AN AI ENABLED SYSTEM TO DETECT POTATO DISEASE

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College ***:*** *Malnad College of Engineering, Hassan*
Branch ***:*** *Department of Information and Science Engineering*
Guide(s) ***:*** *Dr. Chandrika J*
Student(S) ***:*** *Ms. Lahari B. S.*
Mr. Mohith H. A.
Mr. Nithish Sagar D.
Mr. Rishab Nandan B. R.

Introduction

Potato, a vital food crop in India, serves as a crucial source of carbohydrates. However, the potato's production faces significant challenges due to various diseases, protecting crops involves dealing with weather, diseases, and threats from animals. While we can take measures against animal risks, we can't control the weather, making agricultural outcomes unpredictable.

One major worry is how diseases affect crop growth, especially for important foods like potatoes, which are a staple for most of India's population. Diseases like late blight (Phytophthora Infestans) and early blight (Alternaria Solani) are serious threats. Identifying and classifying these diseases quickly is crucial to avoid losing crops and facing financial losses.

To address this issue, efficient disease detection becomes imperative. Traditional methods, relying on naked-eye observations by farmers or local experts, prove inadequate due to time constraints and a lack of expertise. Consequently, an automatic leaf disease detection system is essential.

Using digital solutions, especially image analysis, is a more efficient way to monitor and identify plant diseases. We can look at visible patterns on plant leaves using different image processing methods. The patterns we find are then compared with historical data, and machine learning helps classify the diseases.

In summary, combining image processing and machine learning is a powerful strategy to accurately identify and classify agricultural diseases. This approach helps improve crop protection and promotes sustainable agricultural practices.

Potential of the Problem

Potato disease detection holds significant potential due to advancements in deep learning algorithms. Researchers have explored various methods, such as K-means clustering segmentation and Convolutional Neural Networks (CNNs), to detect and classify potato leaf diseases. These techniques, including VGG19, VGG16, Google Net, Alex Net, and CNNs, demonstrate efficacy in addressing the issue. Image processing- based methods, utilizing features like diffuse reflection, contribute to accurate potato disease detection

Objective of the Present Work - Problem Description

Potato disease detection poses a formidable challenge for farmers, resulting in substantial annual financial losses. The primary objective is to identify and categorize diseases impacting potato plants, with a particular emphasis on early blight, late blight, and overall leaf health. To tackle this issue, cutting-edge studies advocate for inventive methodologies, prominently featuring deep learning models like Convolutional Neural Networks (CNNs) and K-means clustering segmentation. These advanced models aspire to furnish precise and timely disease detection, empowering farmers to proactively implement preventive measures and curtail crop losses. The intricacy of the task lies in the development of sophisticated algorithms capable of effectively discerning between healthy and diseased potato leaves across various stages of infection. This necessitates a nuanced understanding of image segmentation and feature extraction techniques to ensure accurate and reliable results. In conclusion, the pursuit of effective potato disease detection involves not only technological innovation but also a deep understanding of the complexities inherent in agricultural contexts. The aim is to empower farmers with tools that enhance their ability to safeguard potato crops and mitigate financial risks. challenge.

Problem Statement: The production of potatoes decreases Due to some diseases. We believe that, if we detect the disease of potato properly and provide the proper treatment to increase the production growth

1.1 Platform and Tools Used

1.1.1 Platform

The platform and tools used for developing a deep learning-based solution to reduce background noise in speech recordings can vary based on the preferences of the development team and the project requirements. However, here's a potential setup that incorporates commonly used tools and platforms:

1.1.2 Tools and Libraries

To effectively detect potato diseases using machine learning, various tools and technologies are employed

- Deep Learning Frameworks: Implementing Convolutional Neural Networks (CNNs) and other deep learning architectures is crucial. Frameworks such as TensorFlow and PyTorch facilitate the development and training of complex models for accurate disease classification.
- Image Processing Libraries: Tools like OpenCV assist in pre-processing and analyzing potato leaf images. Image segmentation techniques, including K-means clustering, enhance feature extraction and improve model performance
- Machine Learning Algorithms: Utilizing algorithms like K-Nearest Neighbors (KNN), Support Vector Machines (SVM), and Random Forest (RF) enhances disease recognition and classification. These algorithms contribute to the overall accuracy of the detection system.
- Fine-Tuned CNN Architectures: Tailoring CNN architectures for specific diseases, such as potato blight, improves detection accuracy. Fine-tuning is achieved using tools available in deep learning frameworks.
- Motion Learning Frameworks: In some cases, frameworks incorporating motion learning principles are applied for analyzing and categorizing diseases in potato leaves. This contributes to a mechanized framework for comprehensive disease assessment.
- K-Means Clustering Segmentation: For image segmentation, K-means clustering is employed, helping to identify and categorize different regions within potato leaf images.

- VGG19, VGG16, Google Net, Alex Net: These are deep learning architectures and techniques applied for potato disease detection, showcasing the versatility of neural network models.

- TensorFlow: TensorFlow is employed as the deep learning framework due to its popularity, extensive community support, and robust capabilities for building and training neural network models.

- Keras: Keras, as a high-level neural networks API, is often integrated with TensorFlow for its user-friendly interface, simplifying the process of building and experimenting with deep learning models.

- Jupyter Notebooks: Jupyter Notebooks serve as an interactive computing environment for iterative development, allowing the team to experiment, visualize data, and fine-tune models collaboratively.

- Git and GitHub: Git is used for version control, and GitHub is employed as a collaborative platform for code repository hosting, enabling multiple developers to work on the project concurrently.

In summary, the integration of deep learning frameworks, image processing libraries, and machine learning algorithms forms a robust toolkit for potato disease detection. These tools collectively contribute to the development of accurate and efficient models to address the challenges faced by farmers.

System Analysis

2.1 Literature Survey

Identifying diseases in plants during their initial stages is a significant priority in the field of agriculture. Numerous researchers are actively addressing the challenge of early detection and diagnosis of plant diseases. The outcomes of their research efforts in this area include the following results:

In 2017, Monzurul Islam and collaborators [1] developed a method to diagnose plant diseases, specifically potato diseases, that incorporates image processing and machine learning. Employing image analysis on publicly available images from 'Plant Village,' their system efficiently categorizes diseases in potato plants and distinguishes healthy leaves.

Utilizing a segmentation process and employing support vector machine (SVM) methodology for classification, the proposed model demonstrated a noteworthy accuracy of approximately 95% when classifying around 300 images. The implementation of multiclass SVM image segmentation contributes to the development of an automated and user-friendly system. This system successfully identifies major potato diseases, including Late Blight and Early Blight, with minimal computational effort. In essence, this methodology presents a scalable and efficient solution for the automated diagnosis of plant diseases, offering farmers a reliable and time-saving approach to identifying and mitigating issues in their crops.

In 2020, Melike Sardogan[2] and colleagues explored the utilization of transfer learning and diverse pre-trained models on a dataset of potato leaf images. Their findings indicated that VGG 19 exhibited the highest accuracy, reaching 97.8%. This outperformed the accuracy of a backpropagation neural network, which achieved 92%, and a support vector machine, which achieved 95%. The research highlights the efficacy of VGG 19 in accurately classifying potato leaf diseases, showcasing its superior performance compared to alternative models in the experimental setup.

Malvika Ranjan and colleagues [3] presented an intricately designed disease detection system tailored for cotton plants. The methodology involves the capture of images depicting disease-affected cotton leaves. Subsequently, a sophisticated integration of diverse image processing techniques and Artificial Neural Network (ANN) methodologies is employed for the purpose of distinguishing between healthy and diseased samples. Notably, the ANN classification process demonstrated an accuracy level of 80%. This research signifies a systematic and technologically advanced approach to plant disease detection, particularly in the context of cotton crops.

Prajwala TM and team [4] presented a novel approach for detecting and identifying diseases in tomato leaves. Their work utilized a modified

Convolutional Neural Network (CNN) model known as LeNet. The neural network incorporated an automatic feature extraction technique, enhancing its ability to classify various diseases affecting tomato plants. The proposed system demonstrated a noteworthy average accuracy ranging from 94% to 95% in effectively identifying and detecting diseased leaves. This achievement underscores the practicality and effectiveness of employing neural networks for automated plant disease diagnosis.

In their groundbreaking 2016 research, Waghmare and Kokare [5] introduced a novel plant disease detection method for grape leaves. Utilizing image capture and meticulous segmentation, the approach employs a high-pass filter to extract unique diseased leaf textures. Locally based fractal features ensure texture pattern invariance, facilitating multiclass SVM for disease identification. With a remarkable 96.6% accuracy, the system automates Decision Support Systems, aiding farmers in promptly addressing prevalent grape diseases like downy mildew and black rot.

Wang et al.[6] introduced an innovative method for disease discrimination in wheat and grapevines, utilizing K-means segmentation and extracting a comprehensive set of 50 features. This sophisticated approach enhances accuracy by analyzing color, shape, and texture characteristics. The formalization of these techniques contributes valuable insights into image processing applications for agricultural crop disease discrimination.

Namrata R. Bhimte et al. have rigorously classified cotton leaf diseases, as documented in [7]. Their methodology involves employing K-means segmentation, a color-based technique, to isolate the disease-affected portion of a leaf image. The classification process hinges on extracting pertinent features, notably the color and texture, from the segmented image region. Remarkably, their classification model achieves an impressive accuracy rating of up to 98.46%.

2.2 Findings of Analysis

Potato disease detection has advanced significantly, leveraging deep learning algorithms like CNNs for precise identification of leaf diseases, including early blight and late blight . Machine learning methods, such as K-means clustering, enhance accuracy in disease identification. The integration of deep learning frameworks, image processing libraries, and machine learning tools creates a potent toolkit, fostering the development of efficient models to address farmers challenges .

2.2.1 Existing System

The current landscape of potato disease detection involves advanced methods employing deep learning and artificial intelligence. Various models, such as RSNET and PDDCNN (Potato Leaf Disease Detection using Convolutional Neural Network), have been developed for precise identification and classification of potato diseases like Early Blight and Late Blight . These models utilize deep learning architectures and explainable AI for effective disease detection and classification . Traditional methods, including ELISA and reverse transcriptase-quantitative polymerase chain reaction (RT-qPCR), are also employed for tuber testing. The existing disease detection methods range from manual and visual assessments to machine-driven systems using Convolutional Neural Networks (CNNs) .

2.2.2 Proposed System

The proposed system for potato disease detection involves leveraging machine learning techniques, specifically deep learning models like Convolutional Neural Networks (CNNs). Researchers have developed novel deep learning techniques, such as Potato Leaf Disease Detection using Convolutional Neural Network (PDDCNN), to identify and diagnose potato diseases like early blight. Additionally, the integration of advanced machine learning technology, as seen in a study focused on diagnosing potato diseases through leaf pictures, showcases the potential of machine learning in disease detection and diagnosis . Furthermore, combining machine learning with other approaches, like non-imaging spectrometry data and calibration models, enhances the accuracy of identifying and differentiating potato diseases .

2.3 System Requirements

2.3.1 Functional Requirements:

- User should load potato dataset to our application.
- System will preprocess and extract the features using the CNN.
- Create a desktop application using python tkinter.
- System will split the dataset into train set and test set.
- System will train the model using CNN.
- User should load input image
- System will apply CNN pre-trained model to classify the potato disease.
- Application should efficiently classify the potato disease.
- Implementation of feature engineering techniques to extract relevant attributes for model training.

2.3.2 Non-Functional Requirements:

1. Performance:

- The system should be capable of handling large datasets efficiently, ensuring timely model training and prediction.
- The machine learning models should demonstrate high accuracy and efficiency in predicting CPU burst times.

2. Scalability:

- The system must be scalable to accommodate varying computational grid workloads and diverse datasets.

3. Compatibility:

- The system should be compatible with multiple operating systems (Windows, Linux, macOS) to ensure accessibility across different environments.

4. Usability:

- ❖ The user interface (if applicable) should be intuitive and user-friendly, facilitating ease of use for researchers and practitioners.
- ❖ Well-documented code and comprehensive user guides to assist users in understanding and utilizing the system.

5. Security:

- ❖ If the system involves handling sensitive data, there should be provisions for data encryption and secure access control to protect against unauthorized access.

6. Reliability:

- ❖ The system should be reliable, with error handling mechanisms to gracefully handle unexpected scenarios during data preprocessing, model training, and prediction.

7. Portability:

- ❖ The system should be portable, allowing users to deploy and run the models on various computing platforms without significant modification.

8. Maintainability:

- ❖ Code should be well-organized, commented, and modular to facilitate ease of maintenance and future enhancements.

Design

3.1 Dataset

3.1.1 Dataset Description

Plant Village (http://www.plantvillage.org/), a publicly available image database, contains 54,306 images of diseased and healthy plant leaves of 14 crop species collected under controlled conditions and the ground truths are also provided. We analyze 300 images of potato leaves, which have a spread of the following class labels assigned to them:

• Late blight affected potato leaf.
• Early blight affected potato leaf.
• Healthy or Non-diseased potato leaf.

3.2 Design of Functions

1. Data Preprocessing Function:
   - ❖ To design a function for potato disease detection, an end-to-end approach involving various techniques and models can be considered:
2. Dataset Overview :
   - ❖ Utilize datasets like the Potato Leaf dataset, containing images of potato leaves infected with different diseases, for training and testing.
3. Deep Learning Models :
   - ❖ Implement deep learning models such as Convolutional Neural Networks (CNNs) for potato disease detection. For instance, a Multi-Level Deep Learning Model (PDDCNN) has been developed for early blight detection.
4. Three-Stage Detection Model:
   - ❖ Consider a three-stage detection model based on deep learning, involving segmentation of potato leaves and diseases. This approach enhances accuracy.

5. Image Segmentation and Feature Extraction :

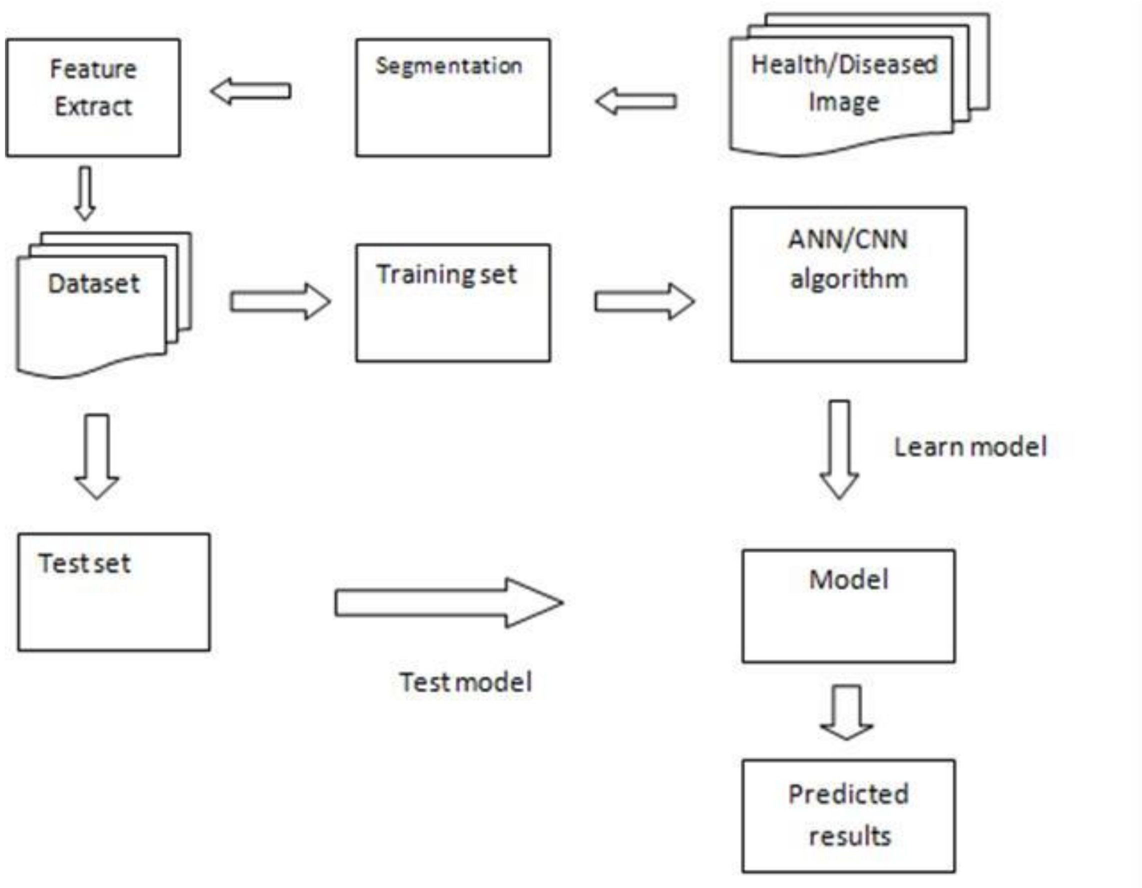
- ❖ Implement image segmentation, feature extraction, and classification phases for effective disease detection.

6. Machine Vision with Deep Learning :

- ❖ Evaluate the potential of combining machine vision with deep learning to identify diseases, such as using DL for real-time early blight disease identification.

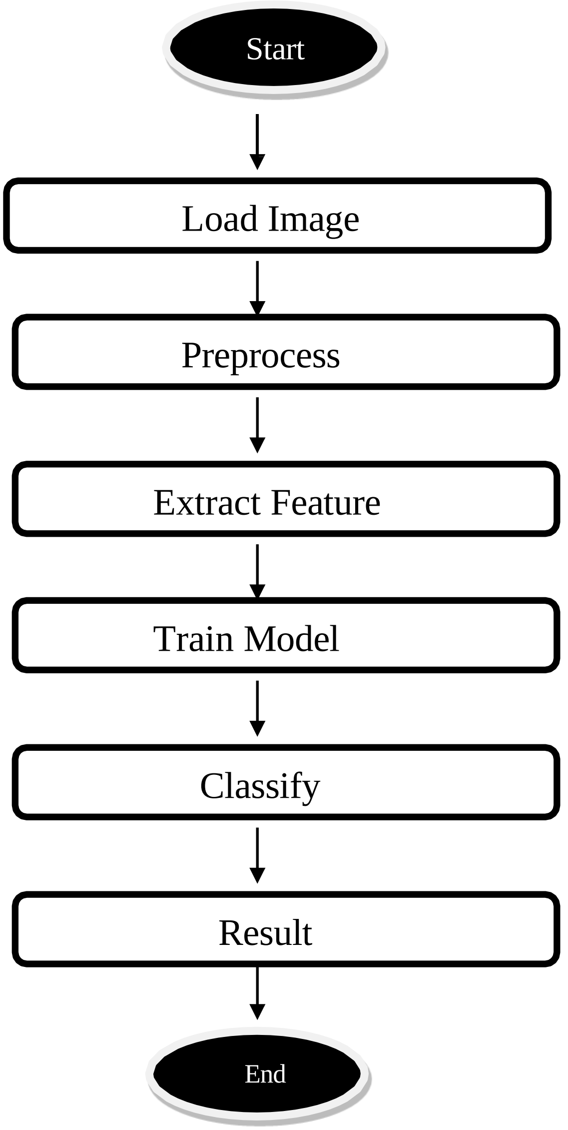
7. Project Guidance :

- ❖ Refer to comprehensive guides on end-to-end potato leaf disease prediction projects for detailed steps and insights



Sample workflow fig 1:

Activity diagram :



3.3 Design of User Interface

The user interface (UI) design for potato disease detection systems plays a crucial role in facilitating user interaction and ensuring efficient disease identification. Here are key considerations in designing the UI for such applications:

1. Image Input :

- ❖ Implement a user-friendly interface allowing users to upload potato leaf images for disease detection

2. Feedback Mechanism:

- ❖ Provide clear feedback on the detection results, indicating the presence of diseases and their classifications.
- ❖ Visual indicators, such as color-coded labels or annotations on the uploaded images, enhance user understanding

3. Model Confidence Level:

- ❖ Display the confidence level or probability associated with the disease prediction. This transparency builds user trust in the system

4. User Guidance:

- ❖ Include tooltips or a user guide to assist users in navigating the application and interpreting the results. This improves the overall user experience and system usability.

5. Responsive Design:

- ❖ Ensure the UI is responsive and compatible with various devices, making it accessible to a wider audience.

6. Integration with Database:

- ❖ If applicable, integrate the UI with a database to store and retrieve historical data, allowing users to track the progression of diseases over time.

7. Visualizations:

- ❖ Incorporate visualizations such as graphs or charts to represent disease trends, historical data, and patterns, aiding users in understanding the disease landscape over time

By incorporating these design elements, the UI in potato disease detection will empower users to compare disease identification results from traditional methods and machine learning models.

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