A Synopsis

for

Plant Leaf Disease Detection using Machine Learning

Submitted in partial fulfillment of the requirement

for award of the degree of

BACHELOR OF TECHNOLOGY

in

Computer Science and Engineering

(Artificial Intelligence and Machine Learning)

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DECLARATION

We hereby declare that the synopsis of project entitled to be submitted for the Degree of **Bachelor Of Technology** in **Computer Science and Engineering (Artificial Intelligence)** is our original work and the synopsis has not been submitted for the award of any degree, diploma, or fellowship of similar other titles in previous work. It has not been submitted to any other University or Institution for the award of any degree or diploma.

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Introduction

India is an agricultural country wherein most of the population depends on agriculture. Research in agriculture is aimed towards increase of productivity and food quality at reduced expenditure, with increased profit. Agricultural production system is an outcome of a complex interaction of soil, seed, and agro chemicals. Vegetables and fruits are the most important agricultural products. In order to obtain more valuable products, a product quality control is basically mandatory. Many studies show that quality of agricultural products may be reduced due to plant diseases. Diseases are impairment to the normal state of the plant that modifies or interrupts its vital functions such as photosynthesis, transpiration, pollination, fertilization, germination etc. These diseases are caused by pathogens viz., fungi, bacteria and viruses, and due to adverse environmental conditions. Therefore, the early stage diagnosis of plant disease is an important task.

- Plant leaf disease detection refers to the use of technology, such as image processing and machine learning algorithms, to identify and classify diseases in plant leaves.
- High-resolution imaging technologies, including cameras and drones, are employed to capture detailed images of plant leaves.
- Machine learning algorithms, particularly deep learning models like Convolutional Neural Networks (CNNs), are trained on large datasets to recognize patterns and characteristics associated with various plant diseases.
- Early detection of plant leaf diseases enables farmers to implement timely and targeted interventions, such as precision application of pesticides or other management strategies.

Problem statement/Need of project

1. Agriculture faces challenges from various plant diseases, impacting crop yield and quality.
2. Traditional methods of disease detection rely on manual inspection, which is subjective and may lead to delayed identification.
3. Delayed detection and mismanagement of plant diseases can result in significant economic losses for farmers.
4. The need for a more efficient, accurate, and timely method for detecting and diagnosing plant leaf diseases is crucial.
5. Early detection allows for prompt and targeted interventions, reducing the reliance on broad-spectrum treatments and minimizing environmental impact.
6. The complexity and diversity of plant diseases make it challenging for farmers to identify them accurately without technological assistance.
7. Advances in technology, such as computer vision and machine learning, present an opportunity to revolutionize plant disease detection.
8. Implementing automated systems for disease detection can enhance the overall efficiency of agriculture practices.
9. Precision agriculture techniques, enabled by accurate disease detection, contribute to sustainable farming practices.
10. The project addresses the pressing need for scalable and accessible solutions that empower farmers to combat plant diseases effectively.
11. Enhancing disease detection methods is crucial for ensuring global food security and supporting the livelihoods of farmers worldwide.
12. Collaboration between agricultural experts, researchers, and technologists is essential for developing effective solutions to plant leaf disease detection.

Review of literature

An approach for early and accurate detection of plant diseases utilizing diverse image processing techniques was introduced by Anand H. Kulkarni and collaborators. In their methodology:

- Gabor filters were employed for feature extraction.
- An Artificial Neural Network (ANN)-based classifier was utilized for disease classification.
- The recognition rate achieved was reported to be up to 91%.

In another study by F. Argenti et al., a fast algorithm for computing co-occurrence matrix parameters was proposed. The method involved supervised learning and the maximum likelihood method for swift classification. The authors incorporated homogenize techniques like Sobel and Canny filters to identify edges, which were subsequently used in disease spot identification.

P. Revathi et al. presented a novel technique using a Homogeneous Pixel Counting for Cotton Diseases Detection (HPCCDD) algorithm. The proposed method demonstrated a high accuracy of 98.1% compared to existing algorithms.

Tushar H. Jaware et al. introduced an improved k-means clustering technique for low-level image segmentation. This novel approach addressed the challenges associated with traditional k-means clustering in image analysis.

Sanjay B. Dhaygude et al. utilized Spatial Gray-Level Dependence Matrices (SGDM) for extracting statistical texture features. The RGB images were transformed into the Hue Saturation Value (HSV) color space, and the components H, S, and V were examined.

Proposed Methodology

There are five main steps used for the detection of plant leaf diseases . The processing scheme consists of image acquisition through digital camera or web, image pre-processing includes image enhancement and image segmentation where the affected and useful area are segmented, feature extraction and classification. Finally the presence of diseases on the plant leaf will be identified. In the initial step, RGB images of leaf samples were picked up.

The step-by-step procedure as shown below:

1) RGB image acquisition;
2) convert the input image into color space;
3) Segment the components;
4) obtain the useful segments;
5) Computing the texture features;
6) Configuring the neural networks for recognition.

Image acquisition Firstly, the images of various leaves acquired using a digital camera with required resolution for better quality. The construction of an image database is clearly dependent on the application. The image database itself is responsible for the better efficiency of the classifier which decides the robustness of the algorithm.

Aim and Objective

- **Data Collection:**
  - Gather a diverse and comprehensive dataset of plant leaf images, encompassing various crops and disease types.
- **Preprocessing:**
  - Implement image preprocessing techniques to enhance the quality and consistency of the dataset, including normalization, resizing, and noise reduction.
- **Feature Extraction:**
  - Explore and apply feature extraction methods, such as Gabor filters, co-occurrence matrices, and spatial texture features, to capture relevant information from the plant leaf images.
- **Classification Algorithms:**
  - Investigate and implement machine learning classification algorithms, including but not limited to Artificial Neural Networks (ANN), k-means clustering, and fuzzy c-means, for accurate disease identification.
- **Model Training and Validation:**
  - Train the developed models on the prepared dataset and validate their performance using appropriate metrics, ensuring high accuracy and reliability.
- **Integration of Techniques:**
  - Integrate multiple image processing techniques, such as edge detection and color space transformations, to enhance the robustness of disease detection across various plant species.
- **Real-time Detection:**
  - Aim for real-time disease detection by optimizing algorithms and minimizing processing time, making the system practical and applicable in agricultural settings.

Practical implementation of the Modules of the Project

1. Data Collection:

- Collect a diverse dataset of plant leaf images, encompassing healthy leaves and various disease types.
- Ensure the dataset includes multiple plant species to enhance the model's generalization.
- Organize the dataset into training and testing sets.

2. Preprocessing:

- Normalize pixel values to a consistent range (e.g., [0, 1]).
- Resize images to a standardized dimension to ensure uniformity.
- Apply noise reduction techniques to enhance image quality.

3. Feature Extraction:

3.1 Gabor Filters:

- Implement Gabor filter functions to extract texture features.
- Convolve each image with Gabor filters at different orientations and scales.
- Obtain Gabor-filtered images as features for subsequent analysis.

3.2 Co-occurrence Matrices:

- Calculate co-occurrence matrices to capture spatial relationships of pixel intensities.
- Extract statistical features (contrast, energy, homogeneity, etc.) from the co-occurrence matrices.

3.3 Spatial Texture Features:

- Utilize methods like Spatial Gray-Level Dependence Matrices (SGDM) for statistical texture feature extraction.
- Extract relevant statistical measures to represent the texture of plant leaf images.

4. Classification Algorithms:

4.1 Artificial Neural Network (ANN):

- Design and implement an ANN architecture for disease classification.
- Train the network using the preprocessed and feature-extracted dataset.
- Optimize hyperparameters to achieve better accuracy.

4.2 K-Means Clustering:

- Implement k-means clustering for segmentation and classification.
- Experiment with different values of k to identify optimal clusters.

4.3 Fuzzy C-Means:

- Apply fuzzy c-means clustering for soft segmentation.
- Fine-tune fuzziness parameter and cluster centers for improved results.

5. Integration of Techniques:

- Combine the results from different modules, such as Gabor filters, co-occurrence matrices, and spatial texture features.
- Investigate ensemble methods to enhance overall performance.

6. Real-time Detection:

- Optimize algorithms and model architectures for real-time processing.

- Test the system on a live feed or a set of images to evaluate real-time performance.

7. User-Friendly Interface:

- Develop a user-friendly interface for users to upload images and receive instant feedback.
- Ensure the interface is accessible to users with varying technical expertise.

8. Comparative Analysis:

- Conduct a comprehensive comparative analysis of different modules and techniques.
- Evaluate the trade-offs in terms of accuracy, speed, and resource utilization.

9. Accuracy Improvement:

- Continuously monitor and evaluate the system's performance.
- Gather user feedback and update the model and algorithms to improve accuracy.

10. Sustainable Agriculture:

- Promote the use of the developed system for sustainable agriculture practices.
- Disseminate information on reducing pesticide use through early disease detection.

11. Knowledge Dissemination:

- Share project findings, methodologies, and outcomes through research publications and educational materials.
- Encourage collaboration and knowledge exchange within the scientific community.

Tools and Techniques

- Android Studio
- Firebase
- Tensoflow Lite
- Machine Learning Model
- Camera API
- Github
- Python
- OpenCV
- Jupyter Notebook

Expected Outcome

- Intuitive and user-friendly interface for image upload and capture.
- Seamless image processing providing real-time feedback during processing.
- Accurate plant leaf disease detection using TensorFlow Lite model with an 80% accuracy target.
- Clear and informative results displaying identified diseases and relevant details.
- Optimized model execution for fast processing times and a smooth user experience.
- Offline capability for disease detection without continuous internet access.
- Feedback mechanism for users to contribute input on detection accuracy.
- Privacy measures ensuring secure handling of user-uploaded images.
- Effective error handling to provide informative messages in case of issues.
- Optional educational content about detected diseases for user awareness.
- Cross-device compatibility for various Android devices.

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