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Monitoring Environment Parameters of Gerbera Flower Cultivation in Greenhouse using Internet of Things

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Abstract

Objectives: To propose a system based on monitoring and analyzing of greenhouse environment, built for cultivating Gerbera with advanced technologies like the Internet of Things(IoT), Android applications, and cloud. **Methods:** To ensure optimal growth of the plant in a greenhouse, smart applications with sensors and Mobile apps are implemented for remote monitoring. Sensors are attached to the Arduino interface which collects and broadcasts the data onto the IoT cloud. This cloud platform (Ubidots) creates real-time dashboards for user-friendly graphic visualization. Further, through the Android Mobile application interface, the data can be regularly monitored and tracked by the end user to take necessary actions. **Findings:** The system is designed to automatically monitor four environmental parameters such as temperature, humidity, soil moisture, and light inside the greenhouse through IoT. The data recorded in the cloud is visualized through an app and the user can monitor remotely the evident conditions of greenhouse parameters. If any of these parameter values crosses the threshold set, then the notification will be sent to the end user. A mobile application developed will guide the farmers to remotely monitor the greenhouse and influence the grower's decisions. **Novelty:** The proposed work ensures that the quality and yield of crops can be effective with automatic remote monitoring with the help of technology. This work highlights designing a user-friendly app for farmers which is safe and can track the current conditions, detect abnormalities, and easy water management. The Signup/login page, data visualization, and alert messages are implemented in the app which marks farming as more efficient compared to traditional methods.

Keywords: Gerbera; Greenhouse; Ubidots; Internet of Things; Android

1 Introduction

A network of sensors can aid in the automation and monitoring of plant growth, controlling the environment, and pest management in a greenhouse environment. IoT has penetrated extensively in the field of agriculture for effective and smart farming systems eliminating human intervention. Besides monitoring, controlling and intelligent actions for preventive measures for more productivity in a protected environment is a challenging part of farming.

Greenhouses can be used to cultivate plants under precise climatic conditions for better production. The use of automation in a greenhouse visualizes the monitoring of the climatic parameters in real-time and the control of indoor parameters in a protected environment(1). Microclimatic modeling is necessary for the simplification of the thermodynamic process(2), and control of CO_2, heating, cooling, and ambient light conditions. Smart farming in a greenhouse provides an ideal production from germination to harvesting at an affordable cost compared to external environmental conditions(3). The applications of IoT in agriculture(4) have tremendous contributions not only in the monitoring of crops but also in crop disease detection, which increases crop production and reduces loss. Implementation of a wireless sensor network helps in the easy monitoring of many smart applications which will have constraints on energy efficiency(5). The challenge in IoT technology is about energy consumption(6) in the sensor network and its lifetime when used in a real-time scenario.

1.1 Greenhouse Gerbera Cultivation

Gerbera flower is mainly used for decorative purposes and it has high market demand, is export-oriented, and uses less water resources with high yield. This flower can be cultivated in open fields, but these flowers are delicate and very sensitive to varying weather conditions which are more prone to damage and requires continuous monitoring, hence they are cultivated in a greenhouse. The most essential features that influence quality and yield are temperature, humidity, soil moisture, and light for monitoring the weather condition for gerbera cultivation. The following Table 1 represents the climatic condition that should be maintained for each parameter to grow flowers inside the greenhouse.

Table 1. Climatic conditions required for growing gerbera flower

Parameter	Value Range
Temperature	22 °C – 35 °C
Humidity	50% - 80% RH
Soil Moisture	7.0-8.5 pH
Light	100 – 200 lux

A smart irrigation system using a wireless sensor network and a smart decision-making system aids in efficient and optimal control of several environmental indices in a greenhouse(7). The extensive growth of IoT methods in farming has been augmented by trending technologies like electromagnetic and electrochemical sensors, Bluetooth/ZigBee, RFID, Artificial Intelligence, and Machine Learning. Particularly, the integration of IoT technologies for sustainable farming has fascinated substantial attention.

Table 2. Shows the different microcontrollers and sensors used for specific plant growth in the greenhouse.

Reference	Technology Used	Sensor	Crop	Limitations
(8)	Arduino Uno & Raspberry Pi 3	Temperature, Humidity, Soil Moisture, Light	Tomato and Brinjal	Useful for small-scale production
(9)	Arduino Uno with ThingSpeak	temperature, humidity, water level, light intensity, and soil pH	Tomato	Not specific to a particular crop
(10)	Adaptive Neuro-Fuzzy Inference System (ANFIS] and Internet of Things (IoT)	temperature, humidity, sunlight, and soil-moisture	Any crop	In a complex system, an alert notification is not implemented
(11)	Internet of Things (IoT) with Decision Support System	Humidity, water nutrient level, pH, temperature, CO_2, light intensity	Any crop	High cost, high maintenance
(12)	ESP8266 microcontroller, ISM 2.4GHz wireless communication	soil moisture, brightness sensor	Gerbera	Very few parameters are considered

The adoption of IoT to design automated greenhouses not only monitors and controls but also optimize the usage of energy, water, and nutrient resources. This paper mainly focuses on monitoring the gerbera crop parameters through IoT technology and analyzing the gerbera crop parameters remotely in real-time using an Android application in the greenhouse. The system also alerts/alarms the user when parameter values cross the threshold which further helps in improving crop production effectively. Unlike the literature, the proposed work focuses not only on implementing IoT technology but also on a user-friendly app to remotely monitor and get an alert notification through app and SMS. Based on this, the farmer can make decisions in water management and necessary lighting conditions for energy saving.

2 Methodology

With the limitations of the existing system, this work focuses on improving the hardware with a low-cost microcontroller, which can embed more sensors to be connected with an inbuilt- Wi-Fi module. This model aids in designing a cost-effective IoT system for a specific crop like Gerbera which needs continuous monitoring for higher yield of the crop. The system is designed to create a user-friendly application with smartphone-based real-time and remote monitoring effectively.

"Monitoring Environment Parameters of Gerbera Flower Cultivation in Greenhouse Using Internet of Things" is a system designed with sensors attached to a microcontroller. The main objective is to improve the Gerbera crop productivity by remote monitoring. The proposed architecture consists of four modules namely the Sensor module, Wi-Fi module, Cloud platform, and mobile application. Each module is designed to perform a specific set of operations. The complete system is built using Arduino Uno integrated with ESP8266 Node MCU as processing chips that collect and transfer the data from sensors which are embedded through a Wi-Fi module. The module is based on the ESP-12 model, which supports an Open-Source IoT platform with more analog and digital pins.

The sensor module consists of four sensors namely the DHT11 sensor, soil moisture sensor, and LDR light sensor. All these sensors are connected to the ESP8266 Node MCU Wi-Fi module and Arduino board. The DHT11 sensor is used to monitor the temperature and humidity of the greenhouse. Capacitive Soil Moisture Sensor V1.2 measures the volumetric content of water in the soil. The LDR LM393 sensor measures the luminosity of light in lux based on radiant energy. The data read from the sensors can be visualized on Liquid Crystal Display (LCD).

The second module ESP8266 Wi-Fi module integrates with the sensor module through Arduino Uno designed with TCP/IP protocol stack. The data read is sent to cloud-based storage. A serial monitor of Arduino software through which data is sent to the cloud platform via COM6 port. The third module is an online cloud service. The cloud platform used in the proposed system is Ubidots, which stores the data sent through the Arduino module. Ubidots provides services to analyze data in the form of graphs and stores data in its database for further processing. It also allows to set of events for each variable and sends a notification to the user's smartphone if any event is triggered. Once the data is stored inside the cloud, an android application is built and the data from the cloud is extracted to the application.

The fourth module is the mobile application installed on the user side to monitor the data and get alerts from the server. The application authenticates the user information through the Sign Up/ Login page for the registration of users. Later the users are linked to the Ubidots cloud platform to receive their farm data. Through this module, the user can check the current values of each parameter. Through the android application, the user can monitor the greenhouse from a remote place, and also alert is given if any of the parameter values cross the threshold.

This system is mainly proposed for monitoring gerbera flower cultivation in a greenhouse and for informing the farmers about the climatic changes that occur inside the greenhouse so that they can take necessary measures/controlling actions and protect the flower from damage or diseases. The four important parameters considered monitoring the greenhouse are temperature, humidity, soil moisture, and light. All these parameters are monitored using IoT sensors at different places in the greenhouse. The real-time data is visualized on the LCD screen. The sensors sense the data and store the data in the local storage of the Arduino board and through the Wi-Fi, the module carries the data to the Ubidots cloud for further analysis. In addition to monitoring and sending, the system alerts the users of preventive and corrective measures.

2.1 System Architecture

The deployment of the complete crop monitoring system is shown in Figure 1, which demonstrates all four modules for collecting and monitoring the greenhouse environment for crop development. Through this online cloud service, the user can visualize the data concerning all parameters by using this application. Further, there is a scope for further improvement by implementing more intelligence for immediate action on the controlling of the greenhouse through better microcontroller boards like ESP32, ARM Cortex, and Raspberry Pi which supports more sensors. Also, to smoothen the power consumption by hardware technology, relay modules like 1-channel, and 2-channel I^2C can best suit smart agriculture systems.

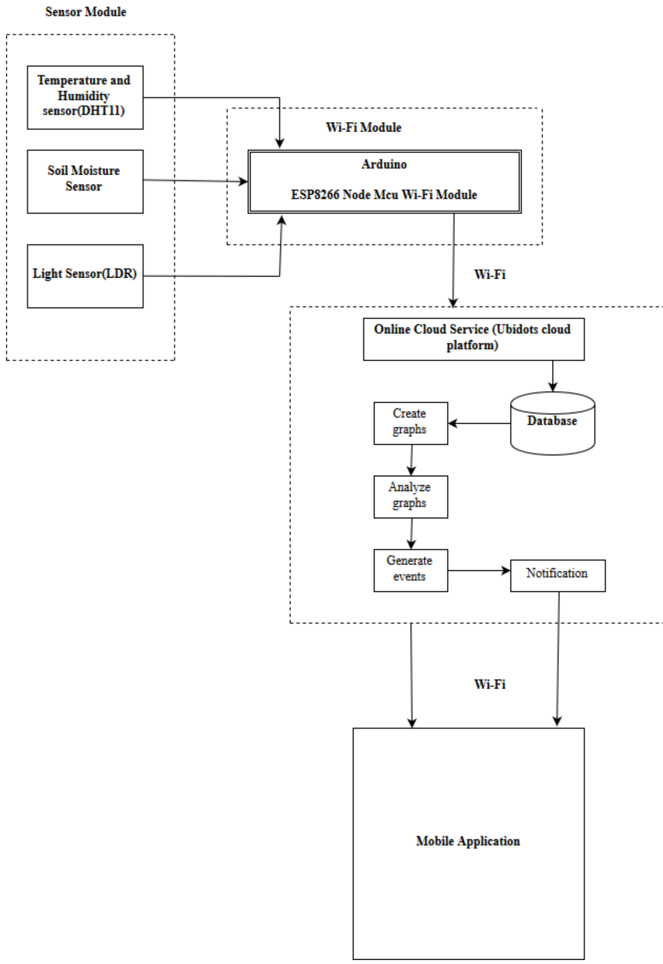

Fig 1. Proposed System Architecture

Figure 2 demonstrates the mobile application designed to monitor the environment parameters. The user has to register for the application before checking the status of the greenhouse farm. The data collected from the sensors like temperature, humidity, soil moisture, and light are sent to the cloud platform Ubidots to store and analyze the data, through which the android application extracts the data and the user can easily monitor and control.

3 Result and Discussion

Many existing systems [12,13] that use IoT technology to automate greenhouse monitoring, are implemented only with a simple Arduino Uno board with very few analog and digital sensors and a separate GSM module to get alert notifications. The survey of mobile robotic applications in greenhouse farming made by the author [14] has highlighted most of the work has a higher-cost mechanical structure that can completely automate farming. These technologies cannot be afforded by the farmers as it incurs high cost.

The crop chosen in the proposed work is Gerbera flowers which are in high demand for farming. The quality of these flowers requires a specific temperature range in a naturally ventilated greenhouse and is more prone to soil-borne diseases. Water management and regular monitoring are necessary for the improved production of this crop. The focus here is to provide the farmers with a low-cost system and remote monitoring through a user-friendly app with no labor cost. The data visualization graphs on the app will provide the data analysis every five seconds without any additional cost.

The implementation of the proposed system is based on sensing/ reading the accurate measurement of parameters and transferring via Wi-Fi module to the cloud, which is visualized in the Dashboard as shown in Figure 3. This also demonstrates the real-time data acquisition of all the sensors from the greenhouse environment of Gerbera flowers. The periodic data is stored

Fig 2. Design of Mobile Application for monitoring

and visualized as graphs in a user-friendly dashboard on the Ubidots platform. The user can visualize the variations of all the parameters and save water and energy which reduces the cost that will be incurred.

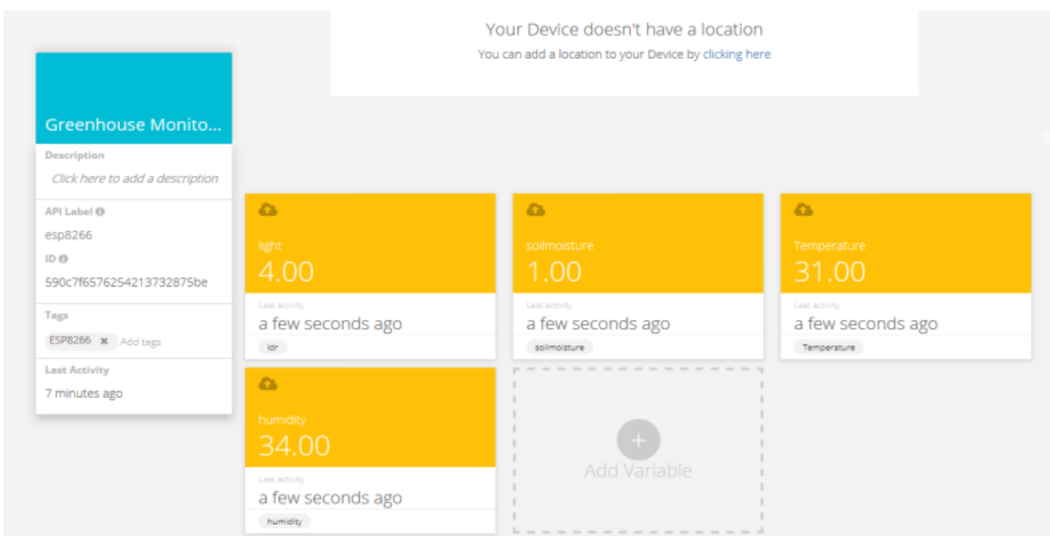

Fig 3. Ubidots interface for the measured parameters

The variation of these parameters over a period of time is shown in Figure 4. Figure 4 (a-d) demonstrates the sample day-wise data of temperature, humidity, soil moisture, and light intensity visualized in the Ubidots dashboard.

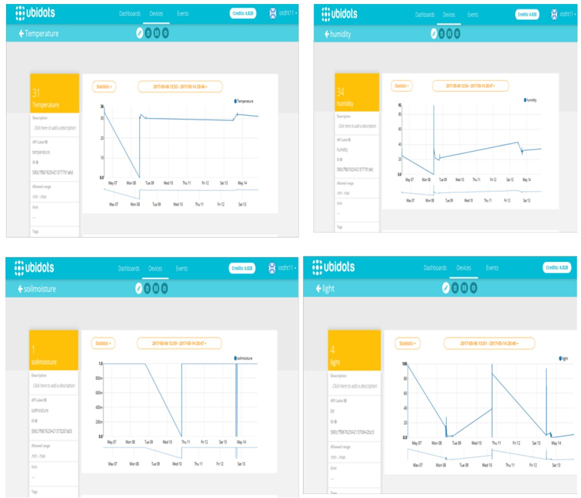

Fig 4. Data Visualization in Ubidots of differentparameters. a) Temperature Graph, b) Humidity Graph , c) Soil Moisture Graph , d) Light Graph

3.1 Android Application

A user-friendly and safe mobile application was designed with a sign-up and login page for the user. The user has to register before using this app to get the greenhouse farm data from his farm. If users try to log in with the wrong credentials, it shows unsuccessful login. Figure 5 a and b demonstrate the user login page and registration page on the mobile application.

The depth-level data graph of all the parameters in the app design is shown in the above Figure 5c. The system notifies the events related to real-time values of all the parameters measured whenever the parameter value goes beyond the threshold value which is shown in Figure 5d.

Fig 5. Data Visualization in mobile app. a) User Sign-up page, b) Login page, c) Data Monitoring Screen, d) Screen showing an alert message

4 Conclusion

Smart greenhouse farming with technology is the most trending in agriculture that includes automation and controlling which helps in more productivity. This work has shown how an IoT-enabled automated system can be considered in the deployment of a real-time greenhouse environment. To smoothly regulate the gerbera plant growth, commercial sensors are considered to measure the environmental parameters inside the greenhouse.

The novelty of this work highlights the use of the ESP8266 module that enables Wi-Fi or Bluetooth technology to upload the data in cloud-based technology. And further, this ESP8266 module supports many sensors to be embedded in a single board without any complexities. The cloud application-Ubidots is a very secure reliable platform for analyzing the parameters and is more scalable and customizable. Further, the smart app is safe and secure, with a Login page, high real-time nature, and a simple operation interface that will guide the farmers to track the conditions remotely. Whenever there is an environmental change beyond the threshold, the system would automatically sends a warning message to the registered farmers so that they can take further necessary actions. With this analysis, we can avoid crop damage, and results in better yield and good quality crops. In the nearest future, more sensors can be implemented and can be monitored for a different types of greenhouse crops. The proposed work is limited to monitoring but needs intelligence to act upon it during the crisis of crop production. In this direction of research, there are opportunities for smart farming with deep learning and computer vision.

References

1) Bersani C, Ruggiero C, Sacile R, Soussi A, Zero E. Internet of Things Approaches for Monitoring and Control of Smart Greenhouses in Industry 4.0. *Energies*. 2022;15(10):3834. Available from: https://:doi:10.3390/en15103834.
2) Gupta D, Santosh DT, Debnath S, Maitra S, Gaikwad, Dj, et al. Modeling and Simulation Application for Greenhouse Microclimatic Studies and Structural Analysis. *Protected Cultivation and Smart Agriculture*. 2020;2020:300–312. Available from: https://doi:10.30954/NDP-PCSA.2020.33.
3) Kumar N, Dey B, Chetri C, Agarwal A, Debnath A. Development of an IoT-Based Smart Greenhouse Using Arduino. In: Advances in Communication, Devices and Networking;vol. 776. Springer Singapore. 2022;p. 455–465. Available from: https://doi.org/10.1007/978-981-16-2911-2_47.
4) Mishra KN, Kumar S, Patel NR. Survey on Internet of Things and its Application in Agriculture. *Journal of Physics: Conference Series*. 2021;1714(1):012025. Available from: https://doi:10.1088/1742-6596/1714/1/012025.
5) Patel NR, Kumar S. Energy-Efficient Approach for Effective Estimation of Delimited Node Position with Limited References. *The Computer Journal*. 2018;61(6):881–895. Available from: https://doi.org/10.1093/comjnl/bxx102.
6) Patel NR, Kumar S, Singh SK. Energy and Collision Aware WSN Routing Protocol for Sustainable and Intelligent IoT Applications. *IEEE Sensors Journal*. 2021;21(22):25282–25292. Available from: https://doi:10.1109/JSEN.2021.3076192.
7) Kitpo N, Kugai Y, Inoue M, Yokemura T, Satomura S. Internet of Things for Greenhouse Monitoring System Using Deep Learning and Bot Notification Services. *IEEE International Conference on Consumer Electronics (ICCE)*. 2019;p. 1–4. Available from: https://doi:10.1109/ICCE.2019.8661999.
8) Shi X, An X, Zhao Q, Liu H, Xia L, Sun X, et al. State-of-the-Art Internet of Things in Protected Agriculture. *Sensors*. 2019;19(8):1833. Available from: https://doi.org/10.3390/s19081833.
9) Raviteja K, Supriya M. Greenhouse Monitoring System Based on Internet of Things. *Lecture Notes in Electrical Engineering*. 2020;p. 581–591. Available from: https://doi:10.1007/978-981-15-2612-1_56.
10) Soheli SJ, Jahan N, Hossain MB, Adhikary A, Khan AR, Wahiduzzaman M. Smart Greenhouse Monitoring System Using Internet of Things and Artificial Intelligence. *Wireless Personal Communications*. 2022;124(4):3603–3634. Available from: https://doi.org/10.1007/s11277-022-09528-x.
11) Tripathy PK, Tripathy AK, Agarwal A, Mohanty SP. *MyGreen: An IoT-enabled smart greenhouse for sustainable agriculture IEEE Consumer Electronics Magazine*. 2021;10(4):57–62. Available from: https://doi:10.1109/MCE.2021.3055930.
12) Kumkhet B, Rakluea P, Sangmahamad P, Pirajnanchai V, Pechrkool T, Sutham T. IoT-based Automatic Brightness and Soil Moisture Control System for Gerbera Smart Greenhouse. *International Electrical Engineering Congress (iEECON)*. 2022;p. 1–4. Available from: https://doi:10.1109/iEECON53204.2022.9741578.
13) Shiyale PD, Thombre GH, Tyagi A, Chauhan. IoT-Based Smart Greenhouse Automation. *International Journal of Creative Research Thoughts*. 2020;8(5).
14) Tangarife HI, Diaz AE. Robotic applications in the automation of agricultural production under greenhouse: A review. *3rd Colombian Conference on Automatic Control (CCAC)*. 2017;p. 1–6. Available from: https://doi.org/10.1109/CCAC.2017.8276478.