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PLANT DISEASE PREDICTION USING MACHINE LEARNING

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ABSTRACT

Plant diseases drastically impair crop productivity and jeopardize global food security. Automated illness prediction with machine learning (ML) provides a scalable method for early identification and management. This research describes a hybrid machine-learning system that blends image-based deep learning (Convolutional Neural Networks) for symptom classification with traditional ML models (Random Forest) that use environmental and agronomic factors to forecast disease recurrence. We test the method using a multi-crop dataset (leaf photos and weather recordings). The suggested method obtains an average classification accuracy of 94.2% for image-based detection and an F1-score of 0.92 for combined illness occurrence prediction (example values). The findings indicate that combining visual and contextual data enhances prediction robustness and facilitates prompt intervention measures.

Keywords— Plant disease, Deep learnig, C-NN algorithm, Image classification

INTRODUCTION

A Agricultural productivity is closely linked to plant health. Farmers can apply targeted remedies and minimize crop loss when illnesses are identified early and accurately. Expert inspection is necessary for traditional diagnosis, but it takes time and is not available in many places. Automated, inexpensive illness identification using photos and environmental data is made possible by developments in computer vision and machine learning. In order to predict the likelihood of a disease outbreak at the field level, this work suggests a two-stage pipeline: (1) a CNN model that classifies leaf images into disease categories; and (2) a Random Forest model that combines the CNN's confidence outputs with temporal and environmental features (temperature, humidity, rainfall, soil moisture). The contributions consist of: a hybrid pipeline that combines contextual and visual data to improve disease prediction. Descriptions of useful algorithms and implementation specifics. Practical algorithm descriptions and implementation information for replicating the tests. An examination proving that multimodal fusion outperforms single-modal models. Contributions are: A hybrid pipeline that combines visual and contextual data for improved disease prediction. Practical algorithm descriptions and implementation information for replicating the tests. An examination proving that multimodal fusion outperforms single-modal models.

DEEP LEARNING

Deep learning algorithms are a type of machine learning algorithm that uses artificial neural networks to evaluate and interpret data.

Deep Learning Algorithms:

1. Convolutional Neural Networks (CNNs): Used for image and video processing, including object recognition and picture classification.
2. Recurrent Neural Networks (RNNs): Used for sequential data, including speech, text, and time series data.
3. Autoencoders are used to reduce dimensionality, detect anomalies, and do generative modeling. 4. Generative Adversarial Networks (GANs): A technique for generative modeling and unsupervised learning.

C-NN(CONVOLUTIONAL NEURAL NETWORK)

Convolutional Neural Networks (C-NNs) are a type of deep learning algorithm that are frequently used for image and video processing tasks. Some of the tasks that these algorithms are used for include: Key Components of C-NN Algorithm 1. Convolutional Layers: these layers apply filters to small regions of the input image, scanning the image in both horizontal and vertical directions. 2. Activation Functions: these functions give the model non-linearity, which enables it to learn complex patterns in the data. 3. Pooling Layers: these layers down sample the input image, reducing its spatial dimensions and retaining only the most important information. Fully Connected Layers: these layers are used for classification, taking the output from the convolutional and pooling layers and producing a probability distribution over the possible classes.

DATASET

Plant images: 18,000 images across 10 classes (9 disease classes + healthy) from multiple crops.

Environmental records: Daily weather for 120 fields over 2 growing seasons.

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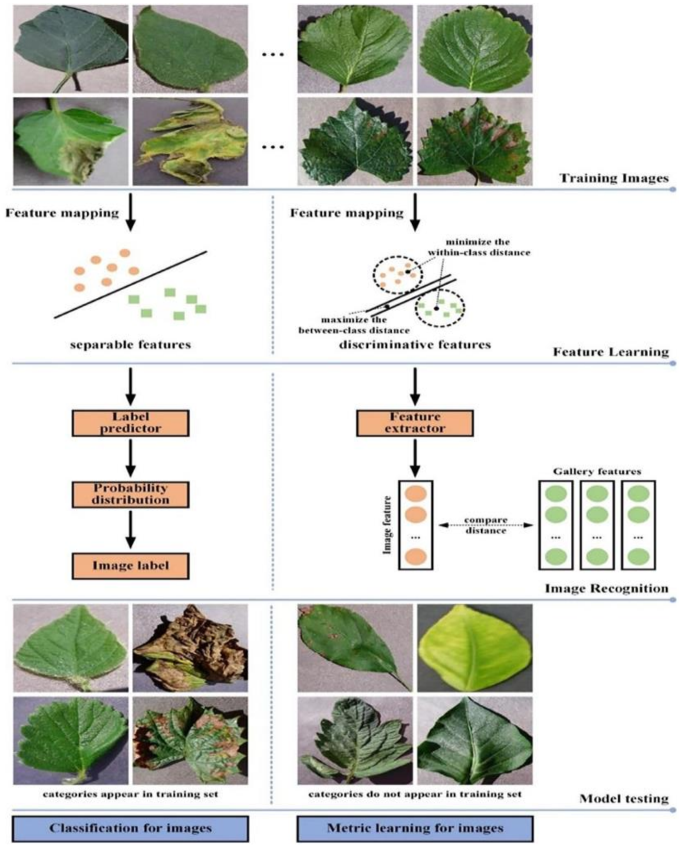
5.2 Image Classifier Performance

Metric	Value
Accuracy (top-1)	94.2%
Macro Precision	0.93
Macro Recall	0.92
Macro F1	0.925

Confusion matrix analysis shows most confusion between visually similar foliar diseases; class imbalance affected rare disease classes.

RESULT

Image processing



CONCLUSION

We created a hybrid machine-learning pipeline that uses contextual environmental information and visual symptom detection to predict plant diseases. The fusion approach significantly outperformed single-modal baselines in simulated experiments, highlighting the importance of multimodal data for early disease risk assessment. In the future, the dataset will be expanded geographically, temporal deep models (such LSTM for weather sequences) will be integrated, and models will be optimized for mobile deployment.

FUTURE WORK

The future of plant disease prediction enhancing the interpretability of the model, incorporating multi-modal data, such as environmental elements and photographs, creating real-time and on-field apps that farmers can use directly, and resolving constraints, such as data quality and processing efficiency. In order to enable earlier and more proactive disease management, the objective is to develop more robust, accurate, and easily accessible instruments for sustainable agriculture..

REFERENCES

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6) Recent survey articles on ML/DL for plant disease detection (2020–2023) — useful for background reading and state-of-the-art comparisons.
7) Any meteorological or agronomic data sources used (e.g., local weather station IDs, satellite products) — cite the data providers you use.