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Sugarcane Disease Recognition using Deep Learning

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Abstract: *This paper "Sugarcane Disease Recognition Using Deep Learning" describes the concept of a "CNN" as a Convolution Neural Networks. Convolutional neural network (CNN) is a type of feed-forward artificial Neural Network whose connectivity structure is inspired by the organization of the animal visual cortex. Recognizing sugarcane diseases using deep learning techniques can be an effective approach to automate the disease detection process. Deep learning models, such as Convolution Neural Networks (CNN), have shown promising results in image recognition tasks, including plant disease recognition. The primary crop used to produce sugar and ethanol in the globe is sugarcane. The eradication of growing crops infected with the illness is one issue in the sugar sector, and if these diseases are not treated and recognized early, small-scale farmers may suffer financial loss. The rationale for undertaking this study was the rapidly expanding classes of diseases and farmers' insufficient knowledge of disease identification and recognition. As a result, this research offers a suggestion for using deep learning algorithms to assist farmers in identifying and categorize sugarcane infections. The paper also discusses the existing literature in the field, addresses the limitations of previous research, and presents the methodology and functioning of the proposed system.*

Keywords: CNN, sugarcane leaf disease recognition, deep learning, image classification

I. INTRODUCTION

The paper titled "Sugarcane Disease Recognition Using Deep Learning" presents a novel approach to address the challenges associated with farmers. If diseases are not promptly identified and treated, they can have a significant negative influence on sugarcane yield and production, which is of great concern to farmers. If there is a decline in the cultivation of these crops, the economy will suffer. In the management of input resources including seed, water, soil, and fertilizers, sustainability of production is crucial. If these crops sustain harm while they are growing, agricultural production and preservation will lose their competitive flexibility.

Understanding and identifying sugarcane diseases is essential because they cannot be prevented. Experts employ a classic method that can be seen with the unaided eye to identify and locate the sugarcane leaf disease. The diagnosis typically needs to be confirmed and validated via ongoing monitoring. But vast farms cannot use this technique. It is expensive and time-consuming to seek the advice of an expert in developing nations like the Philippines. In some studies, machine learning, a popular technology, is used to categories and find plant diseases.

Algorithms that use traditional machine learning methods like Scale invariant feature transform (SIFT), Support Vector Machine (SVM)[1], etc. are frequently used. This approach calls for more complex calculations that are challenging for online applications. Therefore, the effectiveness of these strategies may only produce a desirable outcome. In contrast to traditional neural network topologies, deep learning uses artificial neural network architecture and typically has many more layers to process information. Image detection, image classification, acoustics, and other fields that require processing enormous amounts of data have been altered by deep learning. Overall, the paper presents a comprehensive methodology and system architecture for Sugarcane Disease method and armed patrolling, this system offers a more efficient, cost-effective, and environmentally friendly.

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II. METHODOLOGY

An experimental design through an architecture diagram shows whether the sugarcane plant is infected or not infected with the disease through leaf images.

Image dataset is collecting from Kaggle.

The images will then save in a folder identifying the different class of diseased images and a healthy image of sugarcane leaves. The acquired image dataset consists of images of four different classes. Each image is stored in the uncompressed JPG format using RGB color. Pre-processed images are reduced image size, croppedimage and enhanced imaged. Our study uses colored and resized images to 96x96 resolutions for further processing. The convolution layers obtain features from the resized images.

The Rectified non-linear activation function is applied after convolution and different types of pooling like max pooling and average pooling reduce the dimension of the extracted features. The convolution and pooling layers together will act as a filter to produce features. Classification uses fully connected layers and for feature extraction it uses convolution and pooling layers. The classification of classifying the sugarcane leaves if it is infected with the disease or not is done in this layer.

Here is a general outline of how you can approach sugarcane disease recognition using deep learning:

- Data Collection: Collect a diverse and representative dataset of images containing healthy sugarcane plants and various diseased sugarcane plants. Make sure to include images of different disease types and severities.
- Dataset Preparation: Preprocess and organize the collected dataset. Split the dataset into training, validation, and testing sets. It is important to have a sufficient number of images for each class to ensure balanced training.
- Data Augmentation: Process of making the training dataset by applying transformations such as rotation, scaling, flipping, and cropping. Data augmentation[2] helps increase the variability of the dataset and improves the model's ability to generalize.
- Model Selection: Choose an appropriate deep learning architecture for image recognition, such as a CNN. Other pre-trained models like Inception can be used, which have been trained on large-scale image datasets like ImageNet. Alternatively, you can design your own custom CNN architecture.
- Model Training: Initialize the chosen model with pre-trained weights if applicable. Train the model on the prepared dataset using the training set. During training, the model learns to differentiate between healthy and diseased sugarcane plants based on the features it automatically extracts from the images.
- Model Evaluation: Evaluate the trained model using the validation set to assess its performance and fine-tune hyper parameters if necessary. Common evaluation metrics include accuracy, precision, recall[3].
- Model Testing: Test the trained model on the unseen testing set to get an estimate of its performance on new, unseen data. This step helps determine the model's generalization capability.
- Deployment: Once you are satisfied with the model's performance, you can deploy it in a real-world application. The model can take images of sugarcane plants as input and predict the presence of diseases.

Success of deep learning models heavily relies on the quality and representativeness of the dataset[3]. Additionally, it's important to keep updating the dataset and retraining the model as new sugarcane diseases emerge or new variations of existing diseases appear.

III. MODELING AND ANALYSIS

Testing is a critical element which assures quality and effectiveness of the proposed system in (satisfying) meeting its objectives. Testing is done at various stages in the System designing and implementation process with an objective of developing a transparent, flexible and secured system. Testing is an integral part of software development[4]. Testing process, in a way certifies, whether the product, that is developed, complies with the standards, that it was designed to. Testing process involves building of test cases, against which, the product must be tested.

Test objectives:

Testing is a process of executing a program with the intent of finding an error. A good case is one that has a high probability of finding an undiscovered error.

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Testing principles:

Before applying methods to design effective test cases, a software engineer must understand the basic principle that guides software testing. All the tests should be traceable to customer requirements.

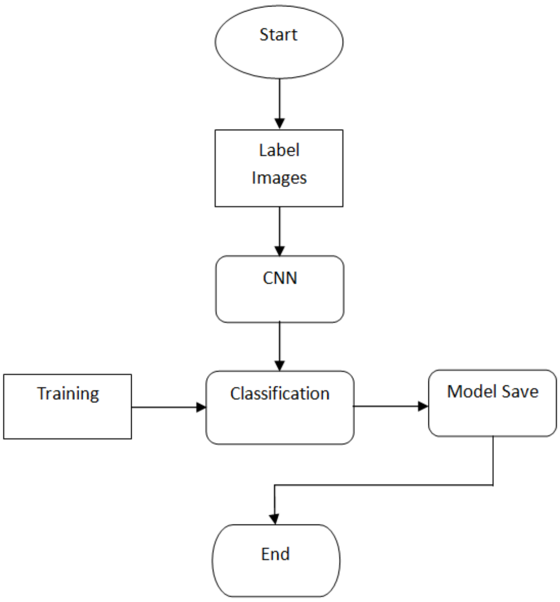

FIG1: Flow chart for training

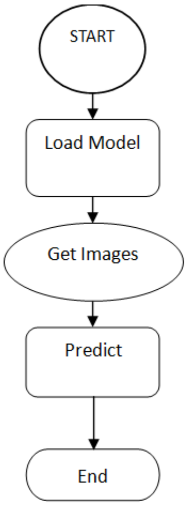

FIG 2: Flow chart for testing

Testing is a critical element which assures quality and effectiveness of the proposed system in (satisfying) meeting its objectives. Testing is done at various stages in the System designing and implementation process with an objective of developing a transparent, flexible and secured system. Testing is an integral part of software development[4]. Testing process, in a way certifies, whether the product, that is developed, complies with the standards, that it was designed to. Testing process involves building of test cases, against which, the product must be tested.

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Testing design:
Any engineering product can be tested in one of two ways:

Testing strategies:
A software testing strategy provides a road map for the software developer. Testing is a set of activities that can be planned in advanced and conducted systematically[4]. For this reason, a template for software testing a set of steps into which we can place specific test case design methods should be defined for software engineering process.

Functional test:
Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.
Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

IV. RESULT AND DISCUSSION

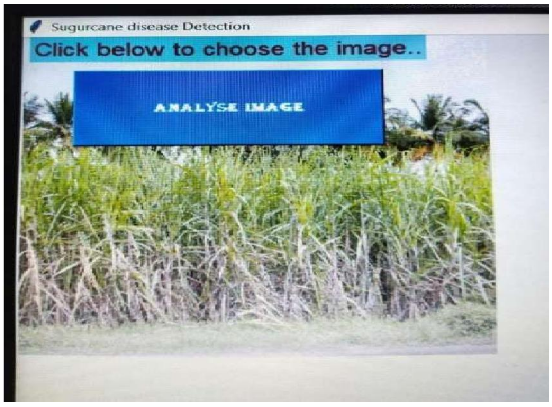

Fig 3. GUI (Graphical Use Interference)

This is the software, where we have given the input and it will analyze the image and show the result.

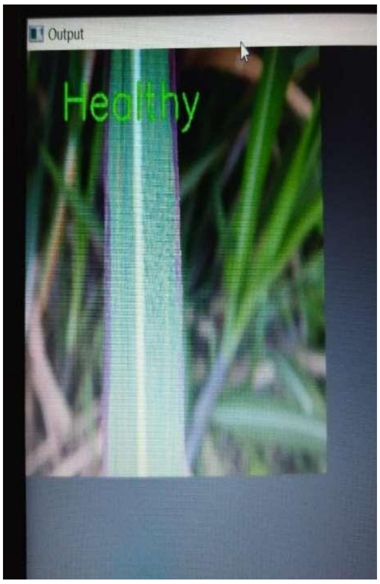

Fig 4. Healthy

Healthy sugarcane leaves exhibit several characteristics that indicate their well-being and optimal functioning. Here are some common characteristics of healthy sugarcane leaves:

- Green color: Healthy sugarcane leaves typically have a vibrant green color. The green coloration is due to the presence of chlorophyll, which is essential for photosynthesis and energy production.
- Turgidity: Healthy leaves are firm and turgid, indicating sufficient water uptake and maintenance of cell structure. They do not appear wilted or limp.
- Symmetry and uniformity: Healthy sugarcane leaves are generally symmetrical in shape and size. They exhibit uniform leaf development, with similar leaf length, width, and spacing along the stalk.
- Absence of discoloration: Healthy leaves do not exhibit discoloration such as yellowing, browning, or necrotic spots[5]. They retain their green color throughout.

It's important to note that the appearance of sugarcane leaves can vary depending on the growth stage, cultivar, and environmental conditions. Regular monitoring and familiarity with the specific characteristics of the sugarcane variety being cultivated will help in assessing leaf health and identifying any.

Fig 5. Bacterial Blight

Bacterial blight disease, also known as Xanthomonas albilineans, is a significant bacterial disease that affects sugarcane crops. Here's some information about bacterial blight disease in sugarcane:
Causal Agent: Bacterial blight is caused by the bacterium Xanthomonas albilineans, [6]which infects the vascular system of sugarcane plants.

Symptoms:

- White leaf streaks: The initial symptom is the appearance of narrow, elongated white streaks on the leaves. These streaks run parallel to the leaf veins.
- Leaf drying and necrosis: The infected areas on the leaves gradually turn yellow and then brown, leading to drying and necrosis of the affected leaves.
- Loss of turgidity: Infected leaves lose turgidity and droop, giving the plant a wilted appearance.
- Stalk symptoms: In some cases, bacterial blight can also cause symptoms on the stalk, such as reddish-brown discoloration and gumming of the vascular tissues.
- Disease Spread: Bacterial blight spreads primarily through infected planting material, including infected buds or cuttings. The bacterium can also be transmitted by insect vectors such as leafhoppers.
- Impact: Bacterial blight can result in significant yield losses and quality reduction in sugarcane crops. Severe infections can cause extensive leaf damage, leading to reduced photosynthetic capacity and ultimately affecting plant growth and sugar production.

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It is important for sugarcane growers to consult local agricultural extension services, plant pathologists, or experienced farmers for specific management recommendations and best practices tailored to their region and prevailing conditions.

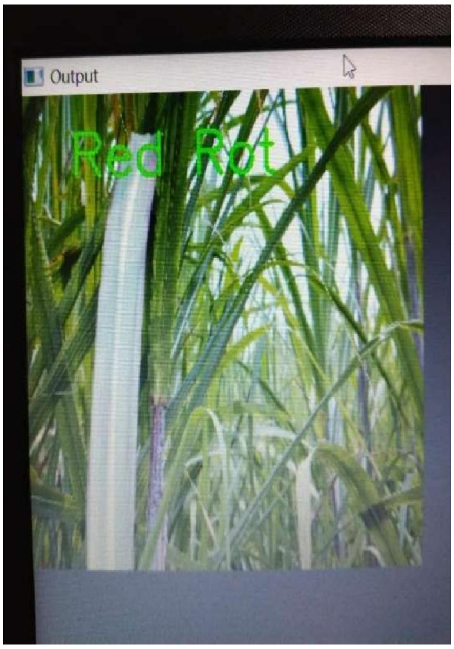

Fig 6. Red Rot

- Red Rot: The infected internodes and vascular tissues turn reddish-brown in color. The red coloration usually starts at the nodes and gradually spreads.
- Rotting and Decay: Infected tissues become soft and mushy, eventually leading to the decay of the affected internodes.
- Splitting of Stalks: Severely infected stalks may split open, leading to the collapse of the plant.

Impact:

- Yield Loss: Red rot disease can cause significant yield losses in sugarcane crops. Infected plants have reduced sugar content and weight, leading to decreased sugar production.
- Quality Decline: The quality of sugarcane juice obtained from infected plants is reduced due to altered chemical composition and increased impurities.
- Economic Loss: Red rot disease can result in financial losses for sugarcane growers and the sugar industry.

Management and Control:

It is advisable for sugarcane growers to consult local agricultural extension services or plant pathologists for specific recommendations and management strategies suited to their region and crop condition.

Red rust, also known as sugarcane rust, is a fungal disease that affects sugarcane crops. The causal agent of orange rust is the fungus Puccinia kuehnii.[7]

Symptoms: Orange rust primarily affects the leaves of sugarcane plants.

The characteristic symptoms include:

- Orange pustules: Small, raised pustules or blisters appear on the leaf surface, giving them an orange or rust-colored appearance.
- Spore production: The pustules release orange spores, which can be observed as a powdery substance on the leaves.
- Lesions: Infected leaves may develop elongated, yellow lesions between the pustules.

- Favorable Conditions: Orange rust thrives in warm and humid environments. Moderate temperatures (around 20-30°C) and high humidity provide favorable conditions for the growth and spread of the fungus.
- Impact: Orange rust can affect sugarcane yield and quality. Infected leaves experience reduced photosynthetic activity, leading to decreased plant vigor. Severe infections can result in leaf death, stunting, and reduced sugar content in the affected plants. Yield losses can vary depending on the severity and timing of the infection.

It is important for sugarcane growers to consult local agricultural extension services, plant pathologists, or experienced farmers for specific management recommendations tailored to their region and prevailing conditions.

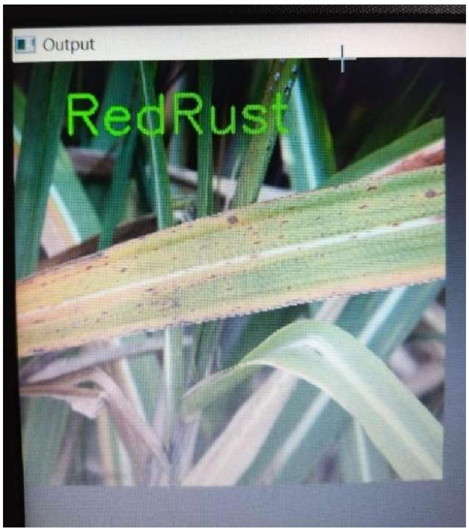

Fig 7: Red Rust

V. CONCLUSION

This study used deep learning to identify and categorize the health or sickness of sugarcane leaves. The classification of the sugarcane leaf was done using a straight forward convolution neural network with four separate classes, and more than 90% accuracy was achieved , By correctly identifying and categorize sugarcane photos into healthy and diseased categories based on the pattern of leaves, the trained model has successfully accomplished its objective .As a result, this study provides a suggestion for how to assist farmers in identifying and categorize sugarcane diseases by using computer vision and machine learning. To assess the model's performance on the training set for upcoming work, various models may be used. The proposed models may also be tested using other learning rates and optimizers.

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