduced [22]. S. Sarangi et al. have created [23] a convenient IoT stage on the edge including a versatile and a configurable sensor hub, which permits us to locally address logically important detecting needs of the rancher. P. Sureephong et al. Examines [24] a prototyping of incorporated arrangement of Internet of Things based wetting front locator (IOT-WFD) which centers on how to improve the IOT based Wetting front identifier plan for brilliant water system framework.

3 Proposed work

Figure 1 depicts the exact smart farming system for greenhouses. Sensor layer, Edge layer, and Cloud layer are the three primary architectural layers. The noteworthy element of the proposed system is that it helps farmers by offering an IoT-based precision agricultural framework for greenhouse management. The goal is to provide agriculturists with field data that is remotely controlled greenhouse agricultural factors such as soil moisture, CO₂, light, and temperature from afar, and based on the soil moisture values, a controlling move for the greenhouse windows/doors to roll on/off may be made. This prevents agriculturists from physically visiting the fields.

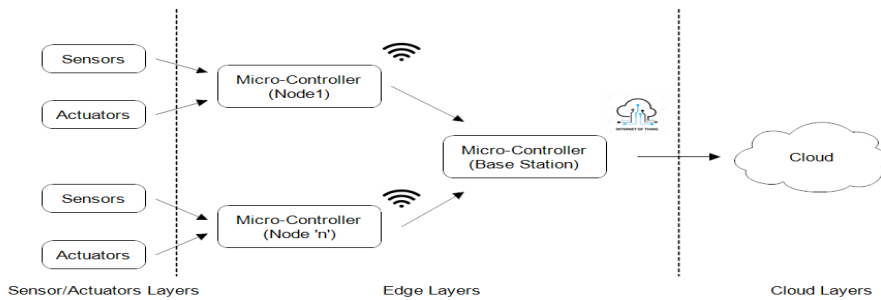


Fig. 1. Smart Farming Framework for Greenhouse Management

3.1 Sensor Layer

We chose Gerbera and Broccoli for testing in the greenhouse, which has a mostly climate-sensitive habitat. Gas sensor, dht11 sensor for temperature and humidity, light

sensor, gas sensor, and moisture sensor are the sensors used to monitor parameters in the greenhouse environment. Actuators will be chosen and deployed to regulate parameters through relay to control devices such as fans and pumps. Controlled conditions of RH, temperature, and light, protection from rains, storms, and searing sunshine, and protection from pests and diseases are all advantages of employing a greenhouse management system for such a crop.

3.2 Edge Layer

Sensors installed in the field at various locations, referred to as nodes or edges, are coupled to a low-power microcontroller suited for IoT. In our experiment, we employed a Node MCU ESP 32, which has the ability to gather and analyses data from sensors before sending it to the edge layer's base station. Sensors gather data in analogue or digital form according to specifications and must be calibrated and verified against a standard value. Data is collected for diverse climate circumstances, both healthy and unhealthy, in order to understand all conceivable environmental conditions and to make it accurate for crop management to ensure their survival.

3.3 Cloud layer

Data from each node in the edge layer, which is then processed and managed at the base station, will be visualized at the cloud layer using a user interface (UI) based application that will assist farmers in monitoring crop cultivation status.

4 Results

The suggested experimental plan is carried out on a prototype that has been thoroughly tested on various crops and farming methods. Creation of preliminary models embedded system for plant growth and nutrition, development of a sensor net for smart greenhouse monitoring, and automation for actuators are the two main phases of experimentation. The suggested system uses an embedded system to analyze greenhouse execution factors such as CO₂, soil moisture, temperature, and light for plants, resulting in realistic results. The greenhouse doors/windows may also be rolled on/off dependent on the soil moisture levels. The plant photosynthesis process need a high level of CO₂ concentration and water in the evenings, as opposed to the daytime; with the help of these two energy, the photosynthesis method maintains the plant cool and aids in rapid growth. After completing a CO₂ concentration level experiment in a green house, maintain a CO₂ level maximum at night as indicated in figure 2, since the greenhouse consumes CO₂ from daytime to nighttime. As a result, the CO₂ level throughout the day is lower, as illustrated in Figure 2.

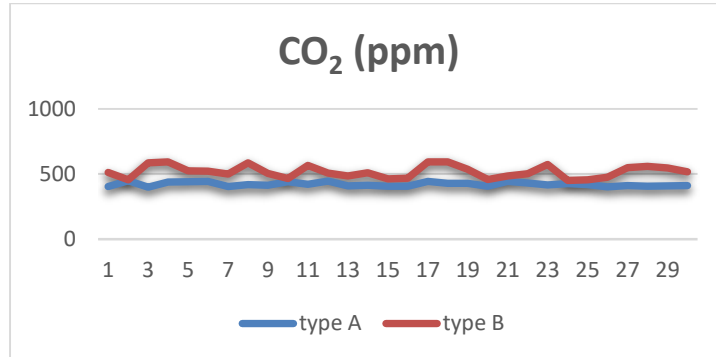


Fig. 2. CO₂ representation, daytime (type A) and nighttime (type B)

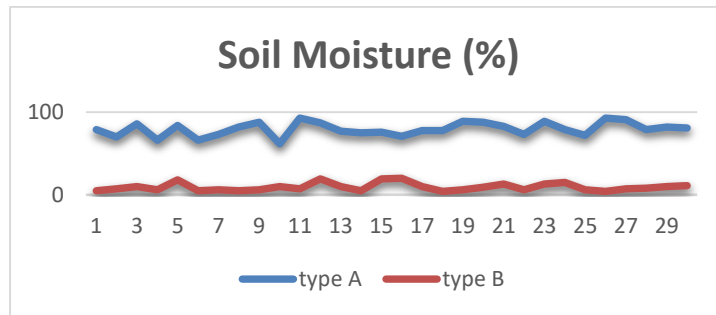


Fig. 3. Soil moisture representation, dry soil (type A) and wet soil (type B)

The amount of water in the soil is essential because too much water can create a fungal infection in the plant, while too little water causes the plant to become dry or even die. As a result, the plant's necessary quantity of water is critical. Plants require more water with CO₂ throughout the night for photosynthesis. When the soil moisture sensor returns a negative value, it implies the plants have completely covered the water, as illustrated in figure 3, and the greenhouse windows/doors will close automatically with the aid of a DC motor. The positive number indicates that the soil is dry, as illustrated in Figure 3, and that it needs to be re-wet.

One of the most essential parameters in a greenhouse is temperature; the temperature should be kept as high as possible. Because temperature aids blooming, fruiting, photosynthesis, seed germination, and other processes.

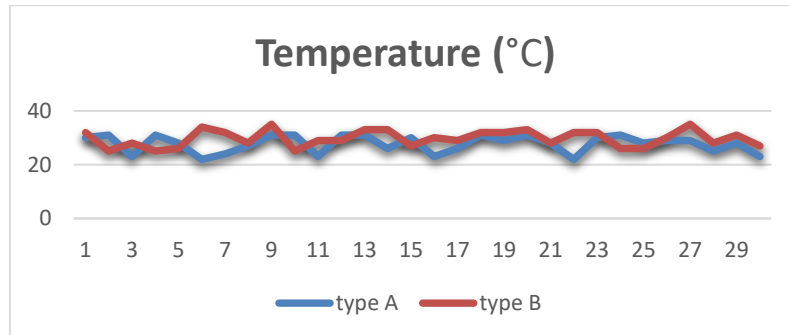


Fig. 4. Temperature Representation, outside Greenhouse (type A) and inside greenhouse (type B)

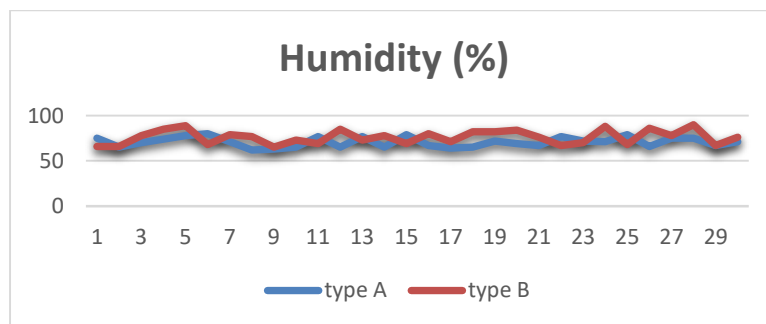


Fig. 5. Humidity Representation, outside greenhouse (type A) and inside greenhouse (type B)

As a result, the temperature and humidity range in the greenhouse was maintained to the fullest extent possible, as shown in Figure 5, in comparison to the temperature and humidity range in the outside greenhouse environment, as shown in Figure 5. The various hues of sunlight are beneficial to the photosynthetic process, which is found in the green portion of plants and is responsible for plant growth, blooming, and form.

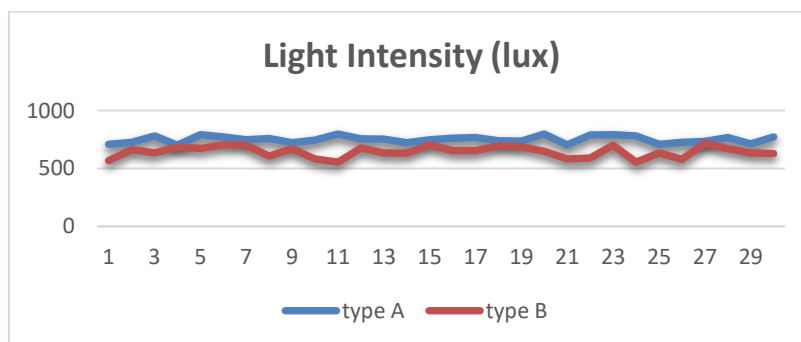


Fig. 6. Light intensity representation, outside greenhouse (type A) and inside greenhouse (type B)

As a result, as shown in Figure 6, a sustainable level of light penetration inside the greenhouse was maintained, as opposed to typical light penetration outside the greenhouse.

5 Conclusion

A smart greenhouse system is a combination of IoT and agriculture that is driven by market demands and based on an optimization schedule. Monitoring and regulating the greenhouse environment requires automation and great efficiency. The detailed information was discovered, allowing them to be fully included in the gap analysis based on their limitations and the likelihood of a job extension. Growers can regulate environmental factors in typical greenhouses using a proportional control system that requires manual intervention, which often results in output loss, energy waste, and higher labor costs. To address these issues, an automated greenhouse monitoring and control system based on the Internet of Things (IoT) comes to the rescue. IoT is a commonly utilized technology for connecting objects and gathering data. The technology is meant to remotely monitor greenhouse factors including CO₂, soil moisture, temperature, and light. Farmers may collect this information using a cloud account and an internet connection. Greenhouse windows/doors roll on/off dependent on soil moisture levels, which is another automated regulating activity. Thus, using IoT, the system will assist farmers in avoiding physical visits to the field while also increasing production by maintaining precise parameters like as CO₂, soil moisture, temperature, and light in the greenhouse. The IoT kit and an internet connection are used to complete the project. With the assistance of graphical representation based on the practical data obtained by the IoT kit, the findings for greenhouse factors such as CO₂, soil moisture, temperature, and light for broccoli and gerbera plants are examined. Work on more specific agriculture crops can be done in the future.

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