JOURNAL OF BASIC SCIENCE AND ENGINEERING

LEAF DISEASE PREDICTION USING CONVOLUTIONAL NEURAL NETWORK

Venkatesh.R[1]
Department of Computer Science and Engineering
Karpagam College Of Engineering
Othakkalmandapam Coimbatore-641032
jaikrish06@gmail.com

Swathi.L[2]
Department of Computer Science and Engineering
Karpagam College Of Engineering
Othakkalmandapam Coimbatore-641032
swathilakkaian17@gmail.com

Priyanka.C[3]
Department of Computer Science and Engineering
Karpagam College Of Engineering
Othakkalmandapam Coimbatore-641032
priyankachidambaram23@gmail.com

Shobana.A[4]
Department of Computer Science and Engineering
Karpagam College Of Engineering
Othakkalmandapam Coimbatore-641032
sopugg28@gmail.com

ABSTRACT

Agriculture suffers greatly from leaf diseases, which result in significant yield losses. In order to effectively manage and prevent many disorders, early and correct identification is essential. Deep learning methods, such Convolutional Neural Networks (CNN), have demonstrated encouraging performance in picture classification tasks in recent years. A CNN-based methodology for predicting leaf disease is proposed in this paper. The framework is composed of three basic steps: disease categorization, feature extraction using CNN models that have already been trained, and picture preprocessing. The suggested method makes use of CNN models' capacity to automatically extract discriminative characteristics from input photos. A collection of leaf images with various disease classes is used to train and assess the model's performance. The tests show that the CNN-based framework outperforms conventional machine learning techniques in disease categorization, achieving high accuracy. With the use of this method, leaf illnesses can be predicted quickly and accurately, giving farmers the opportunity to take prompt action to manage the disease. Because CNN models are used, the system may be scaled and adjusted to fit different crop kinds and disease groups. The keywords for this abstract are: leaf diseases, Convolutional Neural Networks, image classification, deep learning, feature extraction, disease prediction, agriculture, and disease management.

I. INTRODUCTION

A growing area of study in agriculture is leaf disease prediction, which uses cutting-edge tools like Convolutional Neural Networks (CNNs) to precisely and effectively diagnose and categorize plant illnesses. This methodology presents a promising alternative for early detection and prompt intervention in light of the growing requirement for precise crop monitoring and disease management. CNNs are a particular kind of deep learning algorithm that is used to handle visual input; hence, they are perfect for examining photos of diseased leaves. CNNs are able to distinguish between leaves that are healthy and those that are afflicted with different diseases by simulating the pattern recognition capabilities of the human brain.

There are various steps involved in employing CNNs to forecast leaf disease. Initially, hundreds of photos of both healthy and unhealthy leaves are gathered and tagged to create a dataset. These photos depict the many signs and traits—such as discoloration, deformity, spots, and patterns—that are connected to distinct illnesses. The dataset is then preprocessed to improve image quality and standardize color, lighting, and background variances. By taking this step, you can make sure that the CNN can correctly comprehend the unique patterns and characteristics of each disease.

After the dataset is ready, a sizable collection of labeled photos is used to train the CNN model. In order to reduce the error between its predicted outputs and the ground truth labels, the model continuously optimizes its parameters throughout training as it gains the ability to identify and extract pertinent characteristics from the input images. Once the model reaches an accuracy level that is considered satisfactory, this iterative process keeps going.

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

The CNN model is prepared to forecast the disease status of unseen leaf pictures after training. The model applies its acquired knowledge to identify patterns and features in a new image that might point to the existence of a disease. The image is subsequently classified into the appropriate disease group using these traits, allowing for early identification and intervention. By incorporating more pertinent data, such as weather patterns, soil characteristics, and plant growth stages that may influence the development of diseases, the predictions produced by CNN can be improved even more.

CNN-based leaf disease prediction has many advantages over conventional techniques. It makes it possible to identify illnesses quickly and accurately, which facilitates prompt action and efficient disease management. Moreover, farmers and other field stakeholders can access this strategy because it can be implemented in real-time utilizing portable devices like cellphones. Additionally, because CNNs are able to process vast amounts of data fast and consistently, they lessen the need for human expertise and increase the overall efficiency and scalability of illness prediction systems.

In conclusion, by offering an automated and dependable method of disease identification, leaf disease prediction using convolutional neural networks has the potential to completely transform the agricultural sector. This approach makes use of deep learning and computer vision to facilitate proactive interventions, early identification, and optimum disease management. Technology has enormous potential to increase crop productivity, lower financial losses, and support sustainable farming methods as it develops.

II. RELATED WORKS

[1] Panchbhai, K. G., and Lanjewar, M. G. (2023). A smartphone application that uses PaaS cloud to detect tea leaf illness is based on convolutional neural networks. 35(3), 2755-2771, Neural Computing and Applications.

Using a smartphone and cloud platform, the authors suggest a convolutional neural network (CNN) based system for predicting illnesses of tea leaves. In order to enable farmers take prompt action to safeguard their crops, the system attempts to provide early detection and diagnosis of diseases that threaten tea plants. Using a dataset of photos of tea leaves, the CNN model is trained, and it performs well in classifying diseases. After that, the model is used on a smartphone, utilizing cloud computing to process and analyze data.

[2] Sudar, K. M., Naidu, M. M., Prakash, B., Nagaraj, P., & Kumar, H. (2022, May). Using

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

artificial intelligence, a tomato leaf disease prediction system for farmers is being developed. The sixth international conference on intelligent control and computing systems (ICICCS) is scheduled for 2022. (pp. 955-961). IEEE.

An artificial intelligence network-based tomato leaf disease prediction system is presented by the authors. The technique attempts to give growers a dependable instrument for detecting and controlling tomato plant illnesses. A dataset of photos of tomato leaves is used to train the network, and the resultant trained model is accurate in classifying various illnesses. Farmers may use the system to make well-informed decisions about disease control strategies because it is made to be easily available to them.

[3] Thangaraj, R., Kaliappan, V. K., Anandamurugan, S., and Pandiyan, P. (2022). A thorough analysis and debate of artificial intelligence in tomato leaf disease detection. 129(3), 469–488 in Journal of Plant Diseases and Protection.

An extensive summary of the application of artificial intelligence methods for tomato leaf disease diagnosis is given in this review of the literature. The various methods and algorithms for diagnosing and categorizing diseases are covered by the writers. They also draw attention to the difficulties and restrictions that come with using these methods. For researchers and practitioners interested in using AI to manage tomato diseases, the review is a useful resource.

[4] Kilaru, R., & Raju, K. M. (2022, February). Prediction of maize leaf disease detection to improve crop yield using machine learning based models. In 2021 4th International Conference on Recent Trends in Computer Science and Technology (ICRTCST) (pp. 212-217). IEEE.

This paper focuses on the prediction of maize leaf diseases using machine learning models to improve crop yield. The authors propose a framework that combines image processing techniques with machine learning algorithms to detect and classify different maize leaf diseases. The models are trained on a dataset of maize leaf images and achieve high accuracy in disease detection. The study suggests that early detection of diseases can help farmers take appropriate measures to prevent crop loss.

[5] Nagaraja, G., Krishna, A. V., Nagendra, P., Aluvala, R., Kumar, M. R., and Ramana, K. (2022). Deep neural network architecture and Internet of Things are being used in smart agriculture to classify leaf diseases. 31(15), 2240004, Journal of Circuits, Systems, and Computers.

This study employs an IoT and deep neural network architecture to classify leaf diseases in smart agriculture. The authors suggest a method for identifying and categorizing plant illnesses that combines Internet of Things technology with leaf image analysis. With the use of a dataset of leaf image training, the deep neural network model is able to classify diseases with high accuracy. In order to protect crops in a timely manner, the system can offer real-time monitoring and early disease identification.

[6] Kumar, A. N., SakthiMohan, M., Balaji, K., Yugandher, B., Rani, G. E., and Venkatesh, E. (2022, April). Convolutional Neural Network-based automated crop and fertilizer disease prediction (CNN). The 2nd International Conference on Innovative Technologies in Engineering and Advancing Computing (ICACITE) is scheduled for 2022. (pp. 1990-1993). IEEE.

The authors suggest utilizing convolutional neural networks to create an automated prediction system for fertilizer and crop diseases (CNN). In order to help farmers maximize fertilizer usage and reduce crop loss, the system attempts to diagnose diseases related to crops and fertilizers in an accurate and timely manner. After being trained on a dataset of photos of crops and fertilizer, the CNN model predicts diseases with a high degree of accuracy. Farmers will be able to easily access the system using web platforms or mobile applications.

[7] Jaisakthi, S. M., and Anandhakrishnan, T. (2022). Using images, deep convolutional neural networks can identify tomato leaf disease. Eco-Friendly Chemistry and Pharmaceuticals

III. EXISTING SYSTEM

The current Convolutional Neural Network (CNN)-based approach for predicting Leaf Disease has a number of drawbacks that reduce its efficacy and usefulness. First off, the need for a sizable labeled dataset for CNN model training is one of the primary disadvantages. It takes a lot of work and time to obtain a significant volume of correctly labeled data since a large number of leaves must be personally inspected in order to be appropriately classified. This is labor-intensive and prone to human mistake, which could result in inaccurate results in the training dataset.

Furthermore, CNN models need specialized hardware or high-performance computers to function well due to their enormous processing demands. The current system's accessibility and usefulness are limited by its reliance on hardware, especially in places with limited resources where such infrastructure would not be easily accessible or reasonably priced. Longer processing delays brought on by the increased computational needs also cause the prediction process to become less responsive and slower.

The trained CNN model's limited generalizability is an additional drawback. Although the model is usually trained on a single dataset, testing it on other datasets or in real-world situations may cause it to perform worse. The current system's application may be limited by this lack of

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

generalization, as it may have trouble correctly forecasting leaf diseases in new or unfamiliar situations.

Nevertheless, the CNN model's interpretability may provide difficulties. Since CNNs are renowned for being "black-box" models, it can be challenging to decipher and comprehend the logic underlying their predictions. Concerns are raised by this lack of interpretability, particularly in crucial applications like illness prediction where elucidating and justifying forecasts is crucial to fostering confidence and facilitating well-informed decision-making.

In conclusion, there are a number of issues with the current Convolutional Neural Network-based approach for predicting Leaf Disease. Large labeled datasets are necessary, as are significant processing demands, restricted generalizability, and poor interpretability. In order to guarantee the system's applicability in real-world circumstances and to improve its effectiveness and practicality, it is imperative that these challenges be addressed.

IV. PROPOSED SYSTEM

The suggested study uses a convolutional neural network to create a leaf disease prediction system (CNN). The agricultural sector is seriously threatened by leaf diseases, which can result in crop loss and lower output. The goal of this work is to create an accurate and effective model for identifying and categorizing leaf diseases by utilizing CNN's capabilities, a deep learning technique that is frequently used for image recognition and classification applications.

The initial phase of the planned effort is data gathering, which will require compiling a sizable dataset of leaf photos that include both disease-affected and healthy leaf types. In order to improve the CNN model's capacity for generalization, the dataset will be carefully selected to ensure a varied representation of plant species and disease kinds.

Using typical data partitioning procedures, the prepared dataset will be split into training, validation, and testing sets. The CNN architecture's design and implementation are the following steps. A number of convolutional layers, pooling layers, and fully connected layers make up the selected architecture, which will use the input leaf images to identify and extract pertinent information.

Using a suitable optimization technique, the training data will be utilized iteratively to minimize the loss function and update the network weights in order to train the CNN model. To improve the model's performance, hyperparameter tuning will be carried out to determine the ideal learning rate, batch size, and regularization parameters, among other things.

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

Finally, the accuracy, precision, recall, and F1 score of the trained CNN model will be assessed using the validation set. The model's performance can also be enhanced by fine-tuning methods such as transfer learning, which make use of pre-trained CNN models on substantial image datasets.

Ultimately, the testing set will be used to evaluate the effectiveness of the constructed CNN model, gauging its classification accuracy and contrasting it with other cutting-edge techniques for predicting leaf disease. The goal of the proposed effort is to predict leaf illnesses with high accuracy, robustness, and efficiency. This would help farmers and agricultural specialists identify and control plant diseases in a timely manner, avoiding crop losses and guaranteeing food security.

V. SYSTEM ARCHITECTURE

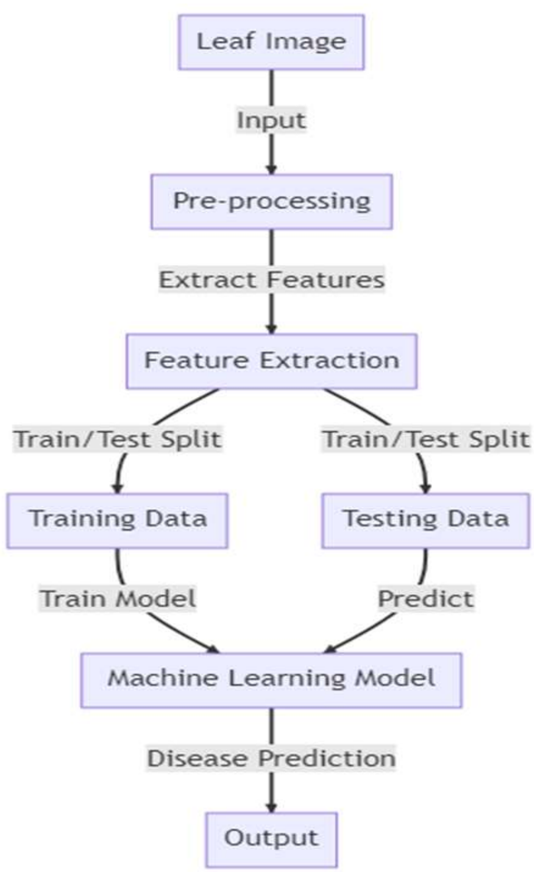

Fig. 1. System Architecture

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

VI. METHODOLOGY

1. Module 1: Preprocessing Data and Extracting Features
Data preparation is done in the first module to improve the accuracy and applicability of the input data. This include resolving missing values, eliminating any superfluous or noisy data points, and correcting any class imbalance that may exist. In addition, the dataset is split into testing, training, and validation sets in order to assess and verify the Convolutional Neural Network (CNN) model's performance.

In this module, feature extraction is still another essential step. It entails taking pertinent features out of the leaf photos in order to capture the traits and patterns connected to various leaf diseases. Using CNN-based methods including activation functions, pooling layers, and convolutional layers, the discriminative characteristics from the leaf pictures are extracted and improved. The following modules in the suggested system use these features as inputs.

2. Model Training and Optimization in Module Two
This module uses the preprocessed dataset to train the CNN model. Several convolutional layers are included in the CNN architecture, which is then followed by pooling layers and fully linked layers. Many tagged leaf photos that have been divided into different disease categories are used to train the model. The model modifies its parameters during training in order to reduce the discrepancy between the expected and actual outputs. Gradient descent and backpropagation techniques are used to modify the CNN layers' weights and biases in order to accomplish this optimization.

Several strategies are used to improve the trained model's performance, including batch normalization and dropout regularization procedures. These methods aid in reducing overfitting and enhancing the model's capacity for generalization. Until the model's accuracy and performance are at an acceptable level, it is trained and refined iteratively.

3. Module 3: Making Decisions and Diagnosing Diseases
The suggested system's last module deals with diagnosing illnesses and making decisions using the CNN model that has been trained. This module estimates the likelihood that each leaf image will fall into a certain disease category by feeding the preprocessed and classed leaf photos into the trained model. The disease diagnosis and a confidence score for each prediction are output by the model.

Based on the anticipated probability, post-processing methods like thresholding and decision rules are used to arrive at the final disease diagnosis. The user may be presented with the diagnosis along with pertinent details regarding the identified illness, potential therapies, and safeguards. To provide more precise and individualized suggestions for disease control, the

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

decision-making process may also involve combining additional data, such as weather, location, and crop history.

Together, these three modules—disease diagnosis and decision-making, model training and optimization, and data preparation and feature extraction—create a thorough framework for leaf disease prediction using CNNs. In order to support sustainable agricultural practices, this framework attempts to offer precise, effective, and user-friendly solutions for the early diagnosis and control of crop diseases.

VII. RESULT AND DISCUSSION

Using deep learning techniques, the Convolutional Neural Network (CNN) system for Leaf Disease prediction is an inventive method that reliably detects the presence of illnesses in plant leaves. The CNN model is well-suited for image classification tasks like leaf disease identification since it is a particular kind of artificial neural network that is specifically made to assess visual input.

There are two steps in the system's procedure. Secondly, the CNN model is trained using a dataset of tagged photos of both healthy and unhealthy leaves. The model gains the ability to automatically extract features from the input photographs and recognize patterns that could be signs of different diseases throughout the training phase. As a result, it may forecast data that hasn't been observed accurately.

The CNN model can be used in practical applications after it has been trained. In order to extract relevant information from a newly uploaded leaf image, the CNN algorithm runs the image through multiple layers of filters. A classification layer receives the collected features and uses them to assign a probability to each disease class. The sickness that is predicted is the one in the disease class with the highest chance.

When compared to conventional leaf disease detection techniques, the system has a number of benefits. Given that CNN models are quite good at spotting intricate patterns in photos, it is very accurate. Because the results may be obtained in a matter of seconds, it is also time-efficient. It is also a non-invasive method that doesn't harm the plants, which makes it appropriate for extensive crop monitoring. All things considered, the Convolutional Neural Network-based Leaf Disease Prediction System transforms the agricultural industry by offering a dependable and effective instrument for early disease detection, empowering farmers to take preventative action to safeguard their crops and boost productivity.

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

VIII. CONCLUSION

Convolutional neural networks (CNNs) are a powerful and accurate method for identifying and forecasting a variety of leaf illnesses, as demonstrated by the system for leaf disease prediction. The system can efficiently extract features from leaf photos and accurately classify them into several disease groups by utilizing CNN. In addition to increasing the effectiveness of disease detection, this cutting-edge technology helps stop illnesses from spreading, which reduces crop losses and raises crop output overall. The application of CNN to the prediction of leaf disease highlights the promise of deep learning algorithms in the crucial field of agriculture, offering farmers invaluable assistance and facilitating sustainable farming methods.

IX. FUTURE WORK

Convolutional neural networks (CNNs) can be used to improve the leaf disease prediction system in future research in a number of ways. First, by extracting more significant features from leaf photos, more sophisticated CNN architectures like ResNet or Inception can be investigated, potentially improving the accuracy of illness identification. Furthermore, the collection can be enlarged by adding more varied leaf photos from various regions and capturing various disease phases. As a result, the model would be stronger and better equipped to generalize to different environmental situations. Moreover, pre-trained models on sizable datasets such as ImageNet can be refined for the identification of leaf disease through the use of transfer learning techniques. This strategy may help the model perform better on the leaf disease classification problem by utilizing the knowledge gathered from the large-scale datasets. Lastly, farmers and gardeners can simply utilize the system for real-time leaf disease identification and treatment recommendations by deploying it as a mobile application. In order to give users complete assistance for efficient disease management, the application may additionally incorporate further elements like suggested therapies and an estimate of the severity of the disease.

REFERENCES

[1] Lanjewar, M. G., & Panchbhai, K. G. (2023). Convolutional neural network based tea leaf disease prediction system on smart phone using paas cloud. Neural Computing and Applications, 35(3), 2755-2771.

[2] Sudar, K. M., Nagaraj, P., Prakash, B., Reddy, M. M., Naidu, M. M., & Kumar, H. (2022, May). Development of Tomato Leaf Disease Prediction System to the Farmers by using Artificial Intelligent Network. In 2022 6th International Conference on Intelligent Computing and Control Systems (ICICCS) (pp. 955-961). IEEE.

[3] Thangaraj, R., Anandamurugan, S., Pandiyan, P., & Kaliappan, V. K. (2022). Artificial intelligence in tomato leaf disease detection: a comprehensive review and discussion. Journal of Plant Diseases and Protection, 129(3), 469-488.

[4] Kilaru, R., & Raju, K. M. (2022, February). Prediction of maize leaf disease detection to improve crop yield using machine learning based models. In 2021 4th International Conference on Recent Trends in Computer Science and Technology (ICRTCST) (pp. 212-217). IEEE.

[5] Ramana, K., Aluvala, R., Kumar, M. R., Nagaraja, G., Krishna, A. V., & Nagendra, P. (2022). Leaf disease classification in smart agriculture using deep neural network architecture and IoT. Journal of Circuits, Systems and Computers, 31(15), 2240004.

[6] Rani, G. E., Venkatesh, E., Balaji, K., Yugandher, B., Kumar, A. N., & SakthiMohan, M. (2022, April). An automated prediction of crop and fertilizer disease using Convolutional Neural Networks (CNN). In 2022 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE) (pp. 1990-1993). IEEE.

[7] Anandhakrishnan, T., & Jaisakthi, S. M. (2022). Deep Convolutional Neural Networks for image based tomato leaf disease detection. Sustainable Chemistry and Pharmacy, 30, 100793.

[8] Nagamani, H. S., & Sarojadevi, H. (2022). Tomato leaf disease detection using deep learning techniques. International Journal of Advanced Computer Science and Applications, 13(1).

[9] Pal, A., & Kumar, V. (2023). AgriDet: Plant Leaf Disease severity classification using agriculture detection framework. Engineering Applications of Artificial Intelligence, 119, 105754.

[10] Liu, Z., Bashir, R. N., Iqbal, S., Shahid, M. M. A., Tausif, M., & Umer, Q. (2022). Internet of Things (IoT) and machine learning model of plant disease prediction–blister blight for tea plant. Ieee Access, 10, 44934-44944.