

NUTRIENT DEFICITS DETECTION IN PLANTS USING CNN AND DEEP LEARNING

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ABSTRACT

The paper outlines various techniques for identifying nutrient deficiencies that can be used in a variety of settings and help to increase food safety. The recommended method or measure starts by dividing the image of the leaf that is given as input into large pieces. Next, each pixel block of the leaf is merged with a series of convolutional neural networks. These CNNs are mainly responsible for identifying the lack of nutrient deficiency from each block. Each and every individual CNN is trained especially for a particular kind of nutrient deficit. Then the outcomes of all the corresponding CNNs are then merged altogether using the winner takes all strategy to obtain a single reply for each block. At last, all the responses are converted into a single response to provide a final response for the entire leaf using a multi-layer perceptron. The suggested idea is tested on a set of black gramme plant leaves cultivated in various areas. A total of five nutrient deficient leaves including calcium, iron, potassium, magnesium and nitrogen and a complete nutrition class is proposed in this method.

Key Words: Nutrient Deficiency, Pre-processing, Training, Testing, Deep Learning, CNN, ANN, Dense Net

1. INTRODUCTION

The safety of food and plant nutrition are tightly correlated. According to FAO the security of the food is affected by various kinds of pests and diseases which results in the loss of the entire food production in the world about 40% approximately. The plants can be guarded by spraying various pesticides and can be harvested later. But the usage of these chemicals/drugs may negatively affect the food production quality. Using these materials is not recommended for long time as they may spoil the air, water and soil quality and also every living thing including plants, animals etc., In order to have a less impact even though using a pest control formula we have to study and understand the characteristics of various kinds of crops. This makes the farmers to take all the required steps at a particular place and time. But still, it is a complex task to say whether the field is robust or not and requires a high skill. A particular disease can be identified on the basis of various kinds of plant species. There can be various problems for various plants and these can also be similar to the same plant. Identifying whether the plant is healthy or not just by looking at a picture is not an easy job. It takes a lot of research and effort to study the plant's health. Plants are generally grown in rich and complicated habitats and they do change their way of growth according to seasons. They also change due to the sunlight rays being fallen on them during the day. The nutrient factors of a plant include the rate at which the plant grows, its production and also the fertility rate. All these factors can be affected if they aren't taken proper care and that will result in the lack of nutrient deficiency in them which in turn may spoil the whole vegetation. Lack of nutrients in certain plants may make them to appear different from others particularly on the leaf parts. The deficiency in nutrients can be identified through naked eyes after a week or two since the deficiency of nutrients in that particular plant begins to start. However, analyzing nutritional deficit visually requires specialized knowledge and is not reliable, particularly in the area of beginning stages of deficiency when a distinctive appearance has not been recognized clearly.

2. RELATED WORKS

In this paper Aditi, Ajar, Shah and Prerna proposed a system that is responsible for the identification of macronutrient content by using various techniques of machine learning. In the proposed system, datasets are collected for the plants that are nutrient deficit and the leaves that do not lack any nutrient are obtained using RGB mechanism used for the extraction of features, for detecting edges and texture etc., The dataset that has been created is used to train using the supervised machine learning that can easily spot the particular deficiency in nutrients and also the plants with full health so that proper care can be taken to boost the yield and production [1]. In this paper Barbedo, Jayme Garcia Arnal proposed a system for the identification of deficit of nutrients in vegetation and classifying them using the modern techniques of image processing and machine learning. This system is used for the identification of as many as nutrient deficient possible. In this each kind of image sensors is considered while capturing Images at a close range.

A brief study about the identification and then classifying the leaves using ML techniques was conducted which helped to find out the major problems to solve that might occur in future [2]. In this paper Ankit Kumar proposed a methodology for the detection of diseases and nutrient deficiencies based on image processing techniques. The proposed system works by using imaging technology where it has advanced to the point where even minor visual changes in plant coloring and forms that can be identified using a proper technology. The concept of spectral images does not only have a good relation with that of plant nutrients but also is very stable in the face of environmental changes. In comparison to traditional disease detection techniques, technological advancements in the field of processing images have given a new way for the identification of crop diseases and defects that are much faster, with more accuracy, and mostly used by the farmers and workers in the field of agriculture level. This technology will lead to the creation of an e-advisory for making of decisions in delivering the advices about the plant or crop disease from the expertise to the crop cultivators directly within a very short span of time. Image acquisition and image processing are the various steps of image processing-based detection [3]. In this paper Anthay, Swetha Reddy, proposed a method for the lack of micronutrients in the leaves of crops and in soil through image processing. The proposed system is based upon image processing and embedded systems that can be used for evaluating the healthiness of a leaf. The soil fertility rate can be studied in a period span using this process which results in maintaining the correct amount of pH and the moisture level quantity in soil. The main steps involved during the identification of nutrient deficiency are the preprocessing of images of the leaves, the values in the sensors and health conditions are displayed on the output monitor screen with the help of a processor. This method uses MATLAB to implement various tactics for producing accurate and time to time tracking of the status about the health of plant leaves and also soil with the help of a processor and a sensor. The system is converted into an IoT-controlled artificial intelligence-based bot. For controlling of the system, the android application is made contact with that of the IoT platform. Raspberry Pi is used to take a shot of the images that can be later used for processing images. Next the image that has been captured will be then sent for processing in the application of Android platform. With the help of calculated values, all the sensor values can be maintained and managed in the cloud for tracking the status of plant health effectively and efficiently [4]. In this paper Swami, Sanjay, and Pritisha Patgiri proposed a methodology to detect nutrient deficiency in plants through AI. Machine learning has grown in popularity in recent years to meet the growing demand for quick and accurate methods of monitoring nutrient status. In this system, the extracted image features are compared to the trained and already available dataset to determine whether the plant is healthy or nutrient deficient. The captured image was processed by CNN, which compares the input images to the dataset's already existing images. When matched, it displayed the nutrient deficiency in terms of percentage [5].

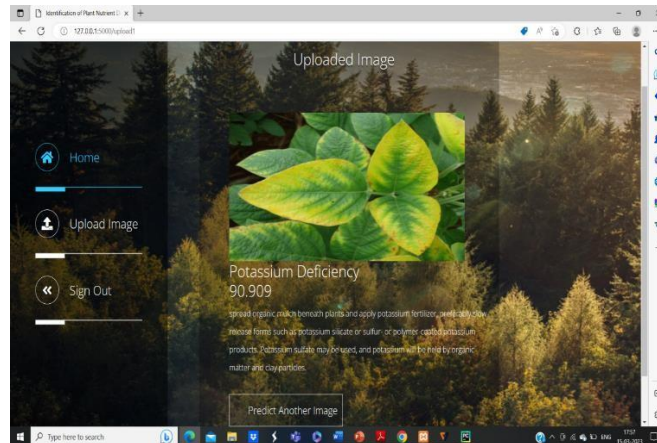
3. PROPOSED METHODOLOGY

Nutrient is an important factor that influences many aspects of a plant's life cycle, including growth rate, productivity, and fertilization. Deficiencies in any essential nutrient would have a significant impact on these processes and result in significant agricultural losses. Our proposed work is an effort to create a low-cost, dependable, and accurate solution for detecting plant health, in which nutrients play an important role. The primary emphasis is on detecting nutrients in plants and implementing various measures to achieve high yield. Our methodology uses the deep learning CNN algorithm to train the model that gives accurate results. During CNN training, the network has been provided with large amount of dataset images with appropriate labels of the class. In CNN network each image is processed with randomly assigned values and they are then made to compare with that of the labels of the class of the provided image as input.

The steps involved in building our model are as follows:

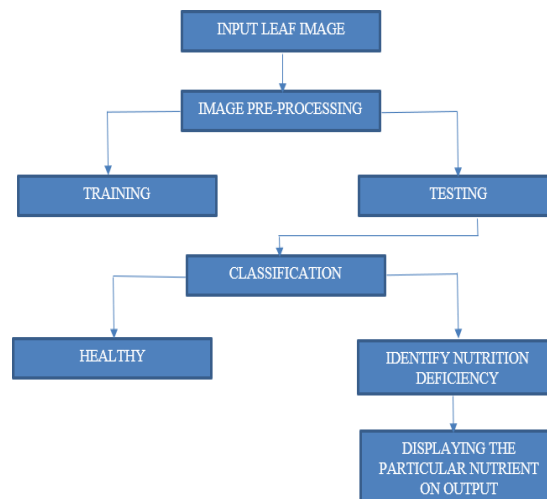
- This methodology starts by first performing all the necessary steps that include data collection and data pre-processing before the model is trained.
- Next by using the algorithms for classification such as the convolutional neural network algorithm the model is trained and the pattern and the type of leaf is identified by performing both training and then testing on the dataset.
- After training, the model is saved for testing which can be done by uploading the image from the dataset and later it can be classified and predicted.
- After classifying the leaf from the dataset, the nutrient that is lacked by the plant leaf can be known and that particular nutrient is displayed on the output screen along with the measures to be taken to avoid the plant from getting infected.
- If the plant does not lack any nutrients, then it displays that it is healthy.

4. EXPERIMENTAL RESULTS



5. BLOCK DIAGRAM

The block diagram explains the work flow of our proposed system.



6. ADVANTAGES

- High accuracy and good prediction on the results.
- With this methodology we can easily identify what kind of nutrient our plant needs and proper measures can be taken to control it from getting infected.
- A simple and cost-effective approach to diagnose nutrition deficiency in plants.
- Plant food safety can be ensured because we can know which plants' products to consume based on the infected percentage.
- Good production and quality of yield can be achieved.
- Less Complexity and Easy Identification.

7. CONCLUSION

New measures for detection and classification of the macronutrient deficiency have been introduced. Using deep learning and machine learning methods, we successfully classified images that are identified and detected as plant nutrient deficits. We have considered a dataset of Plant Nutrient Deficiency images of various types and also the crops that are identified either as healthy or not and are later trained using the algorithms such as CNN, ANN and DenseNet121 for performing classification. When the training process of the dataset gets completed, we then test model by uploading and classifying an image. Deep learning models and digital image processing techniques can be merged together to obtain a single framework for nutrient deficit detection and studying early infection status of a plant. This method can be used in farms that consists of vertically stacked layers at which the plants can be provided with essential intake of nutrients to help them understand the health of their crops and the preventive measures that need to be taken.

8. FUTURE SCOPE

Future work will include developing a unified interface for all plant groups and developing an interactive technological framework to assist farmers in producing high yields. It will be beneficial if the proposed effort is combined with disease detection, fertilizer recommendation, and plant leaf age identification.

It can also be improved by creating a framework that can be eco-friendly to farmers and help them to achieve good yields with high production and by providing a single module or interface that can be used for all kinds of plants and crops. The emergence of high-dimensional phenotyping data introduces both new challenges and opportunities for nutrition analysis and disease detection.

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