Potato Leaf Disease Detection Method Based on the YOLO Model

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Abstract -**Global potato production is at risk because of potato leaf diseases, which cause huge economic losses. To ensure crop productivity and disease management, their efficient and accurate localization is of utmost importance. The YOLOv7 deep learning model is presented in this paper as a means of disease detection and classification in potato leaves. The suggested approach uses YOLOv7's superior detection accuracy to successfully identify and categorize potato leaf diseases. To train the model, we used a wide variety of images showing both healthy and diseased potato leaves. Verified by the test results, the suggested methodology successfully identified and classified diseases affecting potato foliage with a 98.1% accuracy rate. Through early disease detection and prompt control measure implementation, this method holds great promise for enhancing the yield and quality of potato crops in precision agriculture systems. The proposed framework shows great promise for practical implementation, as the experimental results confirm that it offers enhanced accuracy in detecting and predicting potato crop diseases.**

Keywords: Potato, Leaf Disease, YOLO,Classification.

I. Introduction

Plant diseases are a direct threat to food security. Pest insects and diseases cost the world's agriculture industry more than $250 billion every year. This is important for keeping agricultural output high: crop diseases must be found quickly [1]. Predicting and classifying crop diseases by taking pictures of crop growth and creating a detection model [12] can help control diseases more effectively, lower the damage that diseases do to crops, and give farmers early warnings and chances to help their crops grow.

Physiological processes in plants can be altered or halted by plant diseases. Reduced crop yields are often attributed to bacteria, fungi, microbes, or viruses. Before any evaluations are done, it can be said that farming is the primary source of food for 60% of the world's population.

Potato diseases significantly reduce harvest quality and quantity. Misdiagnosis and inaccurate disease classification lead to a dramatic decrease in plant health.

Globally, the agricultural sector is the most important provider of food, income, and jobs. The industrial sector in India contributes 18% to GDP and employs 53.3% of the labor force [1], reflecting the prevalence of such a sector in low and middle-income countries. The growth of India's economy in recent years has been propelled in large part by the agricultural sector, which has increased its gross value added (GVA) contribution to the GDP from 17.6% to 20.2% [2][14]. There is a risk to agriculture and, by extension, the quality of food production because preventative drugs are not very effective at stopping epidemics or endemics of diseases that affect plants and insects. Losses in production quality can be reduced through early detection and surveillance of crop diseases, especially when combined with suitable crop protection measures.

There has been a lot of interest in using YOLO (You Only Look Once) models to detect and classify diseases in potato leaves in recent years because of how well they work at doing just that. The high processing speed and accurate detection

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of YOLO models make them ideal for real-time applications in agriculture [15].

II. RELATED WORK

A study about the identification of diseases affecting plant leaves is given in Related Work. CNN provides the highest predicted accuracy for plant disease diagnosis (Convolutional Neural Network). A deep-learning model equipped with a disease-detection specialized convolution network was trained using images of sick plant leaves. The system learned to distinguish between potato leaves with early blight, late blight, and healthy leaves [9][10]. When put through its paces on multiple datasets, it showed an impressive overall classification accuracy of around 98%. If this technology works as intended, it will allow farmers to quickly identify crop diseases in their earliest stages, allowing them to take preventative action.

In [3], we see that CNN can detect the potato leaf disease. The classification of the disease in potato leaves achieved a 99 percent accuracy rate by utilizing a dataset consisting of 700-800 pictures. Additional photographs may be required to improve results [4], which is a limitation of the aforementioned dataset. The proposed method may be able to predict events with an unprecedented degree of precision. It can both identify plant diseases and treat them. Improving the plant's health and yield requires first understanding the disease and how to treat it. Python's implementation of the CNN algorithm ensures an 80% accuracy framework [5].

The fifth experiment uses Dense Net and three different plant species (tomato, potato, and bell pepper) to correctly identify and classify different forms of leaf diseases. The Plant Village dataset acquires all data through the utilization of a mobile camera and instantaneous detection. Improving the accuracy of the model, streamlining computation for mobile devices, and developing an accessible mobile application should be the primary goals of future work on this system or investigation.

The authors of the paper [6] utilized different machine learning algorithms, including naive Bayes, K-nearest neighbors (KNN), and support vector machines (SVM), to attain accuracies of 88.67%, 94.00%, and 96.83%, respectively.

The feasibility of using a Convolutional Neural Network model to predict plant diseases was investigated by the authors of [7]. They utilized images from a specific dataset collected from the field, along with prior knowledge indices.

To categorize leaf diseases, a method is used [8]. To complete the process of dividing the sick part, we employ the K-Means algorithm. This article discusses the possibility of using deep learning algorithms in the future for plant disease diagnosis. This research delves into various approaches to creating an efficient classifier for potato leaf disease from an RGB image. Findings from the study suggest that an extensive input dataset be developed. Not only do the leaves and affected area play a role, but so do several other factors that help determine how well the models' learned features represent the overall structure of an image [11].

Figure 1. Illustrative images representing each category within the dataset. [13].

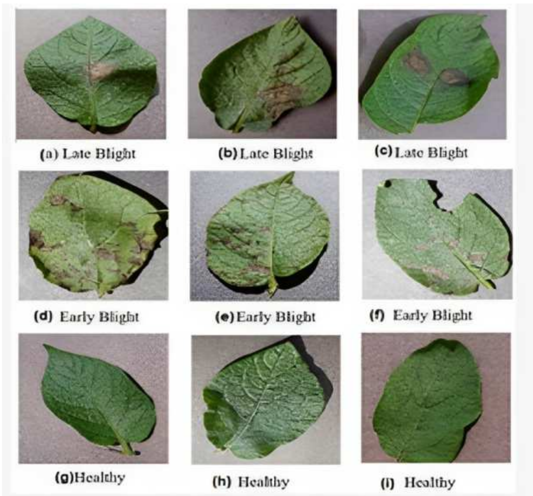

Figure 1. Illustrative images representing each category within the dataset.

A. Research Gap

Problems with the Existing Model include:

- While there is some success with current models for leaf diseases, there are also some limitations to these approaches.
- The research gap is complicated and needs a lot of data to train;
- The model might not be able to find diseases in plant species other than the ones it was trained on;
- The model has not been tested on a large dataset of real-world images.
- Choosing features makes the best accuracy with less overhead.

III. Proposed Methodology

This research presents a strategy for the precise diagnosis of agricultural diseases. Gathering data, preprocessing it, improving it, and finally classifying images are the four steps that make up the process. This study mainly focuses on the YOLOv7 deep learning model because it is designed for this particular purpose.

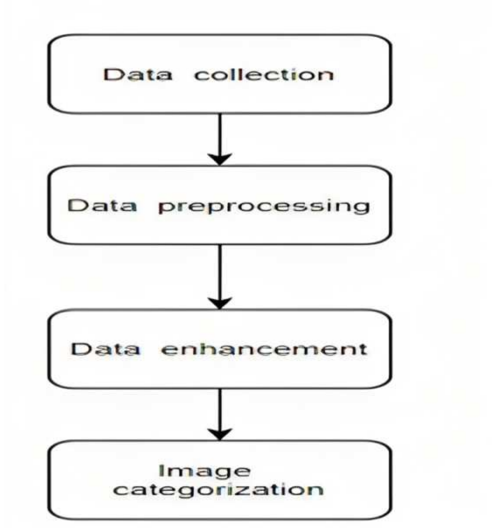

Figure 1. Proposed Methodology

Data Collection: Gathering data pertinent to the algorithm is the first step in evaluating and implementing the algorithm. An extremely precise prediction is within your reach if you have access to a mountain of data. Collecting relevant data is the initial stage of the suggested approach.

Data Pre-processing: To get accurate results from any dataset, pre-processing the data is essential, and we have done it. Restoring data balance to a plant leaf dataset increases the dataset's usefulness. By following the proposed method, we have cropped all of the images to the same dimensions and only the leaf of the potato plant remains in focus.

Enhancer: The first thing that is done during the enhancement process is the reduction of image noise. A large image was successfully compressed to a size that is easier to work with by utilizing feature extraction, and there was no discernible drop in image quality as a result. In addition to that, it will disable any unnecessary options.

Catagatized: Any system can be utilized to classify an image. Because of its higher level of accuracy in comparison to other algorithms, the YOLOv7 deep learning model, also known as a classification algorithm, is currently the algorithm of choice for image classification.

Proposed Model

It is critical to identify diseases in potato leaves promptly to prevent crop yield losses. Exactly for this reason, precision agriculture has emerged. Because of its great accuracy and real-time performance, the YOLO (You Only Look Once) object detection algorithm has demonstrated promise as a tool for this task. To identify and categorize diseases in potato leaves, the proposed model employs the YOLO paradigm.Some have proposed a YOLO-based approach to potato leaf disease detection that is both more accurate and able to detect diseases in realtime. Better crop health management and more environmentally friendly farming methods may result from this.

Algorithm 1: A Learning Model for the Recognition of Potato Leaf Diseases

1. Gather images of potato plants in their natural habitat.

2. turn the videos into frames (images) if they have video.

3. create three separate datasets: training, validation, and testing. Each dataset will contain images of potato leaves.

4. The annotated images are pre-processed by auto-orienting and resizing.

5. involves preparing the training set for analysis by adding new data.

6. Convert the dataset of potato leaf images to YOLOv7 PyTorch format.

7. Prepare the YOLOv7s model for training and validation.

8. Use 80% for training, 10% for validation, and 10% for testing as your dataset divisions.

9. Use training images to train the model.

10. At the end of each epoch, validate the model using the validation images.

11. Keep the Verified Model on File.

12. To test the trained model, testing images are utilized.

To find a good set of values for the hyperparameters, one can use techniques like grid search or random search to systematically explore the space.

IV. Result and Discussion

If we want your YOLO model to be able to identify and categorize diseases in potato leaves, you need to optimize its hyperparameters. Maximizing the model's efficiency, accuracy, and generalizability requires meticulous hyperparameter selection and tuning. To ensure the YOLO model is configured optimally for practical applications, a systematic process is followed. This process includes data preparation, baseline model establishment, hyperparameter tuning, performance evaluation, cross-validation, fine-tuning, and saving/deployment.

Images of diseased potato leaves, encompassing both Early Blight and Late Blight instances, comprise the Potato Leaf dataset. Machine learning and computer vision researchers make use of the PlantVillage dataset. The primary objective is to develop systems capable of detecting plant diseases autonomously.

we used Python. It was made with TensorFlow 2.6.4 and pictures of potato leaves. Results and Outcomes

It is OpenCV and Python that are used to run our study. Increase the amount of food that is grown and the quality of that food by controlling the living things that cause big drops in yield and using deep learning to find diseases in plant leaves. Our study introduces a YOLOv7 framework for quickly and easily sorting potato leaves into groups based on diseases they have. To sort potatoes into early blight and late blight groups, the system first separated the leaves from a picture of a potato leaf. Following that, a YOLOv7 was taught to only find diseases in potato leaves. In addition, it looks at how environmental factors affect the spread of diseases on potato leaves.

YOLOv7 is a useful and powerful tool for finding and classifying diseases on potato leaves, which makes it an important part of precision farming and crop protection plans. Perfect for use in potato fields due to its high accuracy, robustness in real-time, scalability, good inference capabilities, and resistance to changes.

Species and diseases are used to classify the 54,303 leaf images in the PlantVillage dataset, which is further subdivided into 38 groups.

Table 1: Comparative study

Classifier Name	Accuracy
Proposed - YOLO	98.1%
ANN [15]	92%
SVM [15]	84%
RF [15]	79%

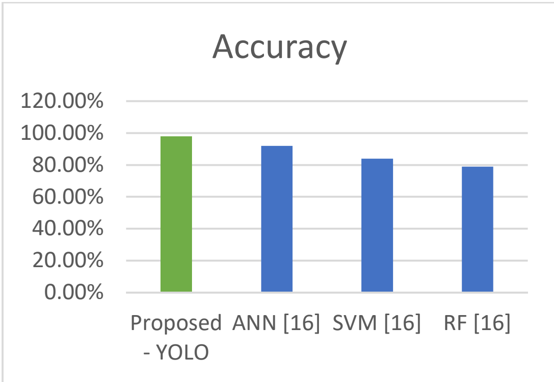

Figure 2: Comparative study

V. Conclusions

One effective method for disease detection and classification in potato leaves is the YOLO model. It employs TensorFlow 2.6.4 in conjunction with the Potato Leaf dataset, which contains pictures of sick potato leaves. Optimizing the model's hyperparameters can boost its efficiency and accuracy. Researchers in the fields of computer vision and machine learning use the PlantVillage dataset to develop algorithms that can detect plant diseases autonomously. To study the environmental factors that impact the spread of diseases, the YOLOv7 framework is utilized to categorize potatoes according to their diseases. Ideal for precision farming and crop protection plans, this method is highly accurate, works in real-time, and is unaffected by changes. Results demonstrate a high degree of accuracy (98.1%), suggesting that the method can correctly detect and classify diseases impacting potato leaves.

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