Journal of Coastal Life Medicine
www.jclmm.com
ISSN: 2309-5288(Print)/2309-6152(Online)
Volume 10 No.2 (2022), Page No. 64 – 72
Article History: Received: 10 July 2022, Revised: 20 August 2022, Accepted: 18 September 2022

Indoor Agricultural Farming and Plant Disease Detections - A Comprehensive Survey

Mrs. D. Radha
Research Scholar, Vels University
Assistant Professor,
Dept. of Computer Science,
Shri Krishnaswamy College for Women,
Anna Nagar, Chennai-40.
radha.aasc@gmail.com

Dr. S. Prasanna
Head Of the Department
Department of Computer Applications
VELS University
prasanna.scs@velsuniv.ac.in

Abstract: Technology has made great advances in every aspect of life, including industry and agriculture. Agriculture development is fundamental to our way of life. Vertical farms, hydroponics, and urban greenhouses can now be seen in many places across the world as we modify the ways we produce food in response to climate change and global warming. A recent set of research had suggested the usage of sensors to check the production and cameras to acquire facts on farming, giving farmers with information reminders, and alerts. We conducted study on indoor agricultural farming and plant disease detection in this publication. To improve indoor agricultural farming, we investigated numerous smart farming and IoT-based agricultural methods. In plant disease detection, we evaluated various strategies to see which performed better.

Keyword: Indoor agricultural farming, plant disease detections, Smart farming, IoT, Machine Learning, Deep Learning.

I. INTRODUCTION

Human population growth, fast industrialization, and the extension of habitable zones have all contributed to the depletion of agricultural areas. The continuation of these conditions can be exceedingly concerning, compelling nations such as India to increase food production. Many modern approaches have been developed in response to the rising need to meet food demand [1]. Local microclimate, groundwater content, growing environment temperature, humidity, and light intensity are just few of the climate and environmental aspects that have a significant impact on the success of horticultural development. A changing climate is causing extreme weather in many places, including Indonesia [2]. Because of the inherent unpredictability of the horticulture industry's planting cycle, fertilization phase, and harvest time, commercial growers frequently resort to indoor farming.

Journal of Coastal Life Medicine
www.jclmm.com
ISSN: 2309-5288(Print)/2309-6152(Online)
Volume 10 No.2 (2022), Page No. 64 – 72
Article History: Received: 10 July 2022, Revised: 20 August 2022, Accepted: 18 September 2022

The rising food demand must be met despite escalating climate change and the negative environmental effects of intensive agriculture practices. By utilizing IoT technology, such as those used in intelligent agriculture, farmers can increase yield while decreasing water and fertilizer waste. With the addition of AI techniques, it can also aid in pollution prevention, monitor weather conditions cheaply, and provide solutions. The agricultural industry is rapidly adopting new technologies that aim to boost output from seed to harvest by means of monitoring, guidance, and help. As crop-related information becomes more widely available, scientists are conducting research on context awareness and prediction. Instead of routes, Indoor Plant use context histories. This is because context histories refer to a wide range of information collected from things rather than only the displacement history [3].

The logical next step in attempting to address the challenges at hand is remote monitoring and control of these farms. The Internet of Things (IoT) comes into play at this point. Whether wired or wireless, the "things" that make up the "Internet of Things" (IoT) are constantly collecting and relaying information that can be accessed by humans. Cisco estimates that roughly 31 billion IoT devices were linked to the Internet in 2019, and that number is expected to grow dramatically over the following decade. Integrating these low-cost, low-power gadgets into CEA will assist farmers manage their daily tasks by lowering the amount of time required for physical crop monitoring [4].

IoT relies heavily on data sharing. The practice of adopting automation for simple tasks will raise our living standards. We are living in the fourth industrial revolution, which is transforming systems from manual to automatic processes. It introduces the notion of smart industry and offers up numerous research avenues [5]. We investigated indoor agricultural farming and plant disease detection in this paper.

II. LITERATURE SURVEY

Each production system's ultimate purpose is to improve output while decreasing losses. Agriculture has been a long-established production activity from the birth of human civilisation. Utilizing computer automation and environmental sensors, smart irrigation systems enable farmers to more efficiently manage resources like water and electricity, as well as pest identification, are examples. Some smart indoor agricultural farming methods and plant disease detection are listed below.

i. SMART FARMING METHODS

A discussion of the use of automated monitoring and controlling methods in an aeroponic system is provided by Imran Ali Lakhiar et al. in [6]. The breakthrough plant cultivation technique used in modern agriculture is the aeroponic system. Its existence enables year-round uninterrupted food production. Furthermore, the techniques utilized in the aeroponic system require the least amount of manual labor, physical intervention, and expertise in plant-specific knowledge, environmental management, and operations to support and regulate plant growth from seeding to harvest. The system has historically been considered to be somewhat unattractive for the farmer as a result, and installation is uncommon for the reasons mentioned above. The intricate procedure of human monitoring and management may restrict

Journal of Coastal Life Medicine
www.jclmm.com
ISSN: 2309-5288(Print)/2309-6152(Online)
Volume 10 No.2 (2022), Page No. 64 – 72
Article History: Received: 10 July 2022, Revised: 20 August 2022, Accepted: 18 September 2022
the idea of the system's utility. The aeroponic system has great potential to increase farmers' and producers' capacity, dependability, and accessibility thanks to the technology.

Francesco Ruscio et al. [7] discussed the creation of a low-cost monitoring system for hydroponic VF that can be used to remotely monitor the system and help quantify the role of each parameter in crop growth. Because the suggested platform is made up of easily accessible inexpensive sensors and modular components, it is both affordable and simple to set up and use. As a result, the system is simply replicable, and additional sensors can be added as needed. After a sufficient amount of information is gathered, the system can be put to use collecting sensor data for a quantitative evaluation of the farm and for strategic planning purposes. The recommended monitoring platform serves as a springboard for fully autonomous farming by using sensor data as input signals for the activation of fans, valves, lights, and motors, among other equipment. Hydroponics' potential can be harnessed inside this system, making it a possible alternative to traditional farming in the context of impending climate change-related issues.

Yap Shien Chin et al. [8] proposed an IoT-based Vertical Farming Monitoring System that might reduce user stress while providing reliable statistics and analysis. Furthermore, because it is an online system, the system can provide users with rapid access. The system might also follow the sensors that detect critical changes in input and locate the equipment in operation. Furthermore, the system is either controlled by the users or acts automatically when difficulties arise. Users could, for example, utilize a web-based application to turn off the watering system or execute watering activities when the humidity level is severely low. The system's simplicity is projected to boost output while decreasing water usage in the agricultural area.

A CPS system enables remote monitoring of plant growth in vertical farming, according to Chuah Y. D. et al. [9]. Android-based application for remote monitoring and control for plantation systems based on cutting-edge CPS technology has been developed. Test results demonstrated that the newly created CPS system required less effort to monitor and adjust plant development parameters like light, humidity, temperature, pH level, and CO_2. The above system can also be used to inhibit algal development, which is detrimental to plant development. Because of this, a CPS system can be successfully implemented in vertical farming to improve plant quality and growth rate.

A Smart Farm Monitoring System was presented by Mythili R. et al. [10] and can be used to predict the future of agriculture. This would help farmers because it would ease their burden of manual labor. The mission offers the chance to study the current structures, as well as their advantages and disadvantages, and a system to monitor soil moisture levels was developed. The aforementioned equipment can be used to automate one of the most time-consuming farming tasks by turning on and off the water sprinkler based on soil moisture levels. One of the most labor-intensive pastimes is agriculture. The device uses information from soil moisture sensors to irrigate the soil. The same is being tested for live knowledge of farm readings (temperature, humidity). The technique helps farmers improve plant quality and average crop output ratings through smart farming.

Journal of Coastal Life Medicine
www.jclmm.com
ISSN: 2309-5288(Print)/2309-6152(Online)
Volume 10 No.2 (2022), Page No. 64 – 72
Article History: Received: 10 July 2022, Revised: 20 August 2022, Accepted: 18 September 2022

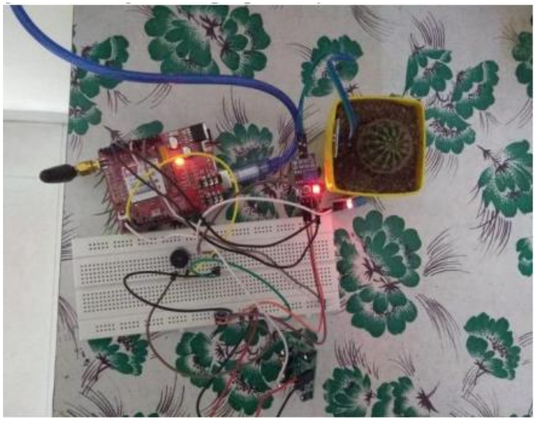

Figure1. Smart Farm Monitoring System [10]

As the number of senior farmers increases, the number of farm house members decreases, and the frequency of lone labor increases in today's agricultural workplace in Korea, Insoo Kim et al. [11] argue that a rapid accident recognition and response system is necessary. This research presented an information and communication technology (ICT) based agricultural safety monitoring system (ASMS) to handle unexpected situations involving farmers and farm labor facilities. The principles of an indoor agricultural safety monitoring system, sensor technology, network technology, and interface technology, as well as a PCB module designed for their execution, were defined in this research. There are several caveats to using this study as basic research to create a safety monitoring system for the farmers, but the study's conclusions can be creatively utilized to reduce the number of accidents caused by recent changes in the agricultural industry.

A modular indoor vertical farming system was created by Isakovic Haris et al. [12] based on the CPS/IoT Ecosystem and Arrowhead IoT framework architecture. The future of sustainable technology is vertical farming. Both unnecessary water use and the use of dangerous chemicals are decreased. Regardless of the weather or other environmental factors, it guarantees healthy and fresh food. The infrastructure for IoT software and hardware is essential for attaining this objective.

ii. PLANT DISEASE DETECTION

Dhruvil Shah et al. [13] argue that applying Deep Learning to solve the problem of early identification of plant diseases could ensure food security. As a result of the many offered solutions, agriculture has become one of the most popular research topics in the fields of Machine Learning and Computer Vision. The goal of this research was to improve upon the results obtained with the previously proposed Teacher/Student design by mixing residual connections and performing batch normalization in the Teacher, Decoder, and Student. ResTeacher + ResDecoder) is an autoencoder that works in tandem with ResStudent. To ensure that the discriminant areas appear exclusively in the recreated images produced by the decoder, ResStudent tells the entire architecture to train in this manner.

A computer vision-based method for identifying plant diseases was developed by Pranesh Kulkarni et al. [14] with an average accuracy of 93% and an F1 score of 0.93. A

Journal of Coastal Life Medicine
www.jclmm.com
ISSN: 2309-5288(Print)/2309-6152(Online)
Volume 10 No.2 (2022), Page No. 64 – 72
Article History: Received: 10 July 2022, Revised: 20 August 2022, Accepted: 18 September 2022

crucial and time-consuming duty in agricultural practices is spotting disease in crops. It requires a lot of time and skilled labor. This study offers a clever and practical method for identifying agricultural diseases using computer vision and machine learning approaches. The recommended method is also computationally effective due to the usage of statistical image processing and a machine learning model. Their approach is more exact and effective than previous approaches. It's a cost-effective solution because it doesn't require specialized hardware.

Figure2. Homepage of deployed API [14].

Modern object detection techniques were employed by Davinder Singh et al. [15] to address the issue of identifying sick vs healthy leaves in photographs. The development of PlantDoc, a brand-new dataset for the detection of plant diseases, is one of the most significant achievements of our work. Our benchmark tests highlight the value of real-world datasets like ours by showing how useless models learnt from controlled datasets are. The dataset's worth could be raised by extracting leaves from photographs using image segmentation methods. We believe that this dataset is an essential first step toward computer vision-based, scalable plant disease diagnosis.

Early detection and prevention of the spread of apple leaf diseases were the goals of Sara Alqethami et al. [16]. 240 images were gathered and categorized as healthy or ill in order to achieve this. The photos were pre-processed to improve the quality of the image, and the segmented region of interest was used to segment features using the Local Binary Pattern (LBP) technique. Prediction models included CNN, SVM, and KNN. The most accurate system was GoogleNet (98.5%). The system offers a user-friendly GUI that shows results of classification and suggestions for treating diseases. Because the indications of several ailments can literally be the same and manifest at the same time, there were some challenging issues that arose during the investigation. This method will eventually be turned into a mobile application to improve usability and speed up diagnosis times.

Eisha Akanksha et al. [17] showed that it is possible to automatically classify plant leaf diseases using an OPNN classifier. To improve the PNN classifier's efficiency, the optimal value for the ANN's smoothing parameter was chosen with the help of AJO. Both AJO and PNN's mathematical operations can be discussed in detail. In addition, the FCM segmentation method has been explained in detail. Our strategy's efficacy has been measured by looking at its precision, responsiveness, and specificity. The proposed approach is equivalent to existing methods in that it has a maximum accuracy of 95.5%. In the future, it will be possible to identify many illnesses in maize plants.

In accordance with Prakash N. et al. [18], the plant is the source of all life. They are the most important and crucial part of our environment. Plants can get sick in various ways, much like people or other living animals. Such illnesses can harm plants in a number of ways, including by preventing the growth of the plant, its blossoms, natural products, and its leaves, among other things, which can lead to a plant's eventual death. For coordinating and documenting plant leaf diseases, use CNN and BRNN. In order to detect and recognize plant illnesses, the research recommended using a mobile application program (APP). The suggested software and hardware output strategy has been proven effective. The mobile APP's output was correctly obtained, and the intended output was successfully completed in the suggested order. Additionally, the MATLAB output was appropriately categorized using CNN and BRNN to identify.

This proposed study focuses on the accuracy values in real-world settings, and this work is implemented by employing several plant disease images. Suresh V. et al. [19] developed an application for differentiating between healthy plants and unhealthy plants. Overall, this effort is quite precise and was entirely original. The next stage is to increase the quantity of images in the provided database and modify the architecture to better match the dataset.

Table1. Accuracy of the Plant disease detection of existing methods.

Author	Methods	Accuracy
Pranesh Kulkarni	Random forest	93%
Davinder Singh	InceptionResNet V2	70.53%
Sara Alqethami	GoogleNet	98.5%
Eisha Akanksha	OPNN	95.5%
V Suresh	Faster RCNN	94.96%

Journal of Coastal Life Medicine
www.jclmm.com
ISSN: 2309-5288(Print)/2309-6152(Online)
Volume 10 No.2 (2022), Page No. 64 – 72
Article History: Received: 10 July 2022, Revised: 20 August 2022, Accepted: 18 September 2022

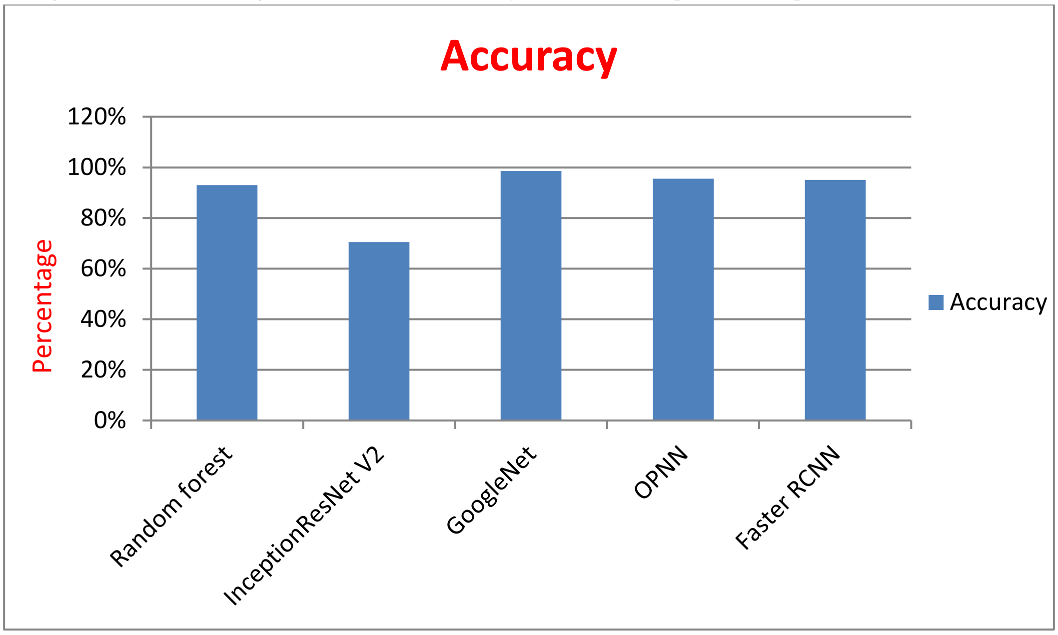

Figure3. Accuracy of the Plant disease detection of existing methods.

Table 1 and Figure3 show the accuracy of the Plant disease detection of different existing methods. From the above figure we can say that deep learning techniques show promising performance in Plant disease detection.

Summary:

- Machine learning and deep learning models should be improved or modified to enable them to recognize and categorize diseases over the course of their whole life cycle because the severity of plant ailments varies over time.
- The datasets should show the actual status as well as photos taken in various field scenarios because the ML/DL model architecture should be effective for particular brightness levels.
- A thorough investigation is necessary to comprehend the factors influencing the detection of plant diseases, such as dataset classifications and size, learning rate, illumination, and so on.
- This system's primary goal is to get ambient temperature, humidity, soil moisture, and brightness from a collection of sensors.
- Precision farming instruments with wireless support may collect data from faraway satellites, feel crop status at ground level, and alter the demand of each individual portion of the agricultural field, as well as put extra fertilizer on places that require more nutrients.
- Farmers can monitor crops at the micro level from a remote place using IoT by monitoring humidity, light, temperature, soil moisture, and so on, and automating watering and other functional aspects.
- Numerous rooftop farms, vertical farms, and green buildings—all IOT-enabled hydroponic farms—can be found close to urban areas, which lowers transportation costs and enables plants to be moved safely.

- It is possible to develop a typical website that will accept sensor data, deliver exact graphics, and help farmers find information. In this way, every farm will be exploited for research.
- Several methods employed by plant scientists to better understand how dietary and environmental factors impact plant growth.

III. CONCLUSION

Agriculture is the world's major source of food. Throughout history, it has been critical to the advancement of civilizations. We conducted study on indoor agricultural farming and plant disease detection in this publication. To improve indoor agricultural farming, we investigated numerous smart farming and IoT-based agricultural methods. In plant disease detection, we evaluated various strategies to see which performed better. Based on the aforementioned results from comparing plant disease detections, we can conclude that Deep Learning approaches perform better in identifying plant diseases with high accuracy. In the future, we can investigate how plant illnesses develop over time. In order to enable them to recognize and categorize diseases during the course of their whole event cycle, Machine Learning and Deep Learning models need be enhanced / altered.

IV. REFERENCES

1. Nuvvula, J., Adiraju, S., Mubin, S., Shahana, B., & Valisetty, V. (2017). Environmental smart agriculture monitoring system using internet of things. *International Journal of Pure and Applied Mathematics*, *115*(6), 313-320.
2. Kaburuan, E. R., & Jayadi, R. (2019). A design of IoT-based monitoring system for intelligence indoor micro-climate horticulture farming in Indonesia. *Procedia Computer Science*, *157*, 459-464.
3. Martini, B. G., Helfer, G. A., Barbosa, J. L. V., Espinosa Modolo, R. C., da Silva, M. R., de Figueiredo, R. M., ... & Leithardt, V. R. Q. (2021). IndoorPlant: A model for intelligent services in indoor agriculture based on context histories. *Sensors*, *21*(5), 1631.
4. Rabka, M., Mariyanayagam, D., & Shukla, P. (2022). IoT-Based Horticulture Monitoring System. In *Intelligent Sustainable Systems* (pp. 765-774). Springer, Singapore.
5. Ali, M., Kanwal, N., Hussain, A., Samiullah, F., Iftikhar, A., & Qamar, M. (2020). IoT based smart garden monitoring system using NodeMCU microcontroller. *International Journal of Advances in Applied Sciences*, *7*(8), 117-124.
6. Lakhiar, I. A., Jianmin, G., Syed, T. N., Chandio, F. A., Buttar, N. A., & Qureshi, W. A. (2018). Monitoring and control systems in agriculture using intelligent sensor techniques: A review of the aeroponic system. *Journal of Sensors*, *2018*.
7. Ruscio, F., Paoletti, P., Thomas, J., Myers, P., & Fichera, S. (2019). Low-cost monitoring system for hydroponic urban vertical farms. *International Journal of Agricultural and Biosystems Engineering*, *13*(10), 267-271.
8. Chin, Y. S., & Audah, L. (2017, September). Vertical farming monitoring system using the internet of things (IoT). In *AIP Conference Proceedings* (Vol. 1883, No. 1, p. 020021). AIP Publishing LLC.

9. Chuah, Y. D., Lee, J. V., Tan, S. S., & Ng, C. K. (2019, June). Implementation of smart monitoring system in vertical farming. In *IOP Conference Series: Earth and Environmental Science* (Vol. 268, No. 1, p. 012083). IOP Publishing.
10. Mythili, R., Kumari, M., Tripathi, A., & Pal, N. (2019). IoT based smart farm monitoring system. *International Journal of Recent Technology and Engineering (IJRTE)*, *8*(4).
11. Kim, I., Lee, K. S., Chae, H. S., & Seo, M. T. (2016). Design of ICT-based agricultural safety monitoring system models. *Journal of the Ergonomics Society of Korea*, *35*(4), 193-204.
12. Haris, I., Fasching, A., Punzenberger, L., & Grosu, R. (2019, June). CPS/IoT ecosystem: Indoor vertical farming system. In *2019 IEEE 23rd International Symposium on Consumer Technologies (ISCT)* (pp. 47-52). IEEE.
13. Shah, D., Trivedi, V., Sheth, V., Shah, A., & Chauhan, U. (2022). ResTS: Residual deep interpretable architecture for plant disease detection. *Information Processing in Agriculture*, *9*(2), 212-223.
14. Kulkarni, P., Karwande, A., Kolhe, T., Kamble, S., Joshi, A., & Wyawahare, M. (2021). Plant disease detection using image processing and machine learning. *arXiv preprint arXiv:2106.10698*.
15. Singh, D., Jain, N., Jain, P., Kayal, P., Kumawat, S., & Batra, N. (2020). PlantDoc: a dataset for visual plant disease detection. In *Proceedings of the 7th ACM IKDD CoDS and 25th COMAD* (pp. 249-253).
16. Alqethami, S., Almtanni, B., Alzhrani, W., & Alghamdi, M. (2022). Disease Detection in Apple Leaves Using Image Processing Techniques. *Engineering, Technology & Applied Science Research*, *12*(2), 8335-8341.
17. Akanksha, E., Sharma, N., & Gulati, K. (2021, January). OPNN: optimized probabilistic neural network based automatic detection of maize plant disease detection. In *2021 6th International Conference on Inventive Computation Technologies (ICICT)* (pp. 1322-1328). IEEE.
18. Prakash, N., Udayakumar, E., & Kumareshan, N. (2020, July). Design and development of Android based Plant disease detection using Arduino. In *2020 7th International Conference on Smart Structures and Systems (ICSSS)* (pp. 1-6). IEEE.
19. Suresh V., Gopinath D., Hemavarthini M., Jayanthan K., Krishnan M. (2020, March). Plant Disease Detection using Image Processing. *In 2020 International Journal of Engineering Research & Technology*. Vol. 9 Issue 03. IJERT.