IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Survey On Smart Greenhouse Monitoring And Controlling System

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Abstract – For most of the countries now-a-days the national agenda is the agricultural production because of rapid climatic changes that affects the crop growth like vegetables, fruits, grains and insect infestation. Because of rapid climatic changes it is becoming hard to achieve maximum yield of the crops, because of this many countries are seeing greenhouse as a very good option to guarantee their agricultural results. In this paper we have proposed a smart greenhouse monitoring system that consists of different sensors which monitor the total area of the greenhouse and these sensors mainly include temperature and humidity sensor, light controlling (LED) sensor, soil moisture and PH controlling sensor. The system consists a facility of fire alert system and SMS alert system which will be displayed on the user's phone. Dataset used for this system has different kinds of pictures of numerous plants which are taken from different angles and the plants captured are both healthy and affected. This system has the ability to capture images and store in the database and predict results based on that data. The system uses Convolution Neural Network (CNN) which helps in training the model and detecting the disease. This survey paper gives information about the system which is equipped with numerous IoT-based applications to control and monitor greenhouse and help in building a suitable agriculture environment.

Key Words: Internet of Things (IoT), smart greenhouse, Convolution Neural Network (CNN), image processing, IOT sensors, Machine learning.

I. INTRODUCTION

Agricultural productions are the important part in the welfare of society and economic exchange between countries. Therefore, food demand is continuously increasing. The agriculture sector can produce only 3% more than required because farmers have postponed seeding different crops on their lands because of climatic changes. Therefore, to counteract undesirable environmental conditions and crops damages because of infestations of insects, in some cases, farmers use fertilizers and pesticides to speed up the planting and harvesting of crops. In some cases farmers use seeds and fertilizers without the knowledge to manage them on a huge scale. As a result of the wrong use of fertilizers and pesticides, the quality of the land decreases as well as the crops grown on it lose essential nutrition also.

A Greenhouse, which is a exceptionally outlined home like structure. This gives a more controllable and monitorable environment to a better crop growth, transplantation, harvest generation and product yields. In today's world, for developing yields, more space of land which has been utilized for commercial purpose, housing area space is accessible. The cost-effective farming such as new blossoms, organic products and vegetables generation is the utilization of Greenhouse development in many tropical nations. The surety of ideal atmosphere development conditions which is to attain to the high return at great quality, low natural dependency and low cost is the effectiveness of plant creation inside Greenhouse which depends fundamentally. Parameters like light, humidity, temperature, soil moisture, pH must be controlled ideally where the given certain criteria through water pump, warming, ventilation and lighting are used to attain certain objectives. By regular monitoring and controlling of these geographical parameters which gives a significant data that is related to individual impacts of the elements differently towards acquiring the most extreme creation of harvest. The present difficulty in Greenhouses is to control environment factors. Temperature changes quickly, In Greenhouse as a result, fluctuations relying upon sun powered UV light level, soil moisture levels and outside temperatures. Poor natural quality frequently bought by the high humidness and poor light intensity. Improving the efficiency of labours by entitle them for the more important tasks, electricity charges, empowering producers and directors to settle on better administration choices and to invest more on the energy dealing with procedures can be decreased by practicing exact control over the system.

We have proposed a system which can read the parameters from the environment which is identified within the Greenhouse and will be controlled manually or by Android app which we will developed. The cloud will store data for future use. If any climate values fluctuate the precautionary measures will be taken by the user.

Image processing is widely used in agriculture for the images taken by remote sensing devices such as cameras and other devices. Only original images are taken for training the plant disease identification model. The training and testing of the models are implemented in Google colab by importing necessary packages using TensorFlow. The proportion of dataset used for training and testing is 80:20. An accuracy of 95% was obtained as the maximum and 72% was obtained as the minimum, with the average accuracy of prediction being 85%. By the usage of the previous technologies we were able to recognize different kinds of diseases. The usage of a huge dataset which was a combination of images for a healthy and unhealthy leaves and the fruit or vegetables was also beneficial.

II. LITERATURE SURVEY

Table 1 : literature survey

Ref. No.	Paper Title and Publication Details	Methodology Used	Dataset Used	Accuracy	Research Gap Identified
[1] Paul D. Rosero-Montalvo And et al.	Title: Smart Farming Robot for Detecting Environmental Conditions in a Greenhouse Journal: IEEE Access (DOI : 10.1109/ACCESS.2023.3283986 Date : 8 June 2023)	To efficiently manage agricultural fields and greenhouses today, farmers have to apply technologies in line with Industry 4.0, such as: robots, Internet of Things devices, machine learning applications, and so on. An unsupervised learning algorithm is implemented to cluster the optimal, standard, and deficient sectors of a greenhouse to determine inappropriate growth patterns in crops .	40 data collection points Central node receives 120 samples Data collected on the basis of parameters sensed by Temprature sensor , Humidity sensor , and CO2 emission	92%	Conclusion : Reached the objective of acquiring valuable data from the greenhouse The proposed data analysis effectively determined the zones of the greenhouse where the environmental conditions affected the crops. Future Scope : To build an autonomous robot with computer vision to give the farmer more information about his crops and the

					possibility of activating water pumps.
[2] Muhammad Shoaib Farooq , And et al.	Title: Internet of Things in Greenhouse Agriculture: A Survey on Enabling Technologies, Applications, and Protocols Journal: IEEE Access (DOI : 10.1109/ACCESS.2022.3166634 Date : 11 April 2022)	A rigorous discussion on greenhouse farming techniques, IoT-based greenhouse categories, network technologies , the success stories and statistical analysis of some agricultural countries have been presented to standardize IoT-based greenhouse farming	Data collected on Cloud Computing Server . The data collected is of parameters like temperature, humidity, the intensity of light, and soil moistness.	80%	Conclusion : The current status of the research has indicated that it was feasible to remotely monitor the greenhouse parameters such as CO2, PH, moisture content, humidity, temperature, and irrigation by using IoT sensors and devices . Future Scope : A generic platform is necessary to build for all kinds of crops and plants, quality of service (QoS), integration of explainable artificial intelligence for pest control, and crop growth .
[3] Jun Jiang , Mehrdad Moallem	Title: Development of an Intelligent LED Lighting Control Testbed for IoT-based Smart Greenhouses Journal: IEEE Access (DOI : 10.1109/IECON43393.2020.9254993 Date : 20 June 2021)	To develop an intelligent control system for mixing color ratios using LED lights in a greenhouse environment. To this end, different components of an experimental testbed is presented for achieving the desired light requirements for plant growth in a greenhouse environment. The proposed testbed provides a easy-to-use plant growth system with IoT-enabled control and monitoring features. To testify the features	Dataset on different types of images of plants from different views	85%	Conclusion : The study in this paper addresses the applicability of a testbed with a intelligent LED lighting control system. The design concept has been depicted and different stages of the forming process has been

		mentioned above, a feedback lighting control method to achieve a desired photosynthetic photon flux desnity (PPFD) set point is implemented			illustrated. With the implementation of the testbed, a intelligent LED control strategy has been testified with the growth of real plant in a real daylight environment. Future Scope : Increase in Crop Productivity.
[4] Randa Osama , Nour El-Huda and et al.	Title: Detecting plant's diseases in Greenhouse using Deep Learning Journal: IEEE Access (DOI : 10.1109/NILES50944.2020.9257974 Date : 16 June 2021)	The proposed system is used to speed up the plant growth and detect the plant's diseases. We used tomatoes to test our proposed system. The detected diseases are early blight, late blight, leaf mold, spider mites, target spot, mosaic virus, septoria, bacterial spot, and yellow leaf curl virus	Dataset consists of 9 classes of different diseased tomatoes leaves images and 1 class for healthy tomatoes leaves images. These images are imported from plant village dataset which contain 54,309 images of tomato leaves including healthy and unhealthy tomatoes leaves.	81.8% in plants stages 98.4% in detecting tomato diseases	Conclusion : In the proposed approach, an automated intelligent system for the greenhouse crop agriculture was developed to make the plant grow faster in a suitable environment. The proposed approach detects certain diseases that could effect plant's growth. Future Scope : Increasing the accuracy of the result and gettin a clear images of the plant with highest resolution of camera
[5] Pradyumna K. Tripathy , and et al.	Title: MyGreen: An IoT Enabled Smart Greenhouse for Sustainable Agriculture Journal : IEEE Access (DOI : 10.1109/MCE.2021.3	This work also accounts for the different challenges of greenhouse rose farming and highlights a new IoT-based solution, which is smart and sustainable	N/A	85%	Conclusion : can increase productivity while reducing cost. The investment needed in the IoT-devices is low as

	055930 Date : February 2021)				compared to the expenditure involved in the manual process. The IoT-enabled process not only gives accurate pieces of information but also lowers the burden of manual work by automation Future Scope : With technology in hand, the new methods of making greenhouse sustainable is higher with more accessibility
[6] Radha N ,Swathika R	Title: MyGreen: An IoT Enabled Smart Greenhouse for Sustainable Agriculture Journal: IEEE Access	The preliminary goal is to identify the type of plant disease. The proposed plant model is used to detect the diseased portions of a plant and also monitors the parameters related to crop production.	The leaf images of healthy and diseased plants are obtained from the plant village dataset	85%	The proposed plant monitoring system enables the early identification of disease in Poly-house. Dataset can also be enlarged and refined with better images to increase the accuracy of the model. This system can be experimented for other set of plants as future work.
[7] Dingzhu Xue 1, and Wei Huang	Title: Smart Agriculture Wireless Sensor Routing Protocol and Node Location Algorithm Based on Internet of Things Journal: IEEE Xplore	Introduced the classification of positioning algorithm, and then analyzed the DV-HOP positioning algorithm. Aiming at the problem of low positioning accuracy and large error of DV-HOP algorithm, an improved method of DV-	Sensor Network Dataset, Crop-Specific Dataset	81%	By testing the algorithm proposed in this paper, the improved DV-HOP algorithm reduces the positioning error by 30% compared with

		HOP algorithm based on average HOP distance was proposed to make positioning more precise.			the original DV-HOP algorithm.
[8] Sandunika Fernando Ranusha Nethmi , and et al	Title: Intelligent Disease Detection System for Greenhouse with a Robotic Monitoring System Journal: IEEE Xplore	This research is focused on diseases that cause yellowish the tomato plants inside greenhouses. There are several reasons for the yellowness in the tomato plant leaves. The system identifies leaf mold, tomato yellow leaf curl, diseases, and healthy leaves.	Greenhouse Captured plants Dataset	99%	This project is mainly focusing on greenhouse plants disease detection. The system is applied inside a robotic system. So that system can diagnose diseases that have harmed the plant leaves. Several leaves from the same plant can be taken and process in order to find the symptoms.
[9] Ahmad F. Subahi And Kheir Eddine Bouazza	Title : An Intelligent IoT-Based System Design for Controlling and Monitoring Greenhouse Temperature Journal: IEEE Access	In Deep Neural network makes accurate predictions by extracting useful features of the input image. Activation maps or feature maps are obtained by applying filters to the input image by each layer of the CNN model.	Rice leaf dataset with 5932 images and 1500 potato leaf images are used in the study	97.66%	The proposed deep learning CNN model demonstrated high accuracy. Performance measures like accuracy, precision, F1 score, recall etc. were used for comparative study. Optimized selection of these hyper-parameters can further increase the performance of the model.
[10] Asmaa Ali, Hossam S. Hassanein	Title: A Fungus Detection System for Greenhouses Using Wireless Visual Sensor Networks and Machine Learning Journal: IEEE Xplore	The Image processing steps are such as image acquisition, image filtering then segmentation and identify and classify vegetable plant and fruit diseases and measure different leaf parameters.	Greenhouse Fungus Detection Dataset	98.6%	The research gap in this paper is in need for automated and accurate plant disease detection system which is specifically trained for the challenges of a greenhouse.
[11] Sami Ur Rahman,	Image processing based system for the detection, identification and	Gray Level Co Occurrence Matrix (GLCM) algorithm, Support Vector Machine (SVM).	Local tomato crop dataset.	accuracy of 100% for healthy leaf, 95% for early blight,	One direction is to find a way to solve the problem of detection

et al.	treatment of tomato leaf diseases. : 24 August 2022			90% for septoria leaf spot and 85% late blight	failures caused by lighting environment and acquisition at different angles. Another future work is to find a way to solve the problem of detection failures caused by low image resolutions. One more direction is to extend this method from tomatoes to other crops.
[12] Chiara Bersani, et al.	Internet of Things Approaches for Monitoring and Control of Smart Greenhouses in Industry 4.0 : 23 May 2022	Fuzzy Logic, ANN, MPC and PID.	Local data from sensors.	NA	A further required research activity is the one related to considering a greenhouse not as an isolated system but as a system interacting with other similar systems
[13] Amjad Rehman, et al.	A Revisit of Internet of Things Technologies for Monitoring and Control Strategies in Smart Agriculture : 5 January 2022	Several sensors, including distributed WSNs, DCNN model, CNN.	Real time Data.	97.8%	This research will be expanded in the future to include security and privacy issues in smart agriculture using IoT methods.
[14] Emerson Navarro, et al.	A Systematic Review of IoT Solutions for Smart Farming: :29 july 2020	IoT technologies; big data; artificial intelligence; cloud computing	Real time Data.	NA	Another important future research direction could be the analysis of the edge and fog computing usage in smart agriculture as a way to deal with

					challenges
[15] R Amelia, M Mardiyah, and et al.	Title-Automated diseases detection of plant diseases in space greenhouses Journal- IOP Conference(Issue-28 October 2023)	To implement the diagnosis of plant diseases in the form of an application to a smartphone, computer vision methods are promising by counting image pixels in the space of color channels of red, green and blue (R, G, B) [5-10]. A commonly used indicator of plant health is leaf color, which is related to their chlorophyll content.	Proposed method of computer vision was originally implemented on a personal computer using previously obtained color images of leaves of garden strawberry	80%	Conclusion- a program have been developed for the automated determination of the degree of damage to plant leaves by fungal diseases. Future scope- The research results can be implemented in the form of a software application that can be autonomously installed on the researcher's Smartphone
[16] Sunidhi Shrivastava*, Pankaj Gugnani, Neha Garg	Title- Deep Learning Models for Leaf Disease Detection for Crops in Agriculture Field : A Survey Journal –International Journal of Scientific Research(Issue- 01 May 2020)	A machine learning technique was traditionally used to detect and identify the leaf diseases. 1) Image Acquisition 2) Image Pre-processing 3) Image Segmentation 4) Feature Extraction 5) Classification	GoogLeNet Cifar10 with hyperparameter changing model on the 500 images of Maize.	98.9% and 98.8%	Conclusion- In this paper plant and crop disease issue has been discussed. how many kind of diereses area there in the plants are present and how many techniques can be utilized for them to identified the specific disease. Future scope- comparison study can be done and more advance scopes in this area
[17] Tariku Birhanu Wudneh and V.V	Title- Implementation of IoT With Image Processing in Greenhouse Monitoring System Journal - International Journal of Innovative Technology and	The various sensing devices that are to be deployed to gather information about greenhouse such as leaf image, temperature and soil humidity. These sensors are interconnected, as demonstrated through WSN. They interact with a	The NDVI (Normalized Difference Vegetation Index) to identifying healthy and non-healthy plants	84%	Conclusion- Various I/O devices and algorithms to identify and classify infected greenhouse plant leaves have been

anitha	Exploring Engineering (IJITEE)(Issue- 9 July 2019)	processing unit and the network so that the data can be processed, analyzed and stored.			implemented. The system is efficient in terms of monitoring and controlling the greenhouse environment. Future scope- Instead of fixing the camera module in one place it can be made move from one place to another by placing it on a custom camera slider
[18] Rahul Sharma , Amar Singh , and et al.	Title- Plant Disease Diagnosis and Image Classification Using Deep Learning Publication- Computers, Materials & Continua(Issue-9 July 2021)	In Deep Neural network makes accurate predictions by extracting useful features of the input image. Activation maps or feature maps are obtained by applying filters to the input image by each layer of the CNN model.	Rice leaf dataset with 5932 images and 1500 potato leaf images are used in the study	97.66%	Conclusion- The proposed deep learning CNN model demonstrated high accuracy. Performance measures like accuracy, precision, F1 score, recall etc. were used for comparative study. Future scope- Optimized selection of these hyper-parameters can further increase the performance of the model.

III. ALGORITHMIC SURVEY

Table 2 : Algorithmic Survey

Sr No.	Paper Title	AlgorithmName	Accuracy	Time Complexity	Space Complexity
1	Smart Farming Robot for Detecting Environmental Conditions in a Greenhouse	k-Means Algorithm	92%	O(NDKI)	O(N(D + K))
2	MyGreen: An IoT Enabled Smart Greenhouse for Sustainable Agriculture	SVM	81.80%	O(N3)	O(N2)
3	MyGreen: An IoT Enabled Smart Greenhouse for Sustainable Agriculture	Fast.ai	98.40%	N/A	N/A

IV. METHODOLOGY

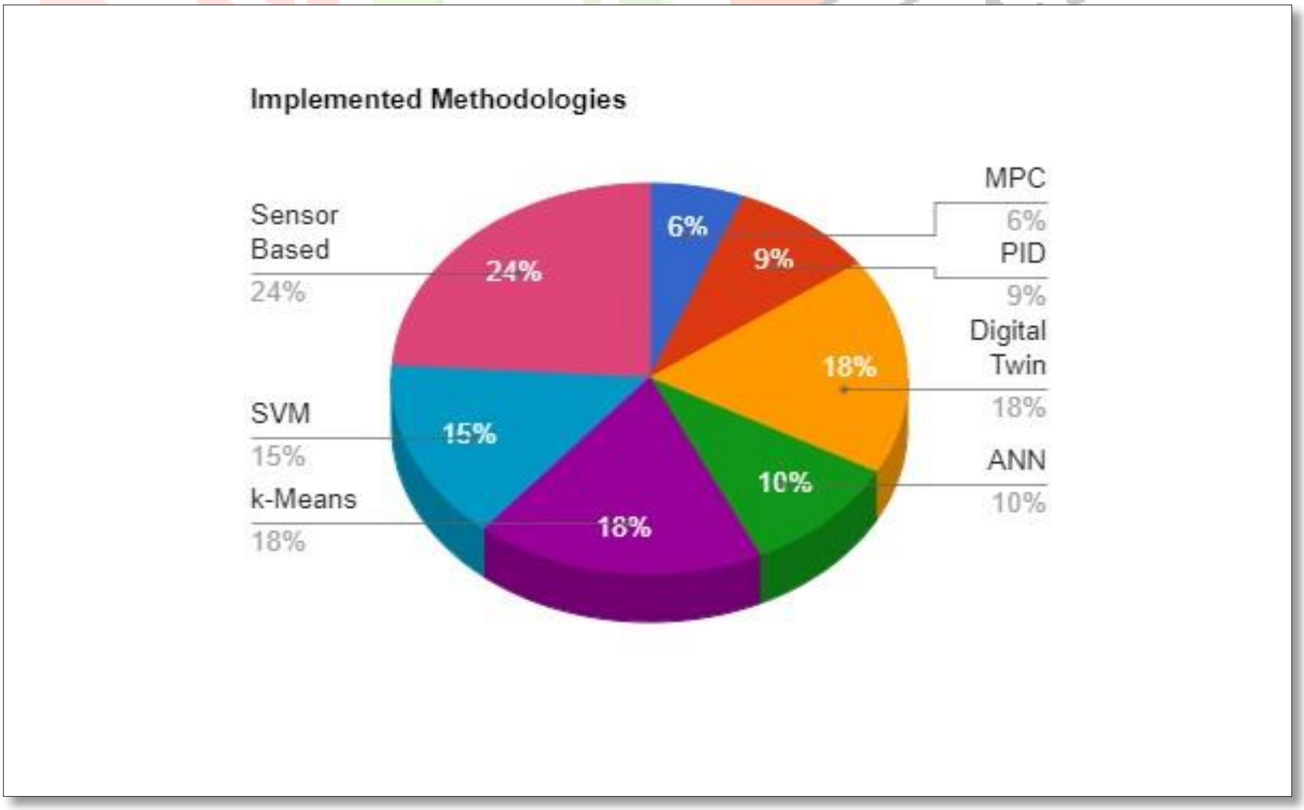

figure 1 : existing methodologies comparison

1) MPC (Model Prediction Control) and PID(Proportional Integral Derivative) :

MPC is the Mathematical Optimization Algorithm used to predict the future behavior of the system . It is also used to control the actions performed by the actuators known as process control .

PID is used to regulate the output of the system taken from the feedback of sensors .

2) Digital Twin and ANN :

Digital Twin is used for predicting real time entities in a digital form . Also it is used to process large amount of sensor data .

ANN is used for analyzing the data from remote sensors . It increases the accuracy and effectiveness of the product

3) Sensor-Based Approach:

This system uses multiple sensors to sense the data . On the data sensed all the parameters are dependent . Thereforsensing the accurate value is the most critical part of the system .

4) SVM and k-Means:

This are the supervised machine learning algorithm used for classifying the images as healthy or unhealthy and also grouping them into different categories of diseases.

V. CONCLUSION

The green house monitoring and controlling system is proposed to address the modern problems of greenhouse systems. Proposed system does monitoring of various parameters such as temperature, humidity, soil moisture and etc.
The systems helps to find out abnormal conditions using above parameters. The system controls the greenhouse by taking remedial actions on the abnormal results of parameters. This data insights are useful for the quality production of crop and is used to predict the health of crop. CNN model is used to identified the plant leaf disease. Where the dataset of plant leaf trained which has leaf images.

The proposed systems also reduces the labor cost which is used for manual controlling and monitoring of green house. Proposed system can be integrated in future. System can extend to use it to outside of the greenhouse system on a wider range. Efficient camera can be introduced for clearer images for better accuracy. Data storage limitations can be overcome by using new age technology such as fog computing. Using fog computing data access will be easier. Security features can be added.

VI. FUTURE SCOPE

Further advancements in smart glove technology can lead to more accurate and robust sign language detection. It can be integrated into educational tools and platforms. Smart gloves can empower deaf or hearing-impaired individuals to live more independently. This technology can also facilitate communication in different settings, such as schools, workplaces, hospitals, and public spaces.

In many countries and regions, various sign languages and dialects exist alongside the standard national sign language. Smart gloves could adapt to these regional variations, enhancing communication for deaf individuals in different local communities. During emergency situations or disasters, it's crucial for first responders to communicate effectively with all members of the community, including those who use local sign languages. Smart gloves can be adapted to assist in such scenarios.

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