



Smart Farming In Artificial Environment

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Abstract: Agriculture needs to be suitable of supporting the world's entire population. Due to in near future it presumably will come impossible to feed the world population. To match this ever adding agricultural demand. It's constantly assumed that abundant water and soil and riotous sun are demanded, which directly translate into farther productive husbandry. While this has been sufficiently true for ultimate of mortal history, several newer and better technologies have proven that this is easily not inevitably true in modern day. Specifically, it's understood that soil is not a demanded element of successful husbandry, also, shops don't actually need true sun, but a bare slice of the whole spectrum. New disquisition and its operation have shown that the true conditions are actually are quality seeds, water and nutrients. Bettered space and water conserving styles off product under soilless culture have shown some promising results all over the world. It's on this idea that hydroponics and aeroponics have come more applicable in the present script.

INTRODUCTION

Aeroponics and Hydroponics and volition for people with limited spaces to grow shops. An aeroponic system is defined as an enclosed air and water/ nutrient ecosystem that fosters rapid-fire- fire plant growth with little water and direct sun and without soil or media. It's an effective and effective way of growing shops for it requires little water (requires 95 per cent less water than traditional husbandry styles) and needs minimal space. We grow plant in these aeroponic and hydroponic system also been shown to uptake more minerals and vitamin, making the shops healthier and potentially more nutritive. The suspended aeroponic shops admit 100 per cent of the available oxygen and carbon dioxide to the roots zone, stems, and leaves, thus accelerating biomass growth and reducing lodging times. The advanced biomass yield of upstanding corridor from the aeroponic treatment indicated that this product fashion should not be limited to root crops, but should be considered for other types of crops as well. Furthermore, using aeroponics, planting viscosity can be increased since plant-to- plant competition fornutrients and water is principally barred. Any species of shops can be grown in a true aeroponic system because themicro- terrain of an aeroponic can be finely controlled.

Smart aeroponic and hydroponic farming represent cutting-edge agricultural techniques revolutionizing traditional farming practices. In these systems, plants are grown without soil, using nutrient-rich water solutions, and in the case of aeroponics, suspended in air. What sets them apart as smart is their integration of advanced technologies like sensors, automation, and data analytics to optimize plant growth conditions. By precisely controlling factors such as nutrient levels, pH, temperature, humidity, and light, smart aeroponic and hydroponic systems maximize yields while minimizing resource use, making them environmentally sustainable alternatives to conventional agriculture. These methods are gaining attention for their potential to address global food security challenges by enabling yearround, high-density crop production in urban areas and harsh environments. First, the system design and component selection phase entails identifying requirements and choosing suitable hardware such as sensors, actuators, and microcontrollers for automation. Next, hardware implementation involves assembling the system,

integrating sensors and actuators, and ensuring proper electrical connections. Subsequently, automation and control programming are essential, requiring the development of software logic and algorithms for optimizing plant growth and user interface creation for monitoring and control. Data monitoring and analysis follow, enabling real-time monitoring, data logging, and analysis for decision support. Finally, iterative optimization and maintenance involve evaluating system performance, fine-tuning parameters, and conducting regular maintenance. This methodology ensures the efficient and sustainable operation of smart aeroponic and hydroponic farming systems.

LITERATURE SURVEY:

1. In this research paper they give the information about hydroponic agriculture and result also they gave the guidelines of project.
2. They have suggested an Internet of Things Hydroponics Agriculture Using Web/Mobile Applications for this project. The monitoring, control, and delivery of the plants' nutritional and water needs are all done using Internet of Things (IoT) technology. According to the findings, the plants did well under the nutritional and environmental conditions that they were subjected to for a period of six weeks. These can be seen in the visual inspections and computer vision employed as proof of plant growth.
3. This project successfully built and deployed an IoT System for Aeroponics Chamber Temperature Monitoring. This system carried out online, real-time monitoring of the temperature and light level. The temperature within the root chamber increased to 32.9 °C with no controls. The root chamber temperature was carefully controlled, yielding an average value of 28.8 °C, well within the range for optimal plant growth.
4. Provides a comprehensive overview of an innovative system designed to enhance hydroponics precision agriculture. The study introduces an intelligent monitoring and controlling system that leverages advanced technologies to optimize crop growth and resource utilization. Through a combination of sensors, data analytics, and automated controls, the system enables real-time monitoring of environmental conditions such as temperature, humidity, and nutrient levels, allowing for precise adjustments to optimize plant growth.
5. THIS PAPER COMPARE ECONOMIC CONDITION. SOILLESS FARMING METHODS, SUCH AS HYDROPONICS AND AEROPONICS, OFFER INNOVATIVE SOLUTIONS TO TRADITIONAL AGRICULTURAL CHALLENGES BY ALLOWING FOR YEAR-ROUND CULTIVATION IN CONTROLLED ENVIRONMENTS, MINIMIZING WATER USAGE, AND MAXIMIZING LAND PRODUCTIVITY.
6. THIS RESEARCH WORK IS AIMED AT STRENGTHENING THE RESOURCES THAT FARMERS HAVE FOR CROPS MANAGEMENT OF PESTS AND DISEASES IN A DIGITAL WAY USING INTERNET OF THINGS THROUGH THE DEVELOPMENT OF A PROTOTYPE. IT CAN OBTAIN IMPORTANT INFORMATION OF VARIABLES WITHIN A STRAWBERRY CROP SUCH AS RELATIVE HUMIDITY, TEMPERATURE AND PH. THESE DATA ARE PROCESSED AND RECEIVED BY MEANS OF PROTOCOLS IN REAL TIME. THESE DEVICES ALLOW MANAGING THE INFORMATION OF DIFFERENT VARIABLES THROUGH COMMUNICATION AMONG SENSORS. THIS STUDY PRESENTS THE MOST CRITICAL CHARACTERISTICS OF THE STRAWBERRY BY USING THE DATA COLLECTION OF AN IoT SYSTEM. IN THIS WAY THE INITIAL RESULTS CAN DEMONSTRATE THAT THE SYSTEM YIELDS IMPORTANT INFORMATION FOR THE APPROPRIATE MANAGEMENT OF STRAWBERRY CROP production.
7. HYDROPONICS REFERS TO A MODERN SET OF AGRICULTURAL TECHNIQUES THAT DO NOT REQUIRE THE USE OF NATURAL SOIL FOR PLANT GERMINATION AND DEVELOPMENT. THESE TYPES OF CROPS USE ARTIFICIAL IRRIGATION SYSTEMS THAT, TOGETHER WITH FUZZY CONTROL METHODS, ALLOW PLANTS TO BE PROVIDED WITH THE EXACT AMOUNT OF NUTRIENTS FOR OPTIMAL GROWTH. THE DIFFUSE CONTROL BEGINS WITH THE SENSORIZATION OF THE AGRICULTURAL VARIABLES THAT INTERVENE IN THE HYDROPONIC ECOSYSTEM, SUCH AS THE ENVIRONMENTAL TEMPERATURE, ELECTRICAL CONDUCTIVITY OF THE NUTRIENT SOLUTION AND THE TEMPERATURE, HUMIDITY, AND PH OF THE SUBSTRATE. BASED ON THIS KNOWLEDGE, THESE VARIABLES CAN BE CONTROLLED TO BE WITHIN THE RANGES REQUIRED FOR OPTIMAL PLANT GROWTH, REDUCING THE RISK OF A NEGATIVE IMPACT ON THE CROP. THIS RESEARCH TAKES, AS A CASE STUDY, THE APPLICATION OF FUZZY CONTROL METHODS TO HYDROPONIC STRAWBERRY CROPS (*FRAGARIA VESCA*).
8. Integrating cloud and IoT technologies, into farming offers advantages for strawberry cultivation this suggested IoT-focused method optimizes environmental conditions to enhance crop quality and yield while reducing waste and increasing overall efficiency effectively. It involves real-time monitoring

and adjustments to ensure the growth environment, for strawberry plants. Cloud and IoT technologies simplify the collection and analysis of real-time data significantly; thereby improving resource management practices and decision-making processes substantially. As a result of the integration of technology, farming practices are introductory due to these advancements. Employing these technologies allows farmers to enhance crop yields and achieve sustainability, in the agricultural sector.

9. Strawberries are sensitive fruits that are afflicted by various pests and diseases. Therefore, there is an intense use of agrochemicals and pesticides during production. Due to their sensitivity, temperatures or humidity at extreme levels can cause various damages to the plantation and to the quality of the fruit. To mitigate the problem, this study developed an edge technology capable of handling the collection, analysis, prediction, and detection of heterogeneous data in strawberry farming. The proposed IoT platform integrates various monitoring services into one common platform for digital farming. The system connects and manages Internet of Things (IoT) devices to analyze environmental and crop information. In addition, a computer vision model using Yolo v5 architecture searches for seven of the most common strawberry diseases in real time. This model supports efficient disease detection with 92% accuracy. Moreover, the system supports LoRa communication for transmitting data between the nodes at long distances. In addition, the IoT platform integrates machine learning capabilities for capturing outliers in collected data, ensuring reliable information for the user. All these technologies are unified to mitigate the disease problem and the environmental damage on the plantation. The proposed system is verified through implementation and tested on a strawberry farm, where the capabilities were analyzed and assessed.
10. In this research article gives information that, In every country agriculture is done from ages which are considered to be science and also art of cultivating plants. In day today life, technology is updating and it is also necessary to trend up agriculture too. IoT plays a key role in smart agriculture. Internets of Things (IoT) sensors are used to provide necessary information about agriculture fields. The main advantage of IoT is to monitor the agriculture by using the internet and collect the data from different sensors which are deployed at various locations and send by wirelessly. By using IoT system the smart agriculture is powered by ESP32. It includes the humidity sensor, temperature sensor, moisture sensor, rain sensor and DC motor. This system starts to check the humidity and moisture level. The sensors are used to sense the level of water and if the level is below the range then the system automatically stars watering. According to the change in temperature level the sensor does its job. IoT also shows the information of humidity, moisture level by including date and time. The temperature level based on type of crops cultivated can also be adjusted.
11. The experiment was carried out during October 2022 to January 2023 at Mae Hea Agricultural Research, Demonstration and Training Center, Faculty of Agriculture, Chiang Mai University, Chiang Mai Province, Thailand; latitude: 18° 44' 36" North, Longitude: 98° 57' 50" East, and an altitude 304 msl. Evaporative greenhouse, 9.6 x 40 square meters, with 8 planting troughs was prepared, Sensors and Internet of Things (IoT) system were installed to monitor continuously vital parameters, collect data, and send timely alerts to facilitate problem resolution. The data were displayed via IoT platform dashboard. An average air temperature, light intensity, media moisture and CO₂ concentration in the greenhouse during 4 months was 21.1 C, 12,948 Lux, 2 kPa and 495 ppm, respectively. The average maximum temperature in the evaporative greenhouse was 29.6 °C, which 4.2 C lower than outside; 33.8 °C. Root-zone cooling of the strawberry planting was designed as factorial 3x4 in completely randomized design (CRD), Factor A was the short-day strawberry cultivars: 1) "Pharachatan 88" 2) "Pharachatan 80" and 3) "Akihime". Factor B was the root-zone cooling treatments: 1) normal water dripping (NWD) 2) cold water dripping (CWD) 3) cold water dripping + cold water piping (CWD+CWP) and 4) normal water dripping + cold water piping (NWD+CWP). The results revealed that there was an interaction between the two factors on canopy width, leave width, crown diameter, number of flowers, fruit qualities and fruit color, whereas plant height, leaves length, SPAD and number of inflorescences were not affected by the interaction between the two factors. Four months

after the experiment, the root-zone cooling treatments had no effect on chlorophyll contents, whereas "Pharachatan 80" had lower chlorophyll content than others. The CWD+CWP treatment could reduce 2 °C of root-zone temperature and leading to promote vegetative and reproductive growth in strawberry plants. Anyhow, without the root-zone cooling treatment, "Akihime" and "Pharachatan 88" still could produce flowers and yield, but "Pharachatan 80" could not. Furthermore, "Akihime" seemed appreciable in flowering, TSS and yield as compared to others.

12. The ability to predict how well crops will grow and how much fruit they will yield is important for farmers, consumers, and researchers. Advances in environmental and plant measurement equipment provide the opportunity for more data to be collected from plant growing operations, which could result in more accurate predictions. The objective of this study was to predict the strawberry growth and fruit yield using environmental and growth data collected with this equipment. The correlation coefficients of the average daily air temperature and soil temperature data for strawberry growth predictions were higher than the relative humidity, soil moisture content, electronic conductivity, CO₂ concentration, photosynthetic active radiation, and vapor pressure deficit data. The correlation coefficients of photosynthetic active radiation, vapor pressure deficit, and relative humidity for strawberry yield prediction were higher than the other environmental data and all growth data such as plant height, crown diameter, and leaf length and width. The regression model using environmental data showed high correlation coefficients with the actual yield data ($R^2 = 0.99$). These results indicate that strawberry growth and fruit yield could be predicted using environmental data.
13. Computer-controlled hydroponics, vertical farms, and IoT-based precision agriculture are claimed to be sustainable, healthful, and humane methods of producing food. These so-called "smart" farming methods have arisen over the past decade and have received little scrutiny from a sustainability perspective. Meanwhile, they are attracting vast sums of both research and investment funding. We ask a simple question: how sustainable is the "smart farm"? We take a technical, ecological, and social view of the systems that comprise a smart farm. Our aim is to tease apart which, if any, of the practices are actually beneficial, and which are simply a substitution of resources or a mere shifting of (human and/or ecological) externalities in time or space. To evaluate the smart farm concept, we focus on two scenarios: indoor smart farms (controlled-environment agriculture such as vertical farms), and outdoor smart farms (in which the environment is less controlled, but managed via precision agriculture). We also provide examples of the values that smart farms embody, who stands to gain from their operation, and what better alternatives might exist.
14. Agriculture, or farming, is the science of cultivating the soil, growing crops, and raising livestock. Ever since the days of the first plow from sticks over ten thousand years ago, agriculture has always depended on technology. As technology and science improved, so did the scale at which farming was possible. With the popularity and growth of the Internet of Things (IoT) in recent years, there are even more avenues for technology to make agriculture more efficient and help farmers in every nation. In this paper, we designed a smart IoT-enabled drip irrigation system using ESP32 to automate the irrigation process, and we tested it. The ESP32 communicates with the Blynk app, which is used to collect irrigation data, manually water the plants, switch off the automatic watering function, and plot graphs based on the readings of the sensors. We connected the ESP32 to a soil moisture sensor, temperature sensor, air humidity sensor, and water flow sensor. The ESP32 regularly checks if the soil is dry. If the soil is dry and the soil temperature is appropriate for watering, the ESP32 opens a solenoid valve and waters the plants. The amount of time to run the drip irrigation system is determined based on the flow rate measured by the water flow sensor. The ESP32 reads the humidity sensor values and notifies the user when the humidity is too high or too low. The user can switch off the automatic watering system according to the humidity value. In both primary and field tests, we found that the system ran well and was able to grow green onions.

PROPOSED DESIGN:

THE FOLLOWING FIGURE SHOWS WORK STRUCTURE:

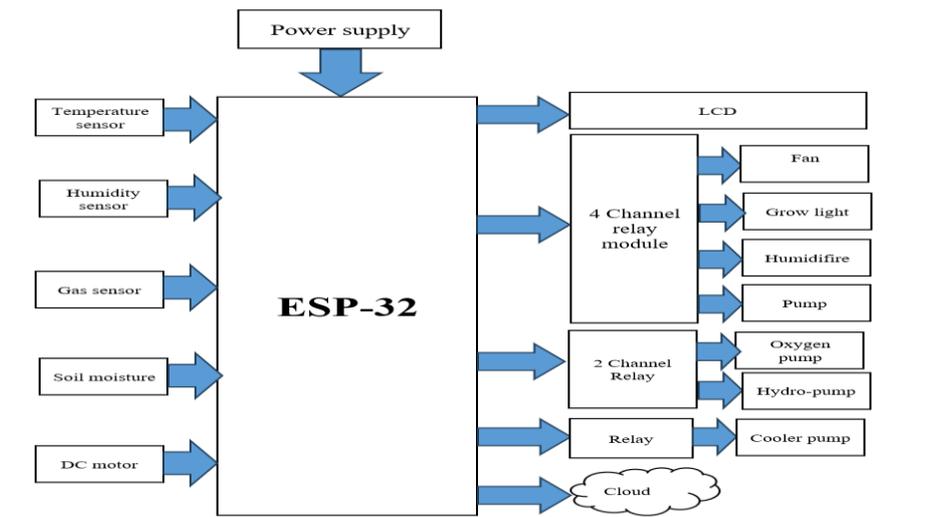


Fig. Block Diagram.

THE FOLLOWING PHOTOS SHOWS WORKING OF MODEL:

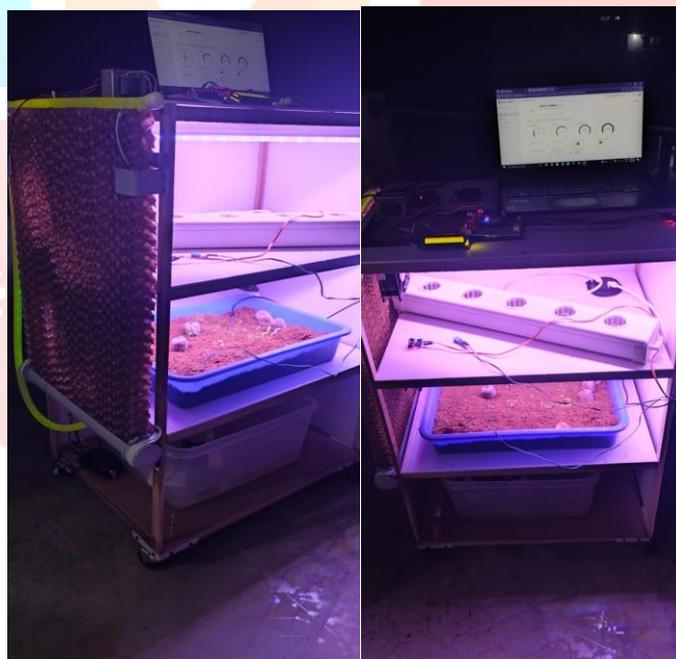


Fig. Mechanism of SMART farming.



Fig. Light Source and Plants

Methodology:

- [1] Selection and Configuration of Components: This phase involves choosing appropriate hardware components for the smart aeroponic and hydroponic system, including sensors environmental for parameters monitoring (such as temperature, humidity, pH level, nutrient concentration), actuators (for controlling water pumps, nutrient dosing systems, and LED grow lights), and the ESP32 microcontroller for data processing and communication.
- [2] Integration of Sensors and Actuators: Sensors and actuators are integrated into the system according to the requirements of aeroponic and hydroponic farming. This may involve mounting sensors at strategic locations within the growing environment and connecting actuators to the water and nutrient delivery systems.
- [3] Programming ESP32: Utilizing the Arduino IDE or similar development environments, the ESP32 is programmed to interface with sensors to collect real-time data and control actuators based on predefined thresholds or user- defined settings. This programming ensures the automation.

Conclusion:

Smart aeroponic and hydroponic farming offer promising solutions for addressing key challenges in modern agriculture. By leveraging technology such as sensors, IoT, and data analytics, these systems enable precise control over growing conditions, leading to higher crop yields, resource efficiency, and environmental sustainability. Despite facing challenges such as initial costs and technical complexity, ongoing research and development efforts hold the potential to further enhance the scalability, affordability, and accessibility of these innovative farming methods. Overall, smart aeroponic and hydroponic farming represent transformative approaches that have the potential to revolutionize food production and contribute to a more resilient and sustainable agricultural future.

REFERENCES

- [1] D. A. A. D. E. Adache Paul, "Internet of Things Hydroponics Agriculture using web/mobile application.," International Research Journal of Engineering and Technology, vol. 09, no. 02, 2022.
- [2] K. S. K. P. K. Jositha C, "An Eye On Hydroponics: The Iot Initiative," International Conference On Electrical Energy System, 2021.
- [3] W. W. A. A. R. T. Jamhari CA, "Design and implementation of aeroponic chamber temperature monitoring," International Conference on Vocational Education and Electrical Engineering, pp. 1-4, Oct 3, 2022.
- [4] a. S. N. Herman, "Intelligent Monitoring and Controlling System for Hydroponics Precision Agriculture," International Conference on Information and Communication Technology, 2019.
- [5] A. L. T. a. O. S. T., "Soilless Farming-A Key Player in the Realization of Zero Hunger.," International Journal of ecological Science and Environmental Engineering, 2018.
- [6] L. R. E. C.-R. C. A. Amaya Diaz Juan Carlos, "Monitoring system of environmental variables for a strawberry I crop using IoT tools," Elsevier , pp. 1083-1089, 2020.
- [7] A. L. F. M. Z. Edgar Maya Olalla, "Fuzzy Control Application to an Irrigation System of Hydroponic Crops under Greenhouse: Case Cultivation of Strawberries (Fragaria Vesca)," MDPI , no. 10.3390, 2023.
- [8] V. M. T. V. C. A. P. M. Jyoti, "Enhancing Strawberry Cultivation Through Iot: A Leap Towards Sustainable Smart Farming," SSRN, no. 10.2139, pp. 1-7, 2025.
- [9] S. M. E. T. a. F. F. Mateus Cruz, "Smart Strawberry Farming Using Edge Computing and IoT," MDPI, no. 22-5866, 2022.
- [10] B. Dr Lakshmi Narayana, "Real Time Automatization of Agriculture Environment for Social Modernization Using ESP32 and Cloud Computing," International research journal of education and technology , vol. 4, no. 2581-7791, pp. 1-7, 2022.
- [11] K. K. 2. C. S. W. P. S. B. N. N. n. a. A. P. Daruni Naphrom ¹, "Integration of Evaporative Greenhouse, Internet of Things and Root zone Cooling to Enhance Growth and Development of Strawberry (Fragaria x ananassa) in Tropical Climate," PREPRINTS, no. 10.20944, pp. 1-15, 2023.
- [12] D. S. K. M. G. A. S. R. A. a. S. K. K. Ha Seon Sim, "Prediction of Strawberry Growth and Fruit Yield based on Environmental and Growth Data in a Greenhouse for Soil Cultivation with Applied Autonomous Facilities," Research Gate, no. 2465-8588, pp. 839-850, 2020.
- [13] M. K. Adam Streed, "How Sustainable is the Smart Farm?," Research Gate, no. 2465 8589, pp. 987-995, 2020.
- [14] M. Z. C. a. F. D. Gilroy P. Pereira, "IoT Enabled Smart Drip Irrigation System Using ESP32," MDPI, no. 10.3390, pp. 221-243, 2023.
- [15] Soelistianto, F. A., Alfian, S. T., & Atmadja, M. D. (2023). Telecontrolling microgreen indoor nursery strawberry. Journal of Telecommunication Network (Jurnal Jaringan Telekomunikasi).
- [16] Parenreng, J. M., Syahrul, S., Wahid, A., & Sary, D. W. (2022). Modern farming biofloc ponds for tilapia aquaculture based on the internet of things using a fuzzy logic algorithm. Iota, 2(4).
- [17] Sukarma, I. N., Ardana, I. W. R., Mastawan, I. G. P., Yasa, I. M. A., & Purbhawa, I. M. (2022). Watering strawberry (Fragaria X Anannasa) plants in a greenhouse using IoT-based drip irrigation. Journal of Computer Science and Technology Studies, 4(1), 72-79.
- [18] Malik, M. F. A., Vajravelu, A., & Karthik, R. P. (2022). Monitoring system for mushroom cultivation in indoor farming using ESP32 Arduino. Evolution in Electrical and Electronic Engineering.
- [19] Khalid, N. K. M., Jamal, N., Mustafa, F., Zambri, N. A., & Abdullah, M. S. R. (2024). Solar power IoT-based smart agriculture system using NodeMCU ESP32. Progress in Engineering Application and Technology, 5(1), 95-102

- [20] Ezema, L. S., Ifediora, E. C., Olukunle, A. A., & Onuekwusi, N. C. (2021). Design and implementation of an ESP32-based smart embedded industrial poultry farm. *European Journal of Engineering and Technology Research*, 6(3), 103-108.
- [21] Parenreng, J. M., Syahrul, S., Wahid, A., & Sary, D. W. (2022). Modern farming biofloc ponds for tilapia aquaculture based on the Internet of Things using a fuzzy logic algorithm. *Iota*, 2(4)
- [22] Hercog, D., Lerher, T., Truntič, M., & Težak, O. (2023). Design and implementation of ESP32-based IoT devices. *Sensors*.
- [23] Sim, H. S., Kim, D. S., Ahn, M. G., Ahn, S. R., & Kim, S. K. (2020). Prediction of strawberry growth and fruit yield based on environmental and growth data in a greenhouse for soil cultivation with applied autonomous facilities. *Korean Journal of Horticultural Science and Technology*.
- [24] Jyoti, Tripathi, V. M., Chamoli, V., & Mani, A. P. (2024). Enhancing strawberry cultivation through IoT: A leap towards sustainable smart farming.
- [25] Janairo, A. G., Concepcion II, R., Fernando, A., & Guillermo, M. (2025). Cloud computing framework for space farming data analysis.
- [26] Abdo-Peralta, P., García-Pumagualle, C., Carrera-Silva, K., Frey, C., Rosero-Erazo, C. R., Ortega-Castro, J., Orozco, J. S. S., & Toulkeridis, T. (2024). Implementation of an enhanced edge computing system for the optimization of strawberry crop in greenhouses: A smart agriculture approach.
- [27] Narayana, L., & Deepthi, B. (2022). Real-time automatization of agriculture environment for social modernization using ESP32 and cloud computing. *International Research Journal of Engineering and Technology*.
- [28] Pereira, G. P., Chaari, M. Z., & Daroge, F. (2023). IoT-enabled smart drip irrigation system using ESP32. *IoT*.
- [29] Jharpla, S., Bhavya, A., Tarun, C., & Sameera, V. (2024). Internet of Things (IoT) based greenhouse monitoring and controlling system using ESP32. *International Journal of Advanced Research in Computer and Communication Engineering*.
- [30] Rehman, A. U., Razzaq, A., Altaf, A., Qadri, S., Hussain, A., Khan, A. N., Tausif-ur-Rehman, & Sarfraz, Z. (2023). Indoor smart farming by inducing artificial climate for high value added crops in optimal duration. *International Journal of Agricultural and Biological Engineering*