International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.101 ISSN: 2581-4621

DIAGNOSIS OF LACK OF SUPPLEMENTS IN PLANTS

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Abstract: - A novel image analysis method for identifying nutrient deficiencies in plants based on its leaf is proposed. First, the proposed method divides an input leaf image into small blocks. Second, each block of leaf pixels is fed to a set of convolution neural network (CNNs). Each CNN is specifically trained for a nutrient deficiency and a utilized to decide if a block is presenting any symptom of the corresponding nutrient deficiency. Next, the response from all CNNs is integrated to produce a single response for the block using a multi-layer perceptron to produce a final response for the whole leaf. Validation of the proposed method was performed on a set of black gram (Vigna mungo) plants grown under nutrient controlled environments.
Keywords: Machine learning, CNN, RNN, Multilayer perceptron.

Introduction

Plant health and food safety are closely linked. The food and agriculture organization of the United Nations (FAO) estimates that pests and diseases lead to the loss of 20% -40% of global food production, constituting a threat to food security. Using pesticides is a way of protecting crops from these infestations and thus preserving yields. Their use has been one of the factors behind the increase in food production since the 1950s, enabling it to meet the needs of a growing population. However, the use of such substances is not environmentally harmless. Applying these substances negatively impacts biodiversity, including insect, bird, and fish populations, as well as soil, air, and water quality.

In this article, five nutrient deficiencies as listed in plant nutrient deficiencies are also proposed. Deep neural networks, which have been increasingly adopted in many image recognition tasks, are exploited. Specifically, convolutional neural networks (CNNS) are utilized to decide if a block of leaf pixels is presenting any symptom of a nutrient deficiency. Black gram (Vigna mungo) is chosen as a target plant for experimentation. The key contributions and features of this work are as follows: investigating the effectiveness 0f CNN-based approach for nutrient deficiency detection, studying many types of nutrient deficiencies which is more challenging than previous works, constructing a large image dataset of nutrient deficient leaves with ground truth, and evaluating the performance of the image analysis approach and comparing with humans.

We expected the three deficient treatments to show differences in weight and standard chlorophyll content, a measure of chlorophyll density within a leaf. Our experiment hypotheses for each treatment were that the weight and standard chlorophyll content would be different from those of the control experiment. Our null hypotheses were that all weights and standard chlorophyll contents would be the same regardless of the treatment.

Related Work

1. Material and Methods:

The number of plant species are extremely huge, with about 391,000 vascular plant species all over the world. Currently, machine learning, a subfield of artificial intelligence (AI), is a popular and widely used technique, that has been applied in various domains including biology, medical, computer vision, speech recognition and others. Deep learning is a modern AI approach, which contributes a robust framework towards supervised learning. It is able to map an input vector rapidly and efficiently to an output vector even in a large dataset. Image enhancement is a process that is used to emphasise the features of an image. Texture is one of the important features of the plant identification system, which can be used to characterize the leaves based on the surface structure of

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the leaves. It is a non-consistent spatial distribution pattern of different image intensities, which concentrates mainly on each single pixel of an image. Cope et al. introduced an evolved vein classifier based on genetic algorithms (GA) and Ant Colony algorithms to extract the vein structure. Anami et al had proposed a combination of colour and texture features based plant identification system. Larese et al. constructed an automated leaf identification approach for legumes based on the vein architecture only Simple measurements were applied on the vein morphology and then identified by a Random Forests approach. Kadir et al proposed another method on the Foliage dataset and the Flavia dataset. Lee et al. proposed a CNN technique to identify 44 plant species acquired from the Royal Botanic Gardens of Kew, England. The extracted features were then classified with a Multilayer Perceptron (MLP) and a SVM. Two different datasets were used, namely, whole image (D1) and leaf patches (D2). Both datasets achieved an accuracy of more than 97%. Furthermore, researchers had combined both local and global features together in and achieved more than 91% accuracy. Furthermore, Sladojevic et al. employed CNN for plant diseases recognition. Another study based on leaf vein morphological patterns and using deep learning technique for plant identification was proposed in Grinblat et al.

2. Algorithm

Convolutional Neural Network Algorithm

A Convolutional Neural Network (CNN) is a type of Deep Learning architecture commonly used for image classification and recognition tasks. It consists multiple layers, including Convolutional layers, Pooling layers, and fully connected layers. The Convolutional layer applies filters to the input image to extract features, the Pooling layer down samples the image to reduce computation, and the fully connected layer makes the final prediction. The network learns the optimal filters through backpropagation and gradient descent.

It is assumed that the reader knows the concept of Neural networks. When it comes to Machine Learning, Artificial Neural Networks perform really well. Artificial Neural Networks are used in various classification tasks like image, audio, words. Different types of Neural Networks are used for different purposes, for example for predicting the sequence of words we use Recurrent Neural Networks more precisely an LSTM, similarly for image classification we use Convolution Neural networks. In this blog, we are going to build a basic building block for CNN.

Algorithm 1: Conventional Neural Network.
Input: d: dataset, 1: dataset true labels, W:
Word2 Vec matrix
Output: score of Parallel-CNN trained model on test dataset.
Procedure:
1: **algorithm** Parallel-CNN
2: **input**: d: dataset, 1: dataset true labels, W:
Word2 Vec matrix
3: **output**: score of Parallel-CNN trained model on test dataset
4: **let** f be the featureset 3d matrix
5: **for** i in dataset **do**
6: **let** fi be the featureset matrix of sample i
7: **for** i **in** i **do**
8: Vi ← vectorized $_{(j,w)}$
9: **append** v_j to f_i
10: **append** f_i to f
11: f_{train}, f_{test}, I_{train}, I_{test} ← split feature set and labels into train subset and test subset
12: M ← Parallel-CNN (f_{train}, I_{train})
13: score ← evaluate (i, I_{test}, M)

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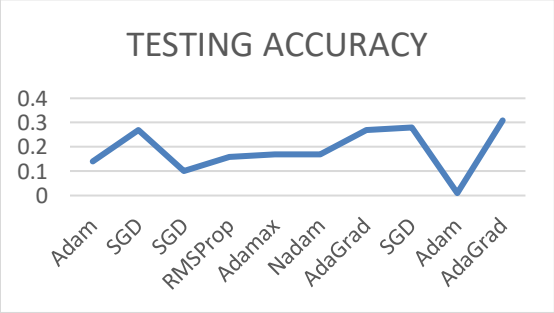
14: **return** score

4. Result:

It is observed that Convolutional Neural Network classifier achieved the best performance of more than 90% of accuracy. However, the other classifiers obtained accuracy of not less than 85%. Hence, in this research we can claim that CNN is highly suitable with contours for feature extraction model. In contrast, SVM and KNN is a classification approach, which classifies a sample according to the majority vote of its neighbours. The number of neighbours in this research is fixed as one with the city block distance metric. were less suitable with the contours. On the other hand, conventional feature extraction method extracts each type of feature separately and manually consuming a lot of time. For example, if the shape features are considered in this work, different sets of processes will be required for segmentation followed by shape feature extraction. Thus, machine learning approach is more practical and appropriate than conventional methods for developing an automated plant species classification system.

Table 1: Performance of the Classifiers without Feature Selection

Classifier	ACC	LOSS	RATE
Adam	0.140	3.790	0.01
SGD	0.270	3.320	0.01
SGD	0.100	0.030	0.01
RMSProp	0.160	3.600	0.01
Adamax	0.170	3.900	0.01
Nadam	0.170	7.030	0.01
AdaGrad	0.270	4.770	0.015
SGD	0.280	3.850	0.01
Adam	0.010	9.860	0.001
AdaGrad	0.309	3.790	0.00495



5. Conclusion:

In this project we have successfully classified the images of Identification of Plant Nutrient Deficiencies, are either affected with the Plant Nutrient or innutritious using the deep learning and machine learning. Here, we have considered the dataset of Plant Nutrient Deficiencies images which will be of different types and different plants (healthy or unhealthy) and trained using CNN, ANN along with some DenseNet121 transfer learning method. After the training we have tested by uploading the image and classified it.

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