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Classification of Macronutrient Deficiencies in Maize Plant using Machine Learning

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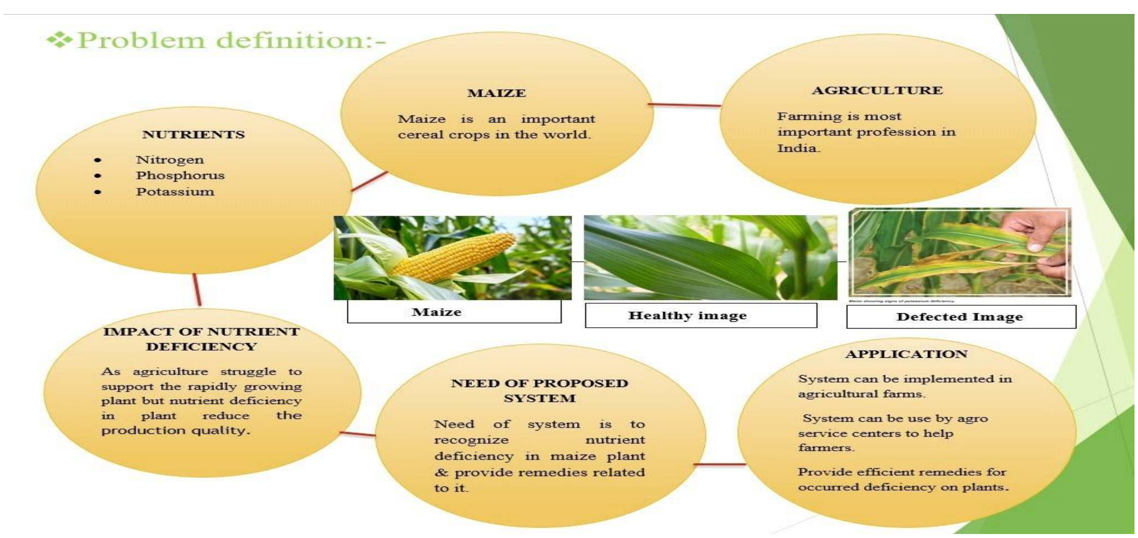
Abstract: Detection of nutritional deficiencies in plants is vital for improving crop productivity. Timely identification of nutrient deficiency through visual symptoms in the plants can help farmers take quick corrective action by appropriate nutrient management strategies. Manual checking of plant nutrient deficiency does not give adequate result as naked eye observation is old method and requires more time for deficiency recognition, and also need expert person. which is very costly for farmers hence it is non-effective. To overcome disadvantages of traditional eye observing technique, we used the application of computer vision and machine learning techniques offers new prospects in nondestructive field-based analysis for nutrient deficiency detection. In the proposed system, we are using unsupervised machine learning algorithm, which learns features on its own from given dataset. Initially, we perform preprocessing on image to be tested. preprocessing includes image enhancement, image restoration, image segmentation. classifier predicts the result based on the image we passed. The system will provide the definite result about a nutrient deficiency along with disease if any and also provide solution for nutrient deficiency.
Keywords: Machine Learning, Convolutional Neural Network, feature learning, nutrient deficiency, Image Pre-processing.

I. INTRODUCTION

India holds 12th position in global agriculture GDP ranking and accounts 7.68 of global agricultural output having the largest area under the cultivation. In spite of agriculture being only the source of livelihood for the large fraction of Indian population, the technological advancement in this fields are not much to bridge the gap between agriculture and technology. Our system work is an initiative towards developing a low cost, reliable, accurate solution for detecting the plant health. Where nutrients play the key role. Therefore, analyzing nutrients deficiencies in plants have become an important task for healthy growth. Detection of nutritional deficiencies in plants is vital for improving crop productivity. Timely identification of nutrient deficiency through visual symptoms in the plants can help farmers take quick corrective action by appropriate nutrient management strategies. The application of computer vision and machine learning techniques offers new prospects in non-destructive field-based analysis for nutrient deficiency. as we are using unsupervised machine learning algorithm, it internally learns all the features to predict the desired result. Convolutional neural network has been used in our system to predict the results. experimental results are analyzed and stored into the Table 1 and compared in terms of classification accuracy to find the best algorithm for getting most accurate solution possible.



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II. OBJECTIVES

Machine learning techniques provide promising solution for identification of nutrient deficiencies. The system can also help in providing exact fertilizers and also minimizing the use of pesticides once we detect which nutrients deficiency in plant. Eventually, will help in maintaining the fertility of soil. The system is a low cost, reliable, accurate solution for detecting nutrient deficiencies.

III. SCOPES

The system is unable to detect nutrient deficiency of leaf which are damaged. The system has been designed to improve crop productivity along with early detection of nutrient deficiency and it also helps farmers to identify and diagnose nutrient deficiencies and toxicity symptoms. In our system we have designed an automated framework for maximizing the yield.

IV. IMAGE DATA COLLECTION

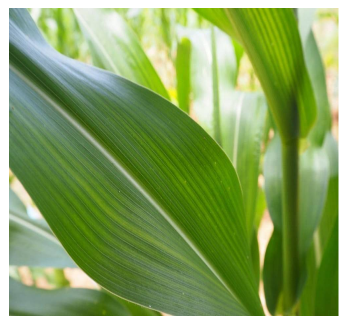
A. Image Datasets for Machine Learning

A machine learning model always perform better with proper data set. Preparing data set for machine learning projects is very crucial. While selecting image set , we need to look after things like variety in images, quantity of images. We can improve the image quality by preprocessing of images.

V. GENERALIZATION

The system can be made generalized if required. It is beneficial to develop other kind of systems with lot more ease. It would be interesting if we design the system which is generalized and not only maize related, so that it can be versatile.

Nitrogen Deficient



Healthy Maize Leaf

Potassium Deficient

Phosphorous Deficient

Fig.2 - Sample Dataset Images

VI. PROPOSED SYSTEM

In this framework we have taken 400 sample of images which contains all the varieties of images in it i.e. infected as well as healthy type of images which has been shown in figure.2. In which we have divided them into two sets, the first set is of 200 image which is used for training our model and the second set of 200 images is used for the testing our model . Then the image to be tested is given input to our system then on the image preprocessing steps are applied where we will get the filtered image and then the part of image which will be required for further will be extracted through segmentation and then feature learning technique will be applied .Then image will be ready for Classification. Here we have use CNN algorithm for Classification and accurate result.

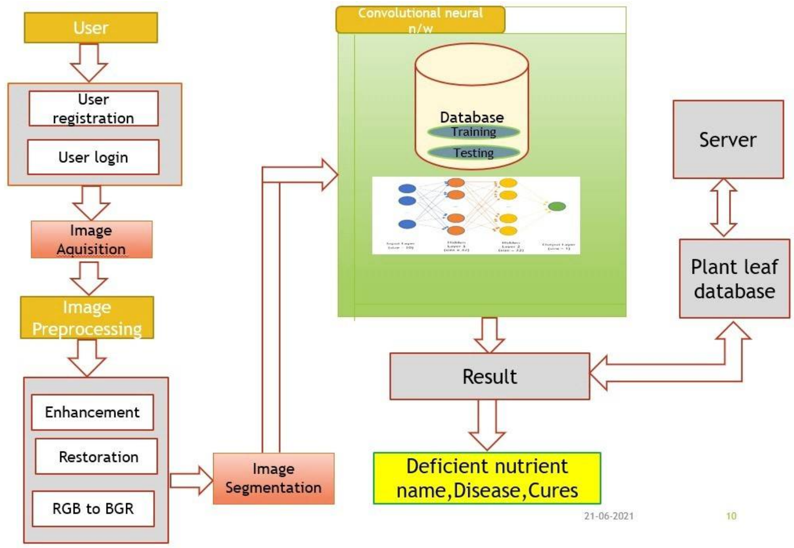


Fig.3 - System Architecture

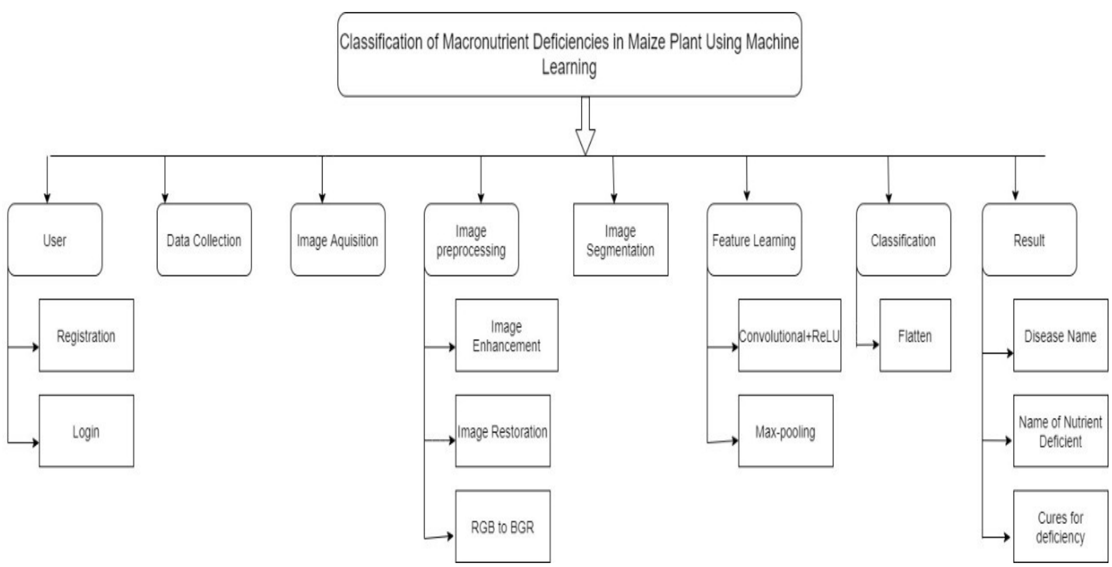
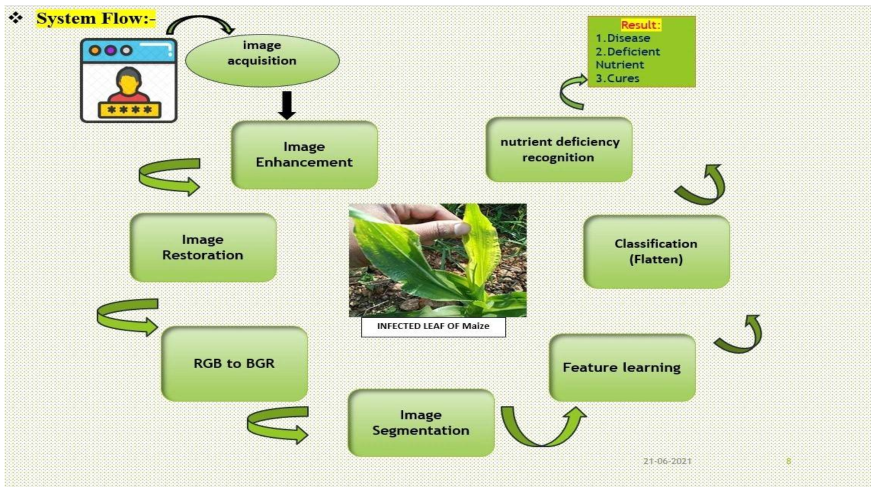


Fig.4 - System Breakdown Structure

VII. ALGORITHM

Step 1:Import the dataset.
Step 2: Explore the data to figure out how they look
Step3 :Pre-process the data.
Step 4:Split the data into attributes and labels.

Step 5:Divide the data into training and testing sets.
Step 6:Train the CNN algorithm.
Step 7:Make some predictions.
Step 8: Evaluate the results of the algorithm.



Figre.5 - System flow in nutrient deficiency detection

The above figure No. 5 shows the methodology flow in which the system will work .It will start from image acquisition steps and follow its flow of implementation and finally end at Classification step. The steps are explained in details as follows

A. *Image Acquisition*

It is the first step in the workflow. In Image Processing Image Acquisition is the action of getting the image from a source i.e. from hardware source in order to process the image for the further requirement.

B. *Image Preprocessing*

1) *Image Enhancement:* If uploaded image of infected leaves is not in good quality then we should apply image enhancement on the images. For detecting very small symptoms of leaves ,images should have better quality for this image enhancement is required .Image enhancement is the process of adjusting digital images so that the results are more suitable for display or further image analysis. For example, you can remove noise, sharpen, or brighten an image, making it easier to identify key features.
2) *Image Restoration:* If the infected images of leaves uploaded by user is blur or not in clear format then we should apply image restoration on the images which are uploaded by user. Image restoration is the operation of taking a corrupt/noisy image and estimating the clean, original image. Corruption may come in many forms such as motion blur, noise and camera
3) *RGB to BGR:* OpenCV is a huge open source library for computer vision ,image processing and other applications .It also supports a variety of programming languages. We will use cvtColor() method to convert RGB to BGR and also vice versa can be done.

Approach :

- Import module
- Read image
- convert it using cvtColor()
- Add wait key
- Add destroy window mechanism

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C. Image Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as image objects). The goal of segmentation in our system is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. In our system image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

D. Feature Learning

In this an initial set of the raw data is divided and reduced to more manageable groups. So, when you want to process it will be easier. A main and most important characteristic of these large data sets is that they have a large number of variables. These variables require a lot of computing resources to process them. So, Feature extraction basically helps to get the best feature from those big data sets by select and combine variables into features, effectively reducing the amount of data. These features are easy to process, but still able to describe the actual data set with the accuracy and originality.

1) *Convolution + ReLU:* Convolution is the first layer to extract features from an input image. Convolution preserves the relationship between pixels by learning image features using small squares of input data. It is a mathematical operation that takes two inputs such as image matrix and a filter or kernel.
2) *Rectified linear activation function(ReLu):* The rectified linear activation function or ReLU for short is a piecewise linear function that will output the input directly if it is positive, otherwise, it will output zero. The rectified linear activation function overcomes the vanishing gradient problem, allowing models to learn faster and perform better.
3) *Max-Polling:* Maximum pooling, or max pooling, is a pooling operation that calculates the maximum, or largest, value in each patch of each feature map. The results are down sampled or pooled feature maps that highlight the most present feature in the patch, not the average presence of the feature in the case of average pooling

E. Classification

It is the last process of the methodology. It is the process of categorizing the given dataset into classes. Here we have use flatten CNN.

1) *A Convolutional Neural Networks Algorithm :*

Step 1: Convolution Operation: In this step, classifier learn features using feature detectors, which basically serve as the neural network's filters. also, classifier identifies parameters for classification in this step.

Step 2: ReLU Layer: The second part of this step will involve the Rectified Linear Unit or ReLU. It is as an activation function.

Step 3: Pooling: Max pooling is a sample-based discretization process. The objective is to down-sample an input representation (image, hidden layer output matrix, etc.), reducing its dimensionality and allowing for assumptions to be made about features contained in the sub-regions binned.

Step 4: Flattening: Flattening is converting the data into a 1-dimensional array for inputting it to the next layer. We flatten the output of the convolutional layers to create a single long feature vector. And it is connected to the final classification model, which is called a fully-connected layer.

Step 5: Full Connection: Fully Connected Layer is simply, feed forward neural networks. Fully Connected Layers form the last few layers in the network. The input to the fully connected layer is the output from the final Pooling or Convolutional Layer, which is flattened and then fed into the fully connected layer.

VIII. RESULT

We perform image processing on the image features for prediction then with the help of train model we output the deficient nutrient along with the disease. Table 1 shows experimental result of sample images that has been tested earlier. Our system has accuracy of 52.36% it can be increased with increasing number of epochs and can be increased up to 70% overall.

Sr.No	No.of leaves	Leave Disease Type	Nutrient Deficiencies
1	38	Healthy	None
2	47	Cercospora_leaf_spot _Gray_leaf_spot	Nitogen
3	52	Common Rust	Potassium
4	63	Northern_Leaf_Blight	Phosphorus

Table 1 - Experimental Results

The table 1 shows the distribution of leaves according to their infected type into nutrient deficiencies in which they occur.

Sr.No	Categories	Precision	Recall	F1-Score	Number
1	Common Rust	82.0%	93.0%	87.0%	85
2	Northern Leaf Blight	88.0%	73.0%	80.0%	79
3	Gray Leaf Spot	90.0%	84.0%	87.0%	83
4	Healthy Leaf	85%	78%	81%	90

Table 2- Classification Report

The table No.2 shows the classification report of all four classes.

IX. CONCLUSION

A system is properly design to get the output of the infected leave of maize plant. The system design was started from the user input leave and there after many processing techniques have being applied on that leaves. The process starts with image preprocessing were image enhancement ,image restoration and rgb to bgr conversion have taken place. After that the segmentation of the leaf is done in order to get the required part of leaves. further Feature learning techniques are applied and then the Classification is being carried out to get the desired output of leaves. Result is provided in the form of disease of the leave along with its Nutrient deficiencies and cure measure that should be done.

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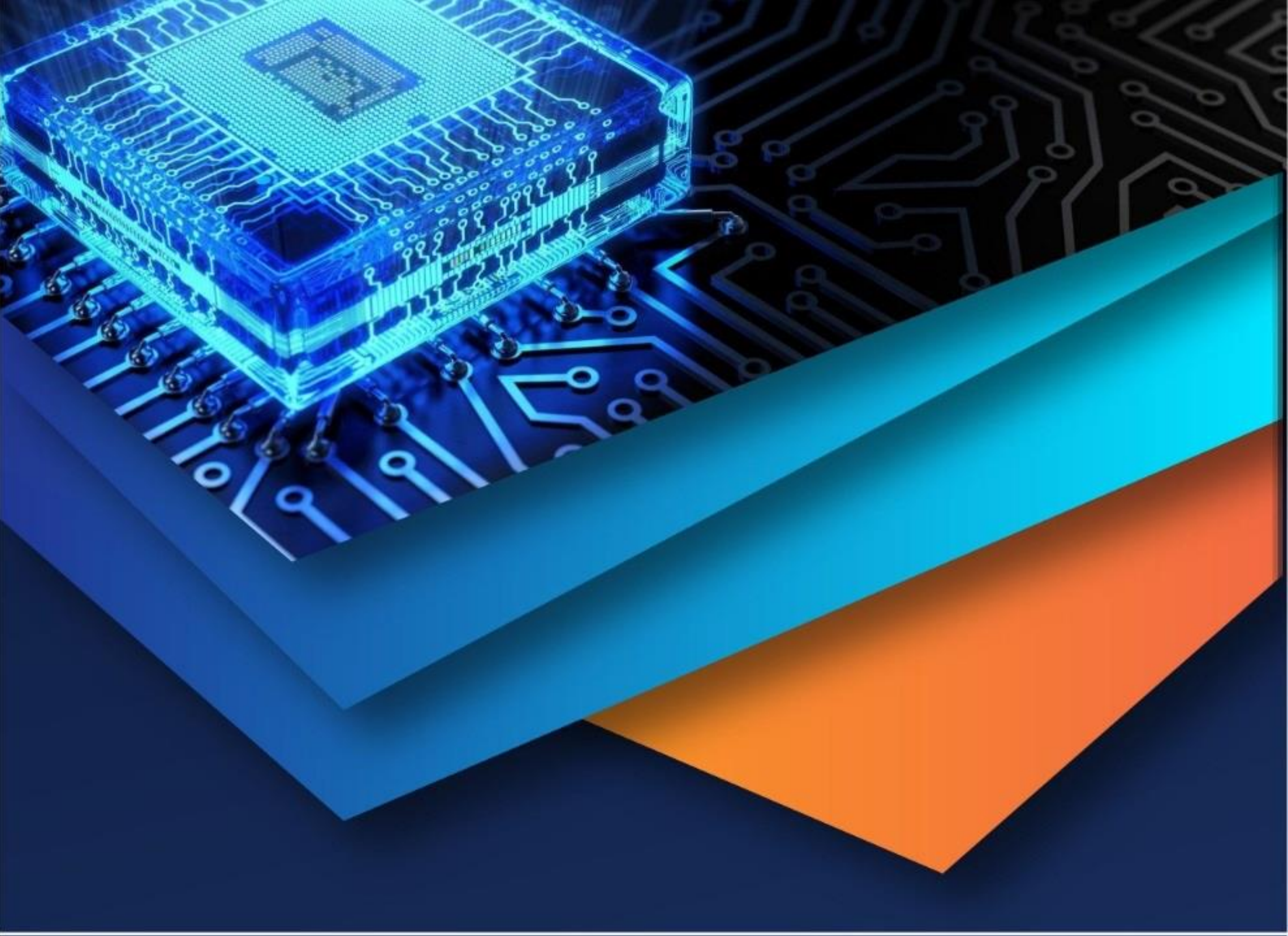

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