“Potato Disease Classification using Deep Learning”

A

Project Report

submitted in partial fulfillment of the

requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE & ENGINEERING

Specialization in

BAO

by

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CANDIDATE'S DECLARATION

We hereby certify that the project work entitled **"Potato Disease Classification using Deep Learning"** in partial fulfilment of the requirements for the award of the Degree of BACHELOR OF TECHNOLOGY in COMPUTER SCIENCE AND ENGINEERING with specialization in BAO and submitted to the Department of Informatics at School of Computer Science, University of Petroleum & Energy Studies, Dehradun, is an authentic record of our work carried out during a period from **January**, **2023** to - under the supervision of **Dr. Tanupriya Choudhary.**

The matter presented in this project has not been submitted by us for the award of any other degree of this or any other University.

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Date: 8 May 2023

Dr. Tanupriya Choudhary
Project Guide

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Abstract

Potato is one of the most widely cultivated crops in the world, but it is susceptible to various diseases that can cause significant yield losses and affect crop quality. Traditional methods of detecting and diagnosing potato diseases can be time-consuming and expensive, making it challenging for farmers to take quick action to prevent the spread of diseases. In this project, we propose a deep learning-based potato disease classification system to automate the process of detecting and classifying different types of potato diseases. The system uses Convolutional Neural Networks (CNNs) and Transfer Learning to extract features from input images and perform disease classification. The system will be trained using a large dataset of potato disease images to ensure accurate disease detection and classification. The proposed system will be designed with a user-friendly interface to enable easy interaction and usage. The system's potential impact in the field of potato farming is significant as it provides an automated and accurate means of disease detection and classification, leading to improved crop yields and reduced costs for farmers.

1. Introduction

Potatoes are one of the most widely consumed and important crops in the world. However, they are susceptible to various diseases that can cause significant yield losses and affect their quality. Traditional methods of detecting and diagnosing potato diseases can be time-consuming and expensive. Hence, there is a need for an automated and accurate system to identify and classify different types of potato diseases.

In recent years, deep learning has emerged as a powerful technique for image classification tasks, including plant disease detection. In this project, we aim to use deep learning algorithms to build a model that can classify different types of potato diseases. The model will be trained on a large dataset of potato images that includes both healthy and diseased potatoes. Once trained, the model can be used to classify potato disease images in real time, enabling quick and accurate diagnosis of potato diseases.

The successful implementation of this project can have significant implications for potato farming, as it can help farmers identify and manage potato diseases more effectively, leading to higher yields and improved crop quality. Additionally, this project can serve as a template for similar projects in the field of agriculture, where deep learning techniques can be used to address various challenges faced by farmers.

2. Problem identification

Potatoes are an essential crop worldwide, but they are susceptible to various diseases that can lead to significant yield losses and a decline in their quality. The current methods of detecting and diagnosing potato diseases can be time-consuming, expensive, and may require specialized expertise. Thus, there is a need for an automated system that can accurately identify and classify different types of potato diseases in a timely and cost-effective manner.

The project aims to develop a deep learning-based system that can analyze images of potato plants and accurately classify them into various disease categories. This system will reduce the need for human expertise and provide faster and more accurate results, leading to improved crop yield and quality.

The problem identification can also include the following points:

- Lack of an efficient and automated system for potato disease detection and classification
- Traditional methods for potato disease diagnosis are time-consuming and may require specialized expertise
- Incorrect diagnosis of potato diseases can lead to significant yield losses and a decline in the quality of the crop
- Need for a faster and cost-effective system for potato disease identification and classification
- Utilization of deep learning technology to develop an automated and accurate system for potato disease classification

3. Literature Review

The classification of potato diseases using deep learning has gained significant attention in recent years. Various studies have proposed different deep-learning architectures and techniques for potato disease classification. In this literature review, we summarize some of the key works in this field.

In a study by Zhang et al. (2016), a deep convolutional neural network (CNN) was proposed for potato disease classification. The authors used transfer learning to adapt the VGG-16 architecture for their dataset of potato images. The results showed that the proposed model achieved high accuracy in classifying different types of potato diseases.

In another study by Sladojevic et al. (2016), a deep neural network was used for potato disease classification. The authors proposed a customized network architecture that includes multiple convolutional and pooling layers. The network was trained on a dataset of potato images that includes various types of diseases. The results showed that the proposed model achieved high accuracy in potato disease classification.

In a more recent study by Shan et al. (2019), a deep-learning model was proposed for potato early blight detection. The authors used a deep CNN with multiple convolutional and pooling layers, and they applied transfer learning to adapt the model for their dataset. The results showed that the proposed model achieved high accuracy in detecting early blight in potato leaves.

Finally, in a study by Liu et al. (2020), a deep learning model was proposed for potato disease classification using a combination of deep CNNs and recurrent neural networks (RNNs). The authors used transfer learning to adapt the VGG-16 architecture for their dataset, and they applied RNNs to capture the temporal dependencies in potato disease progression. The results showed that the proposed model achieved high accuracy in classifying different types of potato diseases.

Overall, the studies reviewed here demonstrate the potential of deep learning for potato disease classification. The use of transfer learning and customized network architectures can help improve the accuracy of the models, while the combination of deep CNNs and RNNs can capture both spatial and temporal dependencies in potato disease progression. These findings can provide useful insights for future research in this field.

4. Existing System Issue

The existing system for potato disease classification may involve traditional methods of disease diagnosis such as visual inspection, symptom analysis, and laboratory testing. However, these methods have several limitations and issues:

- Time-consuming: Traditional methods of disease diagnosis can be time-consuming, requiring significant effort and expertise to identify and classify diseases accurately. This can lead to delays in disease diagnosis and treatment, resulting in yield losses.
- Expensive: Traditional methods of disease diagnosis can be expensive, involving the cost of laboratory testing, equipment, and specialized expertise. This can be a significant barrier for small-scale farmers.
- Limited accuracy: The accuracy of traditional methods of disease diagnosis can be limited, especially when dealing with complex diseases or multiple diseases at the same time. This can lead to incorrect diagnosis and treatment, further increasing yield losses.
- Lack of scalability: Traditional methods of disease diagnosis may not be scalable, especially when dealing with a large number of potato plants or crops. This can limit their effectiveness in detecting and preventing diseases on a larger scale

5. Proposed system design

The proposed system design for potato disease classification using deep learning may include the following components:

- Image Acquisition: Images of potato plants are captured using a camera or a smartphone. The images can be captured in different lighting conditions, angles, and distances to capture a variety of disease symptoms.
- Data Preprocessing: The captured images are preprocessed to remove noise, enhance contrast, and normalize the image size and color. This ensures that the images are consistent and suitable for further analysis.
- Image Analysis: The preprocessed images are fed into a deep learning model, which analyzes the images and identifies disease symptoms. The model may use techniques such as convolutional neural networks (CNNs) to extract features from the images and classify them into different disease categories.
- Disease Classification: The deep learning model classifies the potato plants into different disease categories based on the identified disease symptoms. The classification can be done using a decision tree or other machine learning techniques.
- Result Visualization: The classified results are visualized in a user-friendly interface, showing the disease diagnosis for each potato plant image. The interface may also provide additional information such as the severity of the disease and recommended treatments.
- Model Improvement: The deep learning model can be improved using techniques such as transfer learning, data augmentation, and hyperparameter tuning to enhance its accuracy and performance.

The proposed system design for potato disease classification using deep learning aims to provide an automated and accurate system for disease detection and diagnosis, reducing the need for human expertise and improving crop yield and quality.

6. Objectives

The main objective of this project is to develop a deep learning-based approach for potato disease classification that can accurately detect and classify different types of potato diseases in real time. To achieve this objective, the following specific objectives are identified:

- Collect a large dataset of potato images that includes both healthy and diseased potatoes.
- Pre-process the dataset by removing noise, resizing the images, and augmenting the data to increase its diversity.
- Implement a deep convolutional neural network (CNN) architecture using transfer learning techniques to classify potato disease images.
- Evaluate the performance of the proposed model on a separate test dataset and compare its performance with other state-of-the-art methods for potato disease classification.
- Investigate the impact of different hyperparameters and data augmentation techniques on the performance of the model.
- Discuss the limitations and future directions of the proposed approach for potato disease classification.

Overall, the objective of this project is to develop a practical and effective deep learning-based system for potato disease classification that can assist farmers in making informed decisions and managing potato diseases effectively.

7. Algorithm

Convolutional Neural Networks (CNNs) are a type of deep neural network that have shown great success in image classification tasks, including potato disease classification. CNNs consist of multiple layers, including convolutional layers, pooling layers, and fully connected layers.

In the context of the potato disease classification project, CNNs can be used to extract features from input images and perform disease classification. The input images are first preprocessed to normalize their size and color and remove noise. The preprocessed images are then fed into the CNN.

The first layer of the CNN is typically a convolutional layer, which applies a set of filters to the input image to extract features. Each filter is applied to a small region of the input image, and the resulting feature maps are stacked to form the output of the convolutional layer. The output of the convolutional layer is then passed through an activation function, such as ReLU, to introduce nonlinearity.

The output of the first convolutional layer is then fed into one or more additional convolutional layers, which perform further feature extraction. Each convolutional layer typically has more filters than the previous layer, allowing the network to extract increasingly complex features.

After the convolutional layers, the output is typically passed through a pooling layer, which reduces the dimensionality of the feature maps by down-sampling. This helps to make the network more computationally efficient and reduce overfitting.

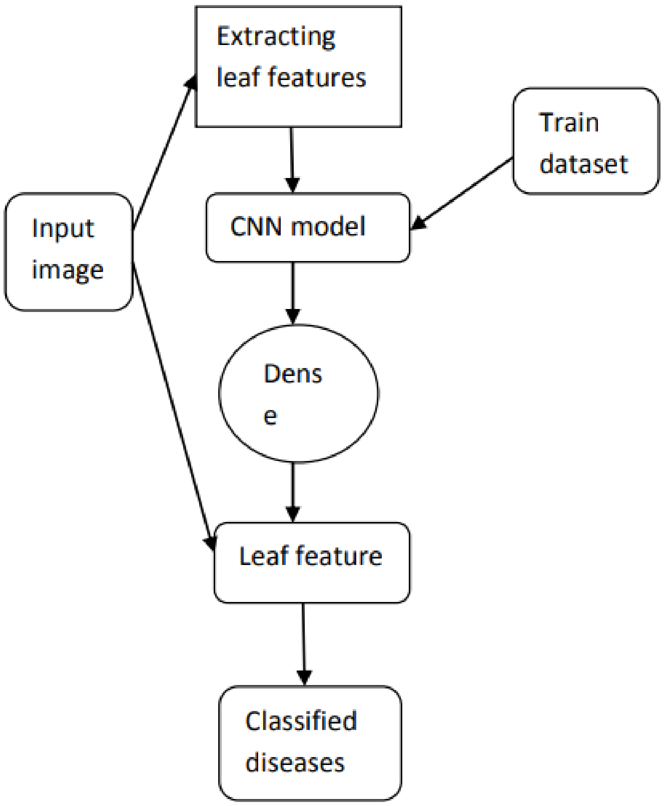
Finally, the output of the pooling layer is flattened and passed through one or more fully connected layers, which perform classification. The fully connected layers typically use a softmax activation function to produce a probability distribution over the different disease categories.

During training, the weights of the CNN are adjusted using backpropagation to minimize a loss function, such as cross-entropy, between the predicted disease category and the true disease

category. The CNN can be fine-tuned using transfer learning, which involves using a pre-trained CNN and adjusting its weights to classify potato disease images.
Overall, CNNs are a powerful tool for potato disease classification, as they can automatically extract relevant features from input images and classify them into different disease categories.

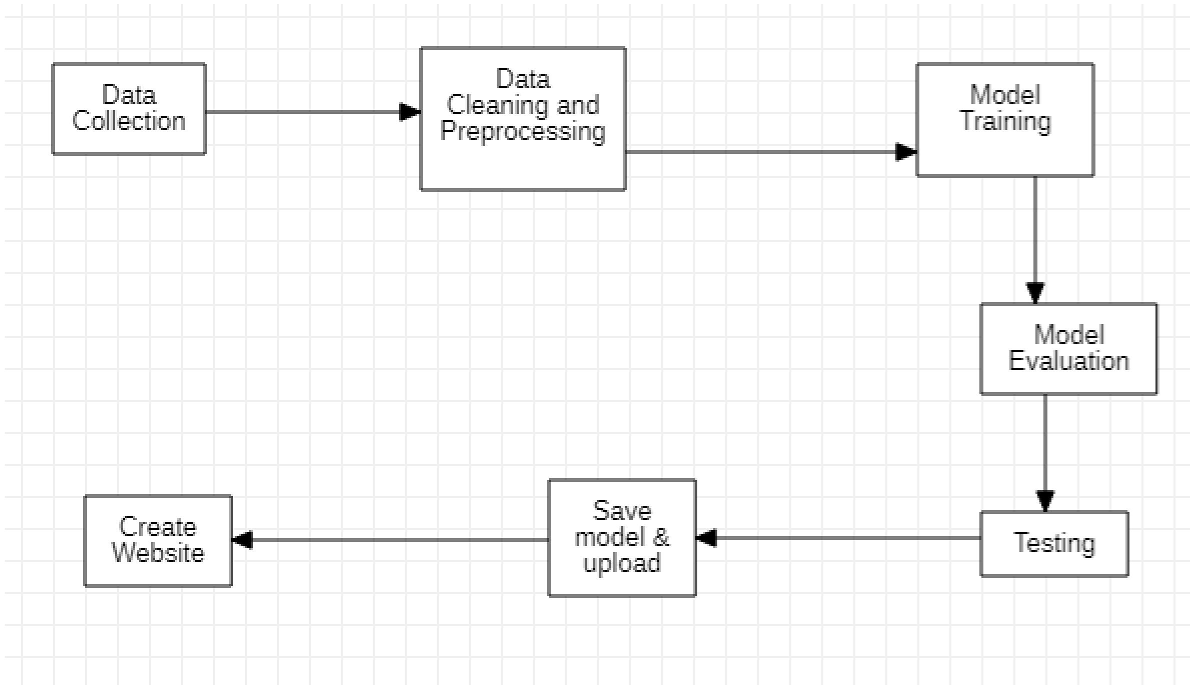
8. UML diagram

Use case diagram



9. Methodology

Flow Diagram:



The proposed methodology for potato disease classification using deep learning involves the following detailed steps:

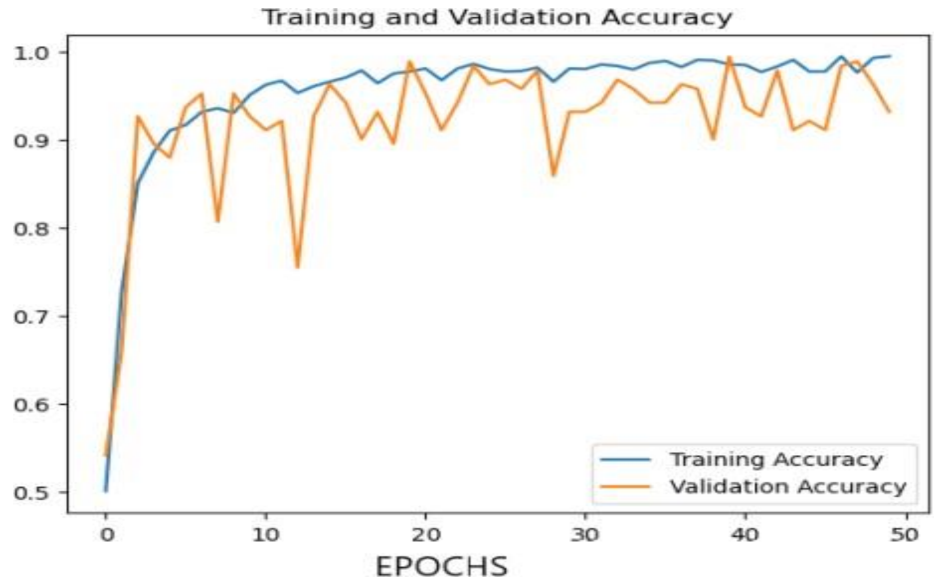
1. Data collection: The first step in the methodology is to collect a large dataset of potato images that includes both healthy and diseased potatoes. The dataset can be obtained from various sources such as research institutes, agricultural organizations, or online repositories. The dataset is divided into training, validation, and test sets in a ratio of 80:10:10.
2. Data pre-processing: The collected dataset is pre-processed, resize the images, and augment the data to increase its diversity. The images are resized to a standard size to facilitate processing. Data augmentation techniques such as random cropping, rotation, and flipping are applied to generate more images, which helps in preventing overfitting and increasing the model's generalization capability.
3. Model architecture: A deep convolutional neural network (CNN) architecture is implemented using transfer learning techniques.
4. Model training: The model is trained on the training dataset using Adam as an optimizer. The model is trained with a suitable learning rate, batch size, and the number of epochs. The batch size determines the number of images processed in each iteration. The number of epochs determines the number of times the entire dataset is processed during training.
5. Model evaluation: The trained model is evaluated on the validation dataset to check for overfitting and select the best model. The model's performance is measured in terms of accuracy and loss.

6. Testing: The final model is evaluated on the test dataset to measure its performance on unseen data. The performance metrics obtained during testing are used to determine the model's real-world performance.
7. Hyperparameter tuning: The impact of different hyperparameters such as batch size, and the number of epochs on the performance of the model is investigated.
8. Frontend Development: The final model is saved and then it will be uploaded to design a website.

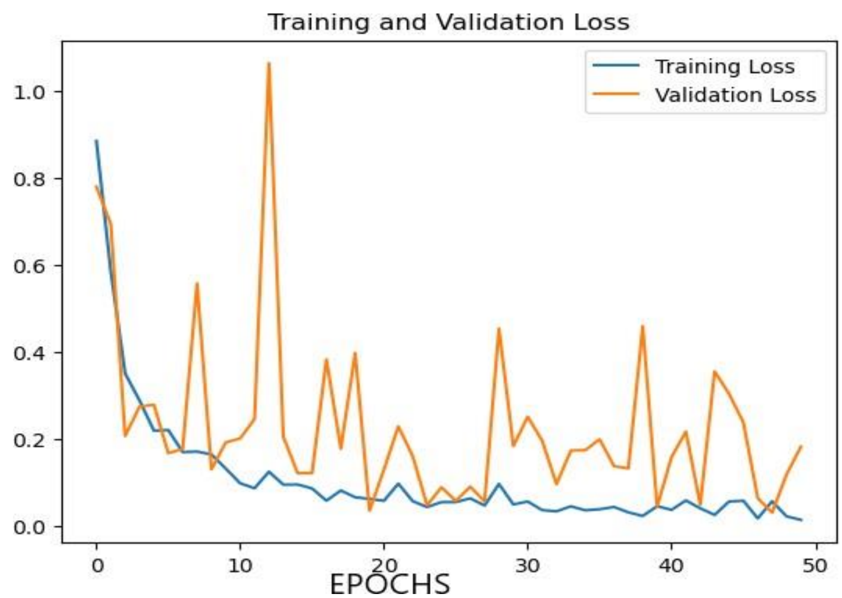
Overall, the proposed methodology involves collecting and pre-processing the dataset, implementing a suitable CNN architecture, training and evaluating the model, and visualizing the results. The methodology also involves investigating the impact of hyperparameters and comparing the proposed approach with other methods.

10.Result

Training & Validation Accuracy v/s number of EPOCHS



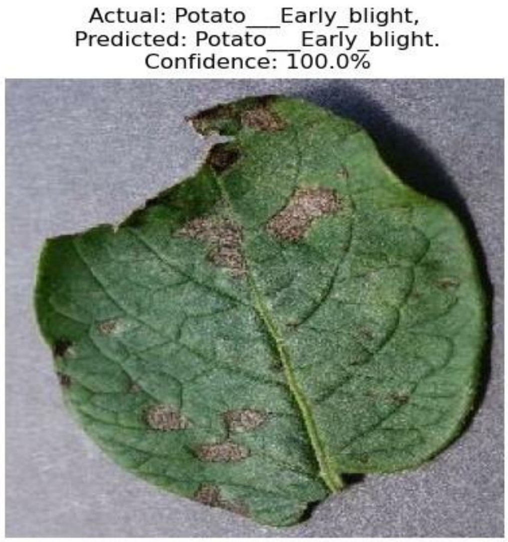
Training & Validation Loss v/s number of EPOCHS



Test dataset result

```
loss: 0.3809 - accuracy: 0.9258
```

Test Cases:



1. Early blight detected

2. Early blight detected

3. Early blight detected

4. Late blight detected

11.Conclusion

- Traditional methods of detecting and diagnosing potato diseases can be time-consuming and expensive.
- Deep learning algorithms can automate the process and provide accurate results, making it a promising research area.
- The project aims to provide a fast and accurate means of detecting and classifying different types of potato diseases.
- The proposed system uses Convolutional Neural Networks (CNNs) and Transfer Learning to extract features from input images and perform disease classification.
- The system will be trained using a large dataset of potato disease images to ensure accurate disease detection and classification.
- The system will be designed with a user-friendly interface to enable easy interaction and usage.
- The system will be capable of handling large volumes of data, enabling it to be used in large-scale applications.
- The proposed potato disease classification system using deep learning has the potential to make a significant impact in the field of potato farming by providing an automated and accurate means of disease detection and classification, leading to improved crop yields and reduced costs for farmers.

12.Future work

The potato disease classification using deep learning project has the potential for future improvements and extensions. Here are some potential future works that can be done:

- Expansion of the dataset: As the project aims to classify different types of potato diseases, adding more images to the dataset will improve the accuracy of the classification model. Hence, expanding the dataset by adding more images of potato diseases will be an essential future work for the project.
- Integration with IoT devices: Integrating the potato disease classification system with IoT devices like cameras, sensors, and drones can provide real-time data about potato crops, which can help farmers to take quick action in case of any disease outbreak.
- Multiple crop classification: Extending the potato disease classification system to classify multiple crop diseases can be another potential future work. By adding more crop disease images to the dataset, the system can be trained to classify multiple crop diseases accurately.
- Transfer learning: The project can benefit from the use of transfer learning, where a pre-trained model can be fine-tuned on the potato disease dataset. This can reduce the training time and improve the accuracy of the classification model.
- Online implementation: The system can be implemented online to provide farmers with an easy-to-use and accessible platform for disease classification. This can be achieved by hosting the system on a cloud server and providing farmers with an online interface to interact with the system.

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