ARTIFICIAL INTELLIGENCE FOR
POTATO LEAF DISEASE CLASSSIFICATION

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DATE: MARCH 7, 2023

Source:gardeningnowhow.com

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Abstract

Potatoes are a well-known vegetable to all of us. Potato cultivation has been very popular in India form the last few decades. But potato production is being hampered due to diseases like early blight and late blight which are increasing the cost of production. The aim here is to build an automated and rapid disease detection process to increase potato production and digitize the system. Our main goal is to diagnose potato disease using leaf pictures that we are going to do through CNN algorithm. This paper offers a picture that is processing and machine learning based automated systems potato leaf diseases will be detected and classified. Image processing is the best option for detecting and analysing these diseases. In this analysis, picture division is done; more than 2000 pictures of healthy and unhealthy potato's leaf, which are collected from Kaggle and a few pre-prepared models are utilized for acknowledgment and characterization of healthy and diseased leaves.

1. Problem Statement

Farmers who grow potatoes suffer from serious financial standpoint losses each year which cause several diseases that affect potato plants. The diseases Early Blight and Late Blight are the most frequent. Early blight is caused by fungus and late blight is caused by specific micro-organisms and if farmers detect this disease early and apply appropriate treatment then it can save a lot of waste and prevent economical loss. The treatments for early blight and late blight are a little different so it's important that you accurately identify what kind of disease is there in that potato plant.

Early Blight Late Blight

Source: agfuse.com

2. Market/Customer/Business Need Assessment

Even though the figures are daunting, there is (in India) NO way of identifying potato diseases directly upon its sighting, there only exist a handful of online sources for identification of these diseases (more on it in External Search).

3. Target Specifications/ Target Characterization

The proposed service will be helpful for biologists, farmers, agriculturalists, nature lovers and the general public in:

→ identifying the type of potato leaf disease.

→ differentiating between Early Blight and Late Blight leaves.

→ Late blight: This disease is caused by the fungus Phytophthora infectants and can infect both leaves and tubers. Symptoms include brownish-black lesions on the leaves, stems, and tubers, as well as a white fungal growth on the underside of the leaves. Target specifications for late blight include resistance to the fungus, early detection and treatment, and proper crop rotation.

→ Early blight: This disease is caused by the fungus Alternaria solani and primarily affects the leaves. Symptoms include concentric rings of brown spots on the leaves, which can eventually lead to defoliation. Target specifications for early blight include resistant potato varieties, proper crop rotation, and timely fungicide applications.

→ Overall, target specifications for potato leaf diseases may include a combination of genetic resistance, cultural practices (e.g., crop rotation, sanitation), chemical control (e.g. fungicides), and integrated pest management strategies.

→ Using Machine learning algorithms to analyse digital images of diseased plants and compare them to healthy plant images. This can help identify specific features or patterns that are associated with different diseases, including potato leaf diseases.

4. External Search

4.1 Brief Summary

Potato leaf disease classification refers to the process of identifying and classifying diseases affecting the leaves of potato plants using various techniques, including AI. Diseases that affect the leaves of potato plants can significantly reduce crop yield and quality, making early detection and treatment crucial for successful farming. With the help of AI, large datasets of potato leaf images can be analysed to identify specific patterns and features that are indicative of particular diseases. AI-based models can then be trained to classify these diseases accurately, leading to faster and more effective diagnosis and treatment. Overall, the use of AI for potato leaf disease classification can improve the efficiency and sustainability of potato farming operations while reducing the impact of disease on crop yield and quality.

Similar attempts have been made to classify diseases in potato leaves with the help of images such as **CIP**, **APS, AHDB, Plantix-app**. Sadly, in India, there has been NO attempt at developing such a tool but there exists some websites and mobile applications created with the aim of imparting information on potato leaf diseases. Let's have a look at them.

4.2 Dedicated Websites for Potato leaf diseases Identification:

4.2.1 **The International Potato Center (CIP)** offers information on potato disease classification, including resources on disease identification, management, and prevention. The CIP website also provides access to research publications and reports related to potato diseases.

4.2.2 **The American Phytopathological Society (APS)** offers a range of resources on potato diseases, including information on disease symptoms, management strategies, and research publications. The APS website also provides access to a directory of plant pathologists who can assist with potato disease identification and management.

4.3.3 **The Agriculture and Horticulture Development Board (AHDB)** in the UK offers resources on potato disease classification and management, including guides on disease identification, control strategies, and research publications

4.3 Dedicated Mobile Applications for Potato leaf diseases Identification:

4.3.1 **The Plantix app** provides a free mobile app that can identify and classify potato leaf diseases using AI technology. It is available for both Android and iOS devices and offers information on over 60 different potato diseases.

5. Applicable Constraints

- → Continuous data collection from websites and databases
- → Quality of collected images for correct identification

6. Business Model

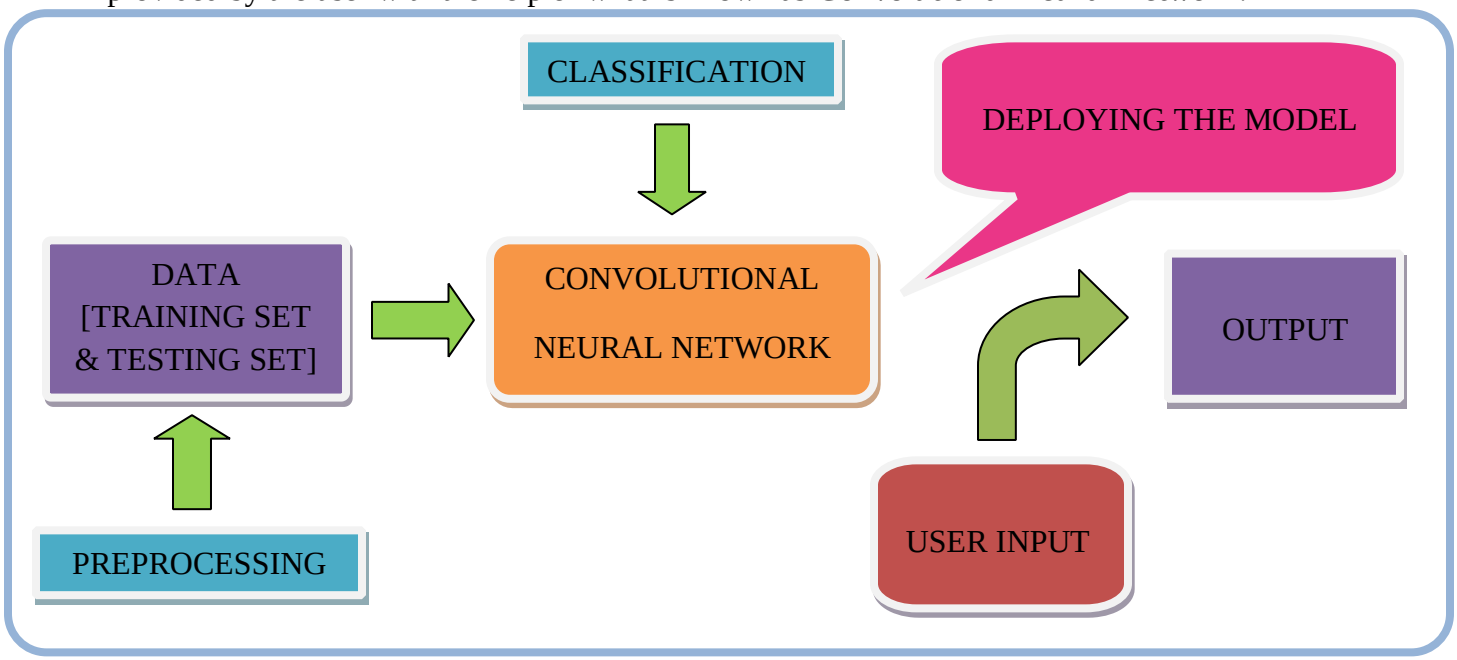
Though AI is capable enough to help build the type of service proposed, NO similar service is in place in India to identify diseases from potato leaves. Therefore, it is highly likely that the service will make a difference in farming and transform the agriculture system one way or the other and benefit the ones mentioned elsewhere (refer to Target Specifications).

7. Concept Generation

Concept is simple that in order to iron out the problem we need to come up with a product/model which can take images as input and classify them as output.

8. Final Product Prototype

The final product will be a web-based or android-based service which will classify the input image provided by the user with the help of what is known as **Convolutional Neural Network**.



9. Product Details

It's a model which will be trained by using collected images from the available sources, converted into a web or android app, and then it will be used to classify the input image to identify the potato leaf disease in that image.

9.1 Data Sources

Any Data Science project starts with the process of acquiring the data. First, we need to collect data. We have 3 options for collecting data first we can use readymade data we can either buy it from a third-party vendor or get it from Kaggle etc. The second option is we can have a team of Data Annotator whose job is to collect these images from farmers and annotate those images either healthy potato leaves or having early or late blight diseases. So, this team of annotators works with farmers, go to the fields and they can ask farmers to take a photograph of leaves or they can take photographs themselves and they can classify them with the help of experts from agriculture field. So, they can manually collect the data. But this process will be time-consuming. The third option is writing a web-scraping script to go through different websites which has potato images and collect those images and use different tools to annotate the data. In this project, I am using readymade data that I got from Kaggle.

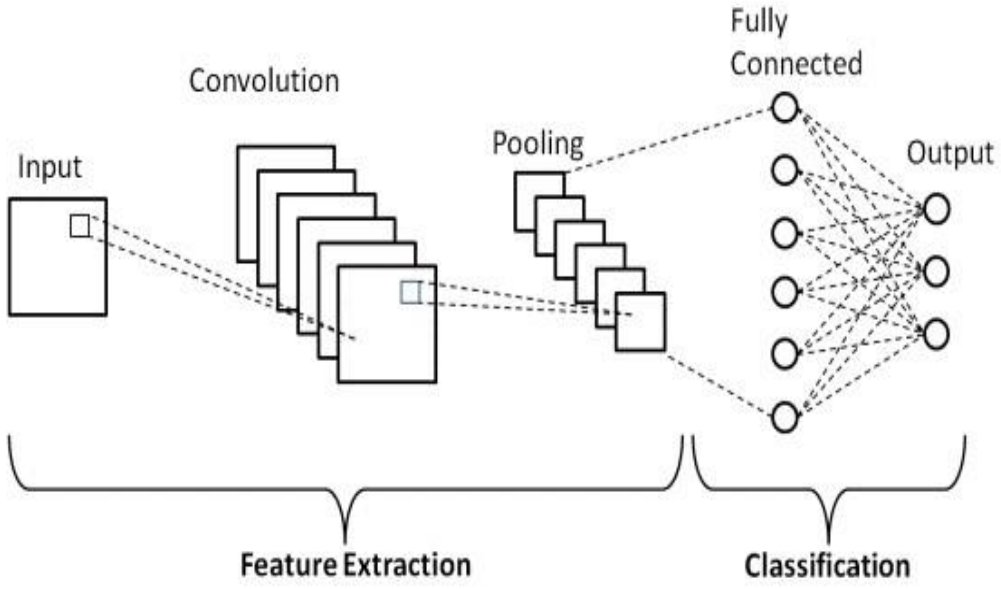
Dataset Link: https://www.kaggle.com/abdallahalidev/plantvillage-dataset

9.2 Algorithms

The workhorse algorithm that will be used at the core of the proposed system is **Convolutional Neural Network**, generally abbreviated as **CNN**.

Key points of CNN:

- → It is a type of **Artificial Neural Network** (ANN) heavily used in the field of computer vision.
- → The building blocks of CNNs are called **Filters** whose job is to extract features (information) present in the input data.
- → Architecture of CNN:
  - **Convolutional Layer**: These layers are made up of a set of filters (also called **Kernels**) that are applied to an input image. The output of the convolutional layer is called **Convoluted Layer** or **Feature Map**, which is a representation of the input image with the filters applied.
  - **Pooling Layer**: This type of layer is responsible for lowering the computational load required to process the data by reducing the size (dimensions) of the convoluted layer.
  - **Fully-Connected Layer**: FC layers are used towards the end of CNNs to take the features learned by the previous layers and use them to make predictions.



Architecture of CNN

9.3 Frameworks

The following Python frameworks will play a crucial role in creating the desired system.

- → **Pandas**: Pandas is a feature-rich library mainly used for handling, manipulating and transforming data.
- → **Scikit-learn**: It is the gold standard library for machine learning which comes with plenty of algorithms for regression, classification, clustering, and also for feature engineering tasks.
- → **Keras**: Keras is a deep learning framework built on top of **TensorFlow**. It facilitates easy creation of Artificial Neural Networks.
- → **Matplotlib and Seaborn**: Both of these libraries are used for visualization purposes and are totally free to install and use just like the above ones.

9.4 Team Required to Develop

- → 1 Data Scientist
- → 1 Software Developer/ Android Developer

10. Conclusion

Artificial intelligence is on the rise as it is being integrated into an array of fields such as healthcare, finance, banking, commerce, wildlife, research etc. It is also leading the way to new innovations to protect plants by providing information to Agriculture's researcher. This model/service, if implemented successfully on large scale, will be a major step towards diseases identification. It will also prove a valuable tool for almost everyone.

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