AI-Powered Plant Disease Detection, Monitoring, and Prediction for Farmers

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ABSTRACT

Plant diseases pose significant threats to farmers, consumers, the environment, and the global economy. In India, crop losses attributed to pathogens and pests account for 35% of farmers' harvests. The use of pesticides, while common, raises serious health concerns due to the toxic nature of many chemicals, which can have harmful effects on living organisms. Effective disease detection, crop monitoring, and tailored treatment strategies can mitigate these issues. Traditionally, agricultural experts identify diseases by searching for visible symptoms; however, farmers often lack direct access to these specialists.

Our initiative introduces the first comprehensive, collaborative platform for the automatic diagnosis, tracking, and forecasting of plant diseases. Through a user-friendly smartphone application, farmers can quickly and accurately identify diseases by capturing images of afflicted plant parts. This process leverages advanced AI algorithms for real-time cloud-based image processing. The AI model continually enhances its accuracy based on data collected from user-uploaded images and feedback from experts. Additionally, farmers can consult local specialists directly through the platform.

The system generates disease density maps and forecasts the likelihood of disease spread using a cloud-stored database of geo-tagged images and micro-climate data for preventative strategies. Agricultural experts can conduct geographically focused disease assessments via a web interface. Our research involved training a convolutional neural network (CNN) AI model with extensive datasets of plant disease images, collected from multiple farms over a span of seven months. Validation of the automated CNN model was performed by plant pathologists, resulting in a remarkable diagnostic accuracy of over 95%. This innovative tool empowers farmers and agricultural experts in managing plant diseases effectively, enabling them to sustainably maximize crop yields.

Keywords: CNN, Machine learning, Neural Network. Artificial Intelligence

INTRODUCTION

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SYSTEM ANALYSIS

EXISTING SYSTEM:

In India, the agricultural sector faces significant challenges, with pathogens and pests causing a 35% failure rate in field crops, leading to substantial financial losses for farmers. The widespread use of pesticides adds another layer of concern, as many of these chemicals are highly toxic and can worsen public health issues through bioaccumulation in living organisms. Current methods for disease management rely heavily on traditional approaches, where agricultural experts primarily look for visible symptoms when diagnosing plant diseases. Unfortunately, farmers often lack direct access to these specialists, making timely intervention difficult.

DISADVANTAGE:

The reliance on pesticides carries serious health risks due to their toxicity. When misused or applied indiscriminately, these chemicals can lead to amplified negative effects on both human health and the environment, underscoring the need for safer, more effective methods of disease management in agriculture.

PROPOSED SYSTEM:

In this study, we leverage a comprehensive dataset of plant disease photographs to train a convolutional neural network (CNN) that can identify plant diseases in newly submitted images. The trained CNN model, along with the associated datasets, is securely stored in the author's cloud account, allowing for accurate predictions of plant diseases to be generated from the cloud.

To facilitate the submission of photographs, a user-friendly online application developed in Python has been created, as developing a dedicated Android app would be prohibitively costly and time-consuming for our project. This online tool enables the training of the CNN and subsequently analyzes the uploaded images for disease prediction.

ADVANTAGES OF PROPOSED SYSTEM:

Utilizes a smartphone to capture images of affected plant parts, enabling precise and efficient disease diagnosis.

SYSTEM DESIGN

SYSTEM ARCHITECTURE DIAGRAM:

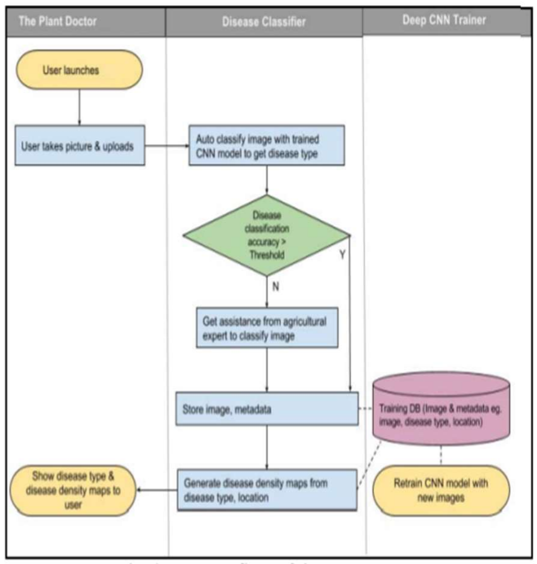


Fig 1: Machine Learning Techniques for Disease Identification:

Discussion of various machine learning algorithms used for plant disease identification

Mention of image recognition techniques, including convolutional neural networks (CNNs), and their role in analyzing leaf images for disease symptoms.

Case studies and examples of successful disease identification systems[2].

Tracking and Monitoring Plant Diseases:

Explanation of how machine learning can be used to track and monitor the spread of diseases.

Utilization of sensor data, satellite imagery, and IOT devices for real-time disease tracking

Illustration of how data-driven insights can aid in early disease detection and control[3].

Forecasting Disease Outbreaks:

Elaboration on the predictive capabilities of machine learning models in forecasting disease outbreaks[4].

Discussing the integration of historical data, weather patterns, and environmental factors to predict disease occurrencesImportance of accurate forecasting in enabling farmers to implement preventive measures[5].

Challenges and Considerations:

- Addressing challenges such as data quality, model robustness, and interpretability.
- Ethical considerations in data collection and sharing, especially when involving farmers' data
- Discussion on the digital divide and ensuring accessibility to technology in different agricultural regions

Benefits and Impact:

- Outlining the potential benefits of implementing machine learning in disease management
- Improved crop yield, reduced pesticide usage, and minimized economic losses.
- Positive ecological impact through targeted treatments

Case Studies and Applications:

Highlighting real-world applications and success stories from different regions

Examples of collaborations between researchers, farmers, and technology developers

Demonstrating the scalability and adaptability of machine learning solutions

Future Directions:

- Speculating on the future developments in this field
- Advancements in AI and data collection techniques
- Integration of other technologies such as blockchain and edge computing

ALGORITHM MODEL

Many studies have discussed utilising transfer learning to identify common CNN models for plant disease diagnosis, and they have found extremely high classification accuracy. However, these untrained models need a lot of storage space and laborious training since they have a significant number of nodes in the flattening layers and convolution layers. This chapter aims to demonstrate that even with simple CNN models, extremely high classification accuracies may be achieved[8]. The method has been demonstrated through the categorization of diseases in tomato and grape crops. The outcomes have also been contrasted with what can be learned using conventional machine learning techniques. The plant village dataset that is utilised for case studies is described after the chapter first explains the light versions of CNN models. Then, using the light versions, tests on tomato and grape crops are conducted[9].

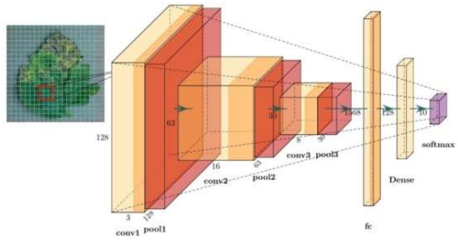


Fig 2: CNN model

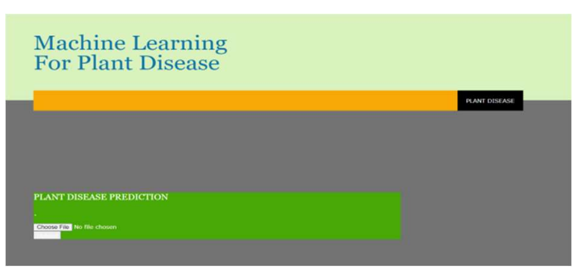
RESULTS

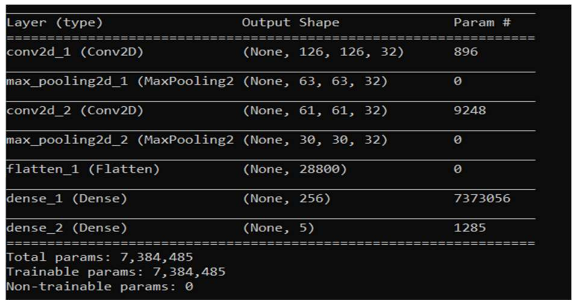
Register page:

Login page:

Main page:

Cotton crop disease:





Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 126, 126, 32)	896
max_pooling2d_1 (MaxPooling2	(None, 63, 63, 32)	0
conv2d_2 (Conv2D)	(None, 61, 61, 32)	9248
max_pooling2d_2 (MaxPooling2	(None, 30, 30, 32)	0
flatten_1 (Flatten)	(None, 28800)	0
dense_1 (Dense)	(None, 256)	7373056
dense_2 (Dense)	(None, 5)	1285

Total params: 7,384,485
Trainable params: 7,384,485
Non-trainable params: 0

CONCLUSION

Farmers face a significant challenge in the accurate, timely, and early identification of crop diseases and awareness of disease outbreaks. Our initiative provides an effective, end-to-end, and low-cost solution to address this issue. By improving their ability to select the most effective strategies to prevent disease spread, farmers can enhance their crop management practices.

This proposal builds upon previous efforts by utilizing deep Convolutional Neural Networks (CNNs) for disease classification, establishing a collaborative social platform that enhances accuracy over time, creating disease density maps using geo-tagged images, and offering an expert interface for detailed analysis. Through a user-friendly mobile application, the advanced deep CNN model, "Inception," enables real-time disease categorization in the cloud.

The collaborative approach allows for ongoing improvements in diagnostic accuracy by automatically expanding the cloud-based training dataset with images uploaded by users for retraining the CNN. The incorporation of geolocation data from these images enables the development of comprehensive disease density maps based on aggregate disease classification data.

Overall, our experimental findings highlight the substantial potential for practical implementation of this proposal. Key factors such as the highly scalable cloud-based infrastructure, the algorithm's accuracy across a wide range of disease categories, improved performance with high-quality real-world training data, enhanced accuracy with larger training datasets, and the capability to detect multiple diseases simultaneously all contribute to the viability and effectiveness of our solution.

REFERENCES

[1] L. Saxena and L. Armstrong, "A survey of image processing techniques for agriculture," Asian Federation for Information Technology in Agriculture, Proceedings, 2014, pp. 401-413.

[2] "Measuring quantitative virulence in the wheat pathogen Zymoseptoria tritici using high-throughput automated image analysis," Phytopathology 104, no. 9, 2014, pp. 985–992.

[3] "Imagenet classification with deep convolutional neural networks," Advances in Neural Information Processing Systems, 2012; A. Krizhevsky, I. Sutskever, and G. E. Hinton. TensorFlow

[4].You may find it at https://www.tensorflow.org

[5] D. P. Hughes, M. Salathé, and others. "An open access repository of images on plant health to enable the development of mobile disease diagnostics through machine learning and crowdsourcing," CoRR abs/1511.08060, 2015.

[6] "Automatic detection of diseased tomato plants using thermal and stereo visible light images," PLoS ONE, S. Raza, G. Prince, J. P. Clarkson, and N. M. Rajpoot, 2015.

[7] "Integrating soms and a bayesian classifier for segmenting diseased plants in uncontrolled environments," D. L. Hernández-Rabadán, F. Ramos-Quintana, and J. Guerrero Juk published in the Scientific World Journal in 2014.

[8] "Visible-near infrared spectroscopy for detection of huanglongbing in citrus orchards," in Computers and Electronics in Agriculture 77, 2011, pp. 127–134. S. Sankaran, A. Mishra, J. M. Maja, and R. Ehsani.

[9] "A comparative study on application of computer vision and fluorescence imaging spectroscopy for detection of huanglongbing citrus disease in the USA and Brazil," Journal of Spectroscopy, 2013. C. B. Wetterich, R. Kumar, S. Sankaran, J. B. Junior, R. Ehsani, and L. G. Marcassa.

[10] "Rethinking the inception architecture for computer vision," by C. Szegedy, Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2016, pp. 2818–2826.