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Plant Leaf Disease Detection and Classification Based on Convolutional Neural Network

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Abstract: ***A strong pillar of the Indian economy is agricultural productivity, making the contributions of both food crops and cash crops crucial for the well-being of both the environment and human beings. Unfortunately, every year, crops fall victim to numerous diseases, resulting in substantial losses. The inadequate identification and lack of knowledge regarding disease symptoms and treatment lead to the demise of many plants. This study offers valuable insights into the detection of plant diseases by utilizing the CNN algorithm. A novel approach based on CNN is proposed for the detection of plant diseases. The study involves conducting simulations and analyzing sample images to assess factors such as time complexity and the extent of the infected region. The technique involves utilizing image processing to recognize the leaf and subsequently identifying and classifying the infected area.***

Keywords: Plant Disease Detection, Machine Learning, CNN.

I. INTRODUCTION

Agricultural production in the Indian economy extends far beyond the realm of food. The expansion of today's agricultural landmass has elevated its significance as a crucial component of the country's economy. In fact, the agriculture sector supports a staggering 75% of the population in India. Unfortunately, plant diseases inflict substantial damage to crops and vegetables, posing a threat to both agricultural productivity and human health due to the release of toxic metabolites. The study of plant diseases involves the detection of visual patterns in plants, and diagnosing these diseases is of paramount importance in cultivation to safeguard the quantity, quality, and overall well-being. Various types of plant diseases, caused by organisms like viruses, bacteria, and fungi, necessitate early identification, which has a positive impact on plant health. Symptoms of diseases are frequently observed on leaves, stems, and fruits, making leaf indicators valuable tools for faster, more reliable, and cost-effective disease diagnosis. Traditionally, the technique for diagnosing plant diseases involved naked-eye inspection by farmers, allowing for disease recognition and detection. However, this method requires the expertise of specialists and continuous monitoring, incurring significant costs, particularly for large farms. Additionally, in certain regions, farmers lack adequate facilities or knowledge to seek expert assistance, making consultation both expensive and time-consuming. Prior to the emergence of deep learning, image processing and machine learning methods were utilized to identify various plant diseases. Image enhancement, segmentation, color space conversion, and manipulation were employed to prepare images for subsequent analysis. Key features extracted from these images were then used as inputs for classifiers, with the overall classification precision relying on image processing and feature extraction techniques. However, recent research has indicated that networks trained on diverse datasets achieve state-of-the-art efficiency. Convolutional Neural Networks (CNNs), as supervised multi-layer networks, dynamically learn features from datasets and have demonstrated exceptional performance in numerous classification tasks. Within the same architecture, CNNs effectively isolate and classify features

II. LITERATURE SURVEY

1) Intelligent Plant Disease Identification System Using Machine Learning

This research paper presents the design and development of a real-time decision support system that integrates a camera sensor module for plant disease identification. The performance of three machine learning algorithms, namely Extreme Learning Machine (ELM) and Support Vector Machine (SVM) with linear and polynomial kernels, was thoroughly analyzed. To implement the system in real-time, a hardware setup using Raspberry PI was utilized. The obtained results demonstrate that the extreme learning machine exhibits superior performance in terms of accuracy and sensitivity, achieving a remarkable 95% accuracy rate compared to the other classifiers employed. Additionally, it was observed that the developed real-time hardware, coupled with the extreme learning machine classifier, effectively detects three different plant diseases. Furthermore, the system can be expanded to identify a wide range of plant diseases by training it with diverse datasets.

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2) Plant disease Identification based on Deep learning algorithm in Smart Farming

In this research, a novel mathematical model is introduced to effectively detect and identify plant diseases using deep learning techniques.

The model aims to improve accuracy, generality, and training efficiency in disease recognition. By leveraging advanced technologies, such as the region proposal network (RPN) and the Chan-Vese algorithm, the model successfully extracts relevant features from leaf images, even when captured in complex environmental settings. The segmented images are then fed into a transfer learning model that has been trained on a diverse dataset of diseased leaves. The experimental evaluation of the model focuses on three specific diseases: black rot, bacterial plaque, and rust. Remarkably, the proposed model outperforms traditional methods in terms of accuracy, showcasing its potential to minimize the negative impact of diseases on crop production and contribute to sustainable agricultural practices.

This research not only holds great significance for intelligent agriculture but also has implications for environmental conservation and overall enhancement of agricultural productivity.

3) Plant Leaf disease detection and classification using Machine Learning

The integration of image processing and machine learning techniques has proven valuable in enhancing plant disease detection methodologies, leading to significant reductions in time, effort, and expertise required for identifying infected plants. The process encompasses various stages, including image acquisition, filtering, segmentation, feature extraction, and classification.

This research paper presents a novel approach for disease detection by analyzing the appearance of diseases from plant images and subsequently determining the specific type of infection, such as Alternaria Alternata, Anthracnose, Bacterial Blight, or Cercospora Leaf Spot. With a minimum accuracy of 95 percent and a maximum accuracy of 99 percent, this approach consistently delivers highly accurate results.

The disease detection process focuses on the affected area, even when it is relatively small, ensuring efficient identification and analysis.

III. III.METHODOLOGY

A. Data Collection

Gather a large dataset of plant leaf images, including both healthy and diseased leaves, representing various plant diseases.

B. Data Preprocessing

Apply image processing techniques such as image enhancement, segmentation, and color space conversion to preprocess the collected images and prepare them for further analysis.

C. Feature Extraction

Extract relevant features from the preprocessed images, such as shape, color, and texture information. These features will serve as input for the classification model.

D. Model Training

Utilize Convolutional Neural Networks (CNNs) to train a classification model on the extracted features. CNNs are capable of learning intricate patterns and features from images, making them suitable for plant disease identification.

E. Model Evaluation

To ensure the accurate identification of plant diseases, it is necessary to assess the trained model using suitable performance metrics like accuracy, precision, recall, and F1-score. This evaluation process confirms the model's capability to effectively and precisely detect and classify plant diseases.

F. Application Development

Develop an application that integrates the trained model, allowing users to capture images of plant leaves and obtain real-time disease identification results. This application can be built using technologies such as FastAPI and ReactJS.

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IV. RESULT AND CONCLUSION

Convolutional Neural Networks, leverage convolutional and pooling layers to extract meaningful features from images. These layers perform operations on the input image, highlighting patterns and edges, and reducing spatial dimensions. By stacking multiple layers, CNNs can learn complex representations of the data. This hierarchical learning enables CNNs to achieve high accuracy in tasks such as image classification and analysis. Below are the images showing output of the model created in this projec

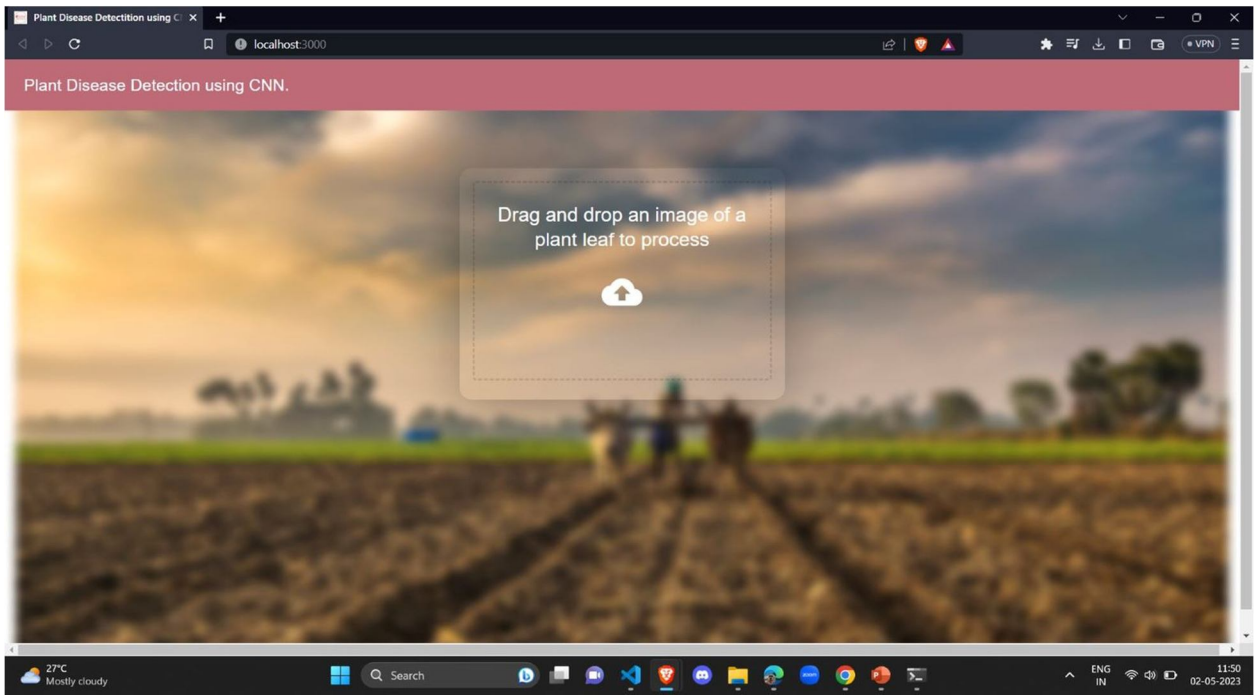


Figure: 2

Fig2 shows the UI (user interface) for uploading the leaf image in order to classify the leaf.

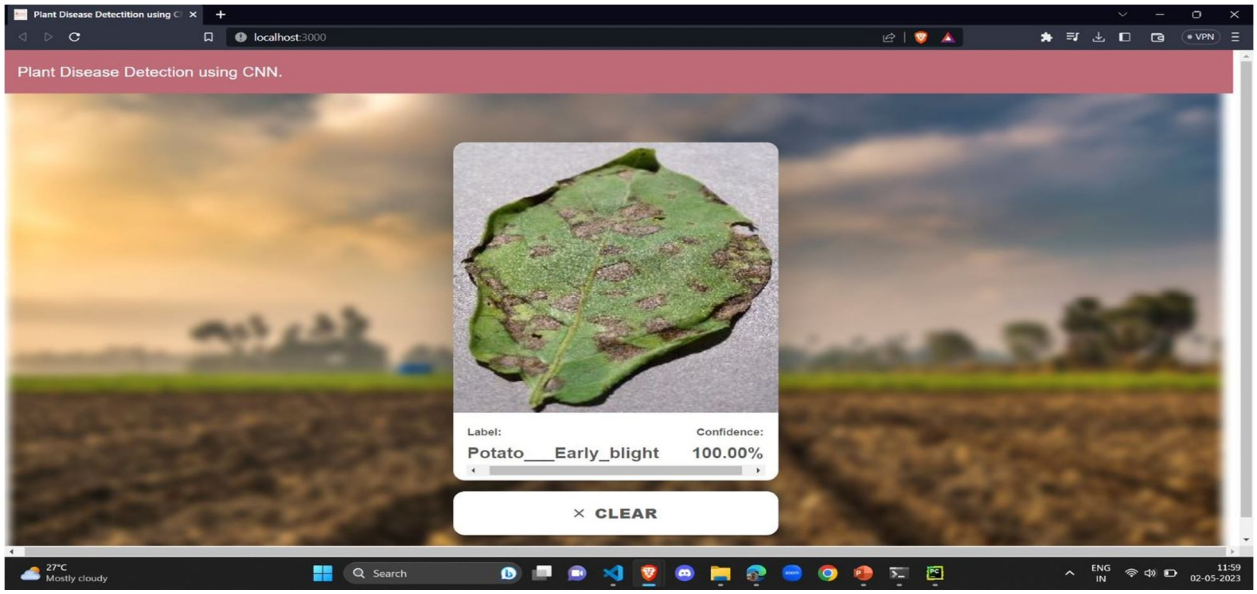


Figure: 3

In fig3 we can observe that leaf disease is detected and classified along with confidence level

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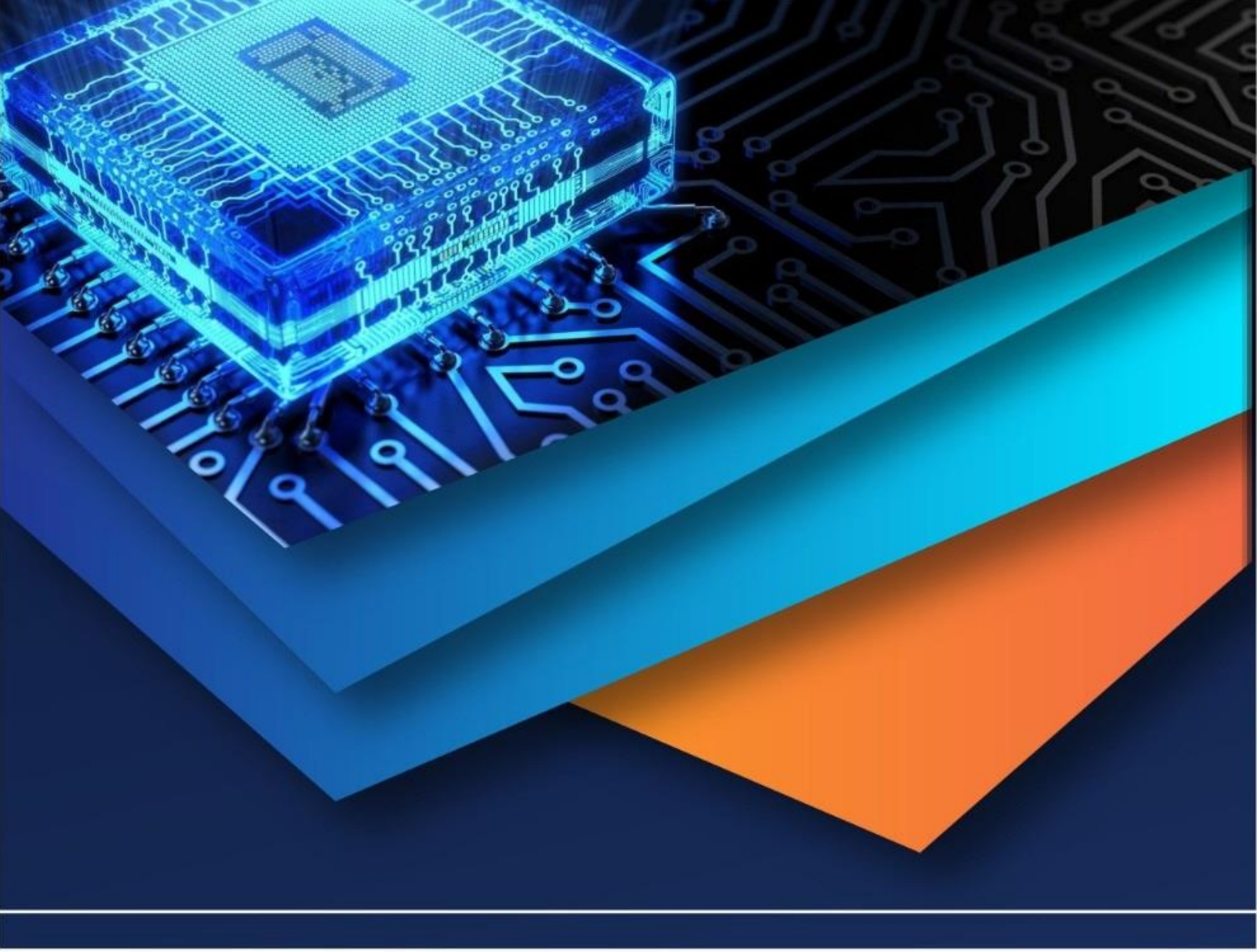
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