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DIAGNOSIS OF DISEASES IN POTATO LEAVES USING IOT

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Abstract: **Crop cultivation plays an essential role in the agricultural field. Presently, the loss of food is mainly due to infected crops, which reflexively reduces the production rate. This paper presents a brief outline of the automatic detection and classification of plant leaf diseases. The internet of things also plays a major role. In this, we are using techniques and algorithms to classify diseases & quick diagnosis can be carried out as per disease. The farmers get early alerts from the device about the diseases and can save their crops. This research applies to rural areas wherever the connectivity is limited.**

Index Terms **- Agriculture, IoT, Potato Leaf Diseases, Image Processing Technique, K-Means Clustering, Genetic Algorithm, Support-Vector Machine, K-Nearest Neighbour**

1. INTRODUCTION

Agriculture has become far more than simply a method to feed ever-growing populations. It's important to know that 70% of the population of an Asian country depends on agriculture. Which means it feeds a nice range of individuals. However, the relative significance of farming has dropped steadily since the beginning of industrialization. So, it's time that we put our hands together to solve the issues faced in the field of agriculture.

The cultivation of the crops for maximum profit and standard manufacture is usually scientific. The supervision for crops needs supreme power especially for the disease management that may have a result on factors of production significantly to make an economic profit. Control of plant diseases is crucial to the reliable production of food, and it provides significant problems in agricultural use of land, water, fuel, and other inputs. Plants in both natural and cultivated populations carry inherent disease resistance, but there are numerous examples of devastating plant disease impacts such as Irish potato famine and chestnut blight. However, disease control is reasonably successful for most crops. It is estimated that diseases typically reduce plant yields by 10% every year in more developed settings.

Traditionally, all the diseases and harms were identified with visual inspection by experienced people who may use certain features like color, texture and shape to analyze which in turn leads to expensive cost and less efficiency. By considering this issue as a challenge, we aimed to provide a solution technically with the method of the Internet of Things. Application of Internet of Things in agriculture includes agricultural monitoring and control, controlled environment agriculture, open – field agriculture, livestock applications, food supply chain tracking. The benefits of smart farming using the Internet of Things improves agriculture in different ways like tons of data collected by smart sensors, provides better control over the internal processes. The use of the Internet of Things in agriculture produces cost management, waste reduction, process automation, and enhanced product quality and volumes.

There exists a variety of symptoms, the internal and external expressions of disease, that result from any disease from the symptom complex, which, together with the accompanying signs make up the syndrome of the disease. Generalized symptoms may be classified as local or systemic, primary or secondary, and microscopic or macroscopic.

The foremost problem is producing a crop of less quality because of disease. So hence, detecting these diseases and insect pests may be a key to stop agricultural losses. This project aims to develop a system that mechanically detects and classifies the disease. Therefore, detecting and classifying diseases and insect pests in agricultural applications is imperative.

1.2 LITERATURE SURVEY

Traditionally, farmers identify the diseases by the naked eye observation method. This makes consulting experts too expensive and time-consuming and farmers are unaware of non-native diseases. Describing the characteristic symptoms exhibited by a specimen can be very difficult to do accurately. Because of this, it is often difficult, if not impossible, to determine what is wrong with a plant when a person is describing symptoms over the phone. As a test of this, you may want to take a plant exhibiting symptoms and have three different individuals describe the symptoms that they observe on a sheet of paper. In doing so, a large team of experts as well as continuous monitoring of plants is required, which costs very high when we do with large farms. At the same time, in some countries, farmers do not have proper facilities or even the idea that they can contact experts. Due to which consulting experts even cost high as well as time-consuming too. In such conditions, the suggested technique proves to be beneficial in monitoring large fields of crops. Automatic detection of the diseases by just seeing the symptoms on the plant leaves makes it easier. Plant disease identification by the visual way is a more laborious task and at the same time, less accurate and can be done only in limited areas. Whereas, if the automatic detection technique is used, it will take fewer efforts, less time and become more accurate. This automated system is designed to overcome the problems of manual techniques.

1.3 LEAF DISEASES AND ITS SYMPTOMS:

While potatoes can be grown in most places, there are many diseases, pests and other issues that can arise. Not all conditions can be reversed and some plants may need to be destroyed, but catching the problem early can make all the difference. Paying close attention to the health and vigor of potato plants and inspecting them closely at the first signs of sickness are the main criteria of this paper. Most of the symptoms can be observed on the leaves of the potato plant itself. So, the main objective is this system is to implement technologies for image processing to increase the growth of the plant. Potatoes can become infected both before or after harvest, with the disease appearing as brown, dry and sunken areas.

Here is a list of common problems while growing potatoes:

Early Blight, Late Blight, Mosaic Virus, Powdery Mildew, Rust, etc.

Figure-1: Diseased leaves

1. **Powdery mildew:** Powdery mildew is caused by the fungus. The disease rarely occurs in the High Plains and is only reported to cause economic damage to potato in Washington State under furrow irrigation. The lower leaves are the most affected, but the mildew can appear on any above-ground part of the plant. Powdery mildew is unsightly. Severe infestations damage plants. It can't infect humans and won't hurt you if you touch it. While it is not directly harmful to humans, it harms potential food sources.

2. **Early blight:** Early blight of potato is caused by the fungus, Alternaria solani, which can cause disease in potato. This disease, also known as the target spot, rarely affects young, vigorously growing plants. It is found on older leaves first. Since the disease appears early in the season it is known as early blight. This disease is more common than late blight and causes about 20-30 % damage to crop every year. It can occur anywhere at any crop period.

3. **Late blight:** The first symptoms of late blight in the field are small, light to dark green, circular to irregular-shaped water-soaked spots. These lesions usually appear first on the lower leaves. Lesions often begin to develop near the leaf tips or edges, where dew is retained the longest. The disease spreads most readily during periods of warm and humid weather with rain. Late blight can also infect potato tubers causing a rapid tuber rot.

4. **Mosaic viruses:** Mosaic viruses are plant viruses that cause the leaves to have a speckled appearance. Mosaic virus overwinters on perennial weeds and is spread by insects that feed on them. Aphids, leafhoppers, whiteflies, and cucumber beetles are common garden pests that can transmit this disease. Cuttings or divisions from infected plants will also carry the virus. Leaves may be crinkled or wavy. Dry, corky areas or necrotic streaks may be present. Spread can be mechanically through brushing and rubbing against by equipment and people. Also spread by plant to plant contact by leaves, roots and seed pieces. Cutting knives can also pick up the viruses and introduce them to uninfected tubers pieces.

2. PROPOSED METHODOLOGY

We planned to design our project to detect the plant diseases of potato and provide the solutions to recover from the leaf diseases which will affect the nutritional quality of potato. The block diagram shown in figure-2 indicates image-processing techniques which are to be applied to the acquired images. This process includes several steps namely, Image Acquisition, Image Pre-processing, Image Segmentation, Feature Extraction, and Classification. The Internet of Things system in our project includes sensors and cameras to capture the image of the plant leaf for training and testing the images.

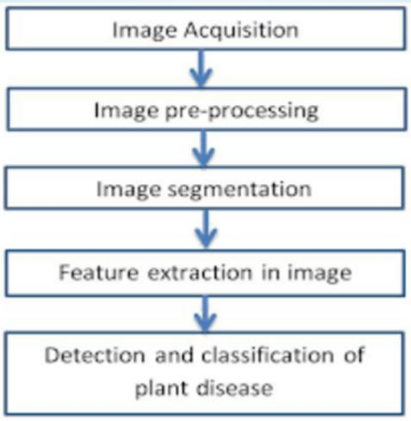

Figure-2 : Image processing technique

2.1 Image Acquisition

The first step in the image processing technique is to capture the image by the IoT device. These images are stored in the database and are sent for further process. Samples of 80 images are collected priory that includes different plant diseases like Powdery mildew, Early Blight, Late blight, Mosaic virus, and Healthy Leaves as well.

2.2 Image Pre-processing

This step is for color transformation structure to enhance the quality of the image. The main aim is to remove the background noise and suppress unwanted distortions. Firstly, we resize the images, captured in the previous step into the required measure since some images captured by the device vary in size. Hence, we establish a base size for all images fed for further processing. These resized RGB images are then converted to HSI format that corresponds to the way humans describe and interprets color, where hue is determined by the dominant wavelength and the intensity, is determined by the actual amount of light, with more light corresponding to more intense colors and the saturation is determined by the excitation purity and depends on the amount of white light mixed with the hue. A pure hue is fully saturated, i.e. no white light mixed in. And then, the histogram equalization which distributes the intensities of the images is applied to the image, to enhance the plant disease image.

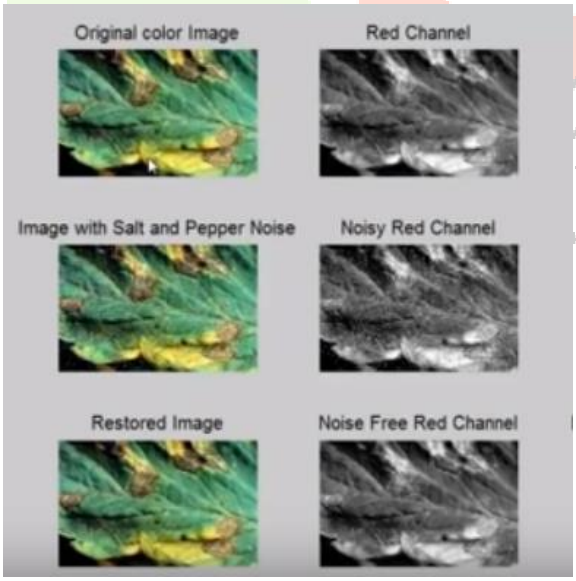

Figure-3 : Image Preprocessing

2.3 Image Segmentation:

This step is for identifying the regions of the image that are most likely to be classified as diseased regions. Here, segmentation is implied for partitioning the image into multiple parts or regions based on the characteristics of the image. There are various techniques for image segmentation such as clustering methods, edge-based methods, histogram-based methods, region-based methods, etc. In this proposed system, the normalized images from the previous step are segmented into different parts using the K-Means clustering method. The K-Means clustering algorithm tries to classify objects based on a set of features into K number of classes. The classification is done by minimizing the sum of squares of distances between the objects and the corresponding cluster or class centroid. And then, a Genetic algorithm is used on segmented images for edge detection. Edge detection includes the detection of boundaries between different regions of the image. Due to these, boundaries discontinuities occur between the pixels of the chosen feature.

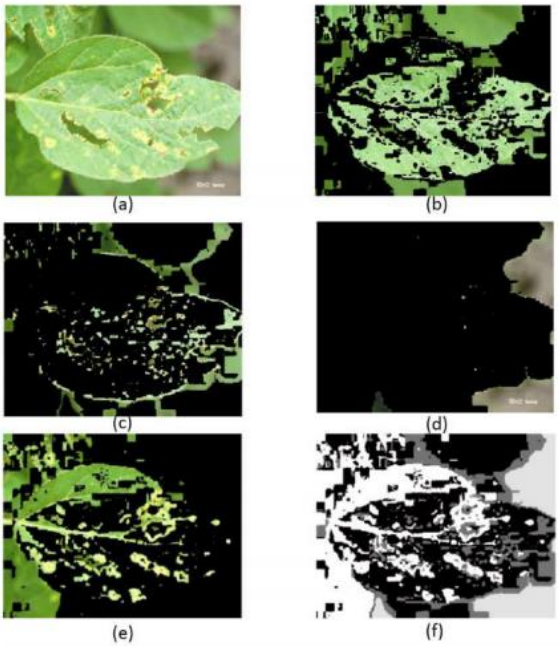

Figure - 4 : Clustered images

2.4 Feature Extraction

This step plays a fundamental role in the image processing technique. The method must be used for describing the objects so that features of interest are highlighted. The description is concerned with extracting features from an image. The features usually include color, shape and texture features of the leaf for diagnosis. The features are necessary for differentiating one class of objects from another. The color feature contains information about boundary, spot and broken area. the shape attribute includes the percentage of the lesion and its type. The texture feature contains uniformity, contrast, probability, variance, and correlation. The texture is one of the most important features which can be used to classify and recognize objects.

2.5 Classification

Data obtained from the feature extraction and image segmentation will be classified into different groups in this step. This step will be performed using SVM [support-vector machine] and KNN [k-nearest neighbour] algorithms.

SVM are supervised learning models with associated learning algorithms that analyze data used for classification. For supervised learning, the algorithm outputs an optimal hyperplane which categorizes data into different classes. The hyperplane is the line that splits the input variable space. In SVM, a hyperplane is selected to best separate the points in the input variable space by their class, either class 0 or class 1.
The distance between the line and closest data points is referred to as the margin. The margin is calculated as the perpendicular distance from the line to only the closest points. These points are called the Support vectors.

K-nearest neighbours is a supervised learning model. Here, non-parametric method used for classification. It classifies new classes based on similarity measures. If K=1, then the case is simply assigned to the class of its nearest neighbour. The distance between two points(data) can be calculated using Euclidean distance.i.e,

Euclidean distance= sqrt ((xi-yi) ^ 2) where i=0, 1, 2, …., k

3. RESULTS

The detection and classification of the healthy potato plant leaves and various potato plant diseases are achieved for various selected diseases among the five categories such as Powdery mildew, Early Blight, Late blight, Mosaic virus and Septoria leaf spot diseases which are commonly affecting the potato plant in the growth period. The trained model will be tested in each class individually. The test will be performed on every image from the validation set. The results are displayed to emphasize how many images from the total of each class are accurately predicted. After the disease is classified, information related to it such as causes, symptoms are to be displayed to the farmers.

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5. CONCLUSION

In this paper, we studied the IoT-based system which can automatically recognize, identify, detect and classify potato plant leaves diseases. The results show that a difference between healthy potato leaf areas and infected potato plants leaf area. Sensor devices play an important role in collecting data as an image of potato plants and plant leaves for the monitoring system. It helps farmers to improve the quality of farming and increase the production of crops. The approach is based on image processing and highly based on K-Mean clustering, SVM technique, K-Nearest neighbour technique, and Genetic algorithm. The proposed approach is a valuable approach and can help to recognize the disease affecting the growth of potato plants. Farmers get the information about the type of disease which is infected to their crops and get an idea about required fertilizers.

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