Implementation of Plant Leaf Disease Detection using K-means clustering and Neural Networks

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ABSTRACT

Plants exist all over the place; we live, as well as places without us. Plant disease is one of the essential causes that reduces quantity and degrades quality of the agricultural merchandises. Plant diseases have turned into a terrible as it can cause significant reduction in both quality and quantity of agricultural products. Images form important data and information in biological sciences. Until recently photography was the only method to reproduce and report such data. It is difficult to quantify or treat the photographic data mathematically. This project, classifies the plant leaves and stems at hand into infected and non-infected classes. The developing software provides a fast and accurate method in which the leaf diseases are detected and classified using k-means based segmentation and neural networks-based classification. Most common diseases seen in the leaves of Tapioca and Mango are discussed here for this approach. In this paper, respectively, the applications of K-means clustering and Neural Networks (NNs) have been formulated for clustering and classification of diseases that effect on plant leaves. Recognizing the disease is mainly the purpose of the proposed approach. Thus, the proposed Algorithm was tested on five diseases which influence on the plants; they are: Early scorch, Cottony mold, ashen mold, late scorch, tiny whiteness. The experimental results indicate that the proposed approach is a valuable approach, which can significantly support an accurate detection of leaf diseases in a little computational effort. This project gives 95% of efficiency using MATLAB simulation results.

Keyword *Leaf, K-means clustering and Neural Networks, RGB, HIS, etc.,*

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1. INTRODUCTION

Digital image processing and image analysis technology based on the advances in microelectronics and computers circumvent these problems associated with traditional photography. Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems.
Using this new tool helps to improve the images from microscopic to telescopic range and also offers a scope for their analysis. It, therefore, has many applications in biology. However, as is the case with any new technology, imaging technology also has to be optimised for each application, since what each user is looking for in an image is quite unique. Images of the leaves, captured by a camera or a scanner for Colour image analysis for estimation of normal leaf, infected leaf and chlorophyll. Many times a viral or a fungal attack on plants results in degradation of chlorophyll pigments in leaves. Such infected leaves have patches of green and yellow colour. In plant breeding, it is important to quantify the leaf infection. Thus the extent of infection can be quantified without much efforts. Plant leaf colour is also commonly used as an indication of health status of plants. The loss of chlorophyll content of leaves occurs due to nutrient imbalance, excessive use of pesticides, environmental changes and ageing. In this project, we develop a software for the automatic identification & classification of plant leaf diseases and provide advice for specific diseases. Here the end-user is the farmer.

2. LITERATURE SURVEY

Following is the work done carried out in various article by the authors

Diseases occur in plants under the influence of various factors—pathogens and unfavorable environmental conditions—and are manifested in the disturbance of functions (photosynthesis, respiration, synthesis of tissue and growth substances, and the flow of water and nutritive substances), and the structure of the organism, causing premature destruction of the plant or affecting some of its organs. There is not yet a precise and comprehensive definition of plant diseases. In the early stages of the development of phytopathology, any deviation from the normal condition of a plant was considered plant disease. The inadequacy of this definition lay in the difficulty of distinguishing a normal (healthy plant) from an abnormal (diseased plant) condition.

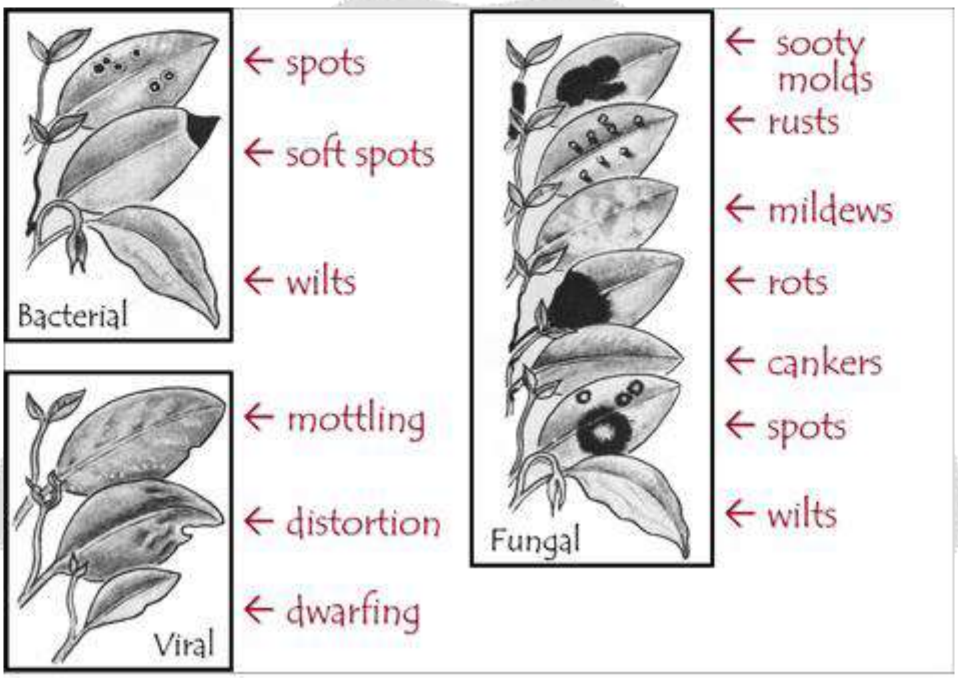

Figure 1: Types of diseases

The determination of the presence of a pathological process in a plant organism made it possible to redefine plant disease in a new way and to conceive it not as a static condition but as a dynamic process that arises and develops as a result of interaction of the plant with its environment. Noninfectious plant diseases are caused mainly by abiotic factors in the environment: disruptions in the regime of mineral feeding, most often by a deficiency (rarely, a unilateral excess) of macroelements (nitrogen, phosphorus, potassium, and magnesium) or a deficiency of microelements, especially boron, zinc, iron, copper, and molybdenum; an unfavorable water regime (deficiency or excess of water in the soil, prolonged rains, or high relative humidity of the air), causing "bleeding" of plants, premature drying up, premature withering of plants, or leaves falling under conditions of water deficiency; or the effects of high or low temperatures on plants, abrupt changes in air and soil temperatures (freezing of shoots, frost cracks, chilling of heat-loving plants in greenhouses and hotbeds or during irrigation of the soil with cold water, and so forth). Causes of noninfectious plant diseases may be harmful impurities in the air and soil (blight and falling of leaves from the effects of sulfur dioxide gas, for example, in the vicinity of metallurgical and chemical plants); residual effects of certain herbicides carried into the soil; an unfavorable light regime, mainly a deficiency of light in greenhouses and hothouses (chlorosis and lodgment or dwarfing with a shortened day); ionizing radiation (alpha, beta, and gamma rays, X rays, and neutrons); or toxins excreted into the soil by certain fungi (species of Fusarium, Botrytis, and so forth) and some higher plants

3. DESIGN METHODOLOGY

The underlying approach for all of the existing techniques of image classification is almost the same. First, digital images are acquired from environment around the sensor using a digital image. Then image-processing techniques are applied to extract useful features that are necessary for further analysis of these images. After that, several analytical discriminating techniques are used to classify the images according to the specific problem at hand. This constitutes the overall concept that is the framework for any vision related algorithm. Figure 3.1 depicts the basic procedure of the proposed vision-based detection algorithm in this research.

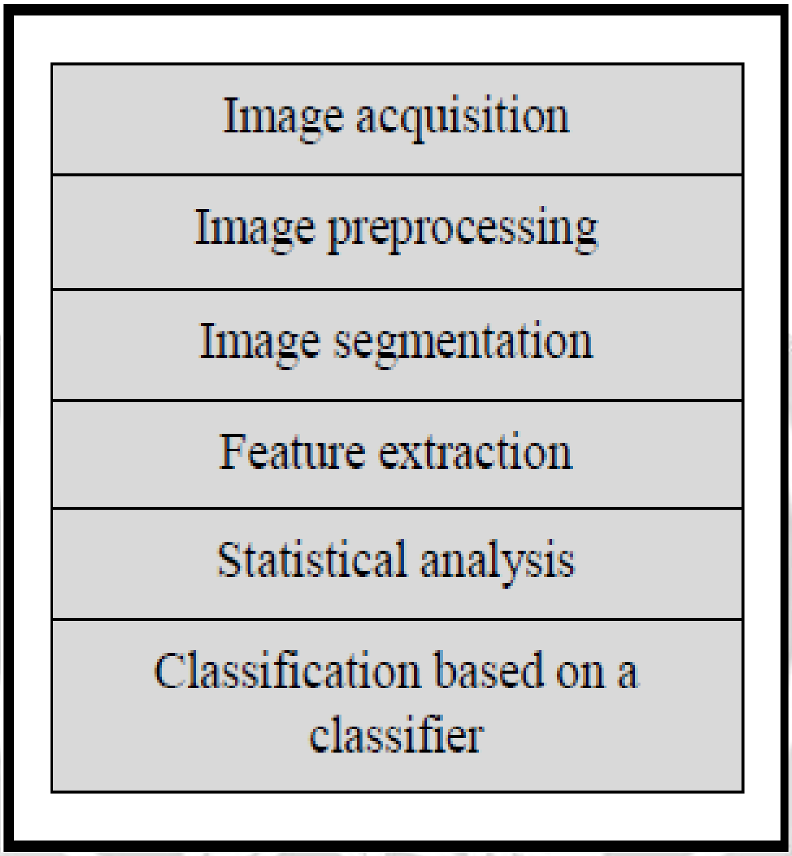

Figure 3.1: The basic procedure of the proposed image processing-based disease detection solution

The first phase is the image acquisition phase. In this step, the images of the various leaves that are to be classifies are taken using a digital camera. In the second phase image preprocessing is completed. In the third phase, segmentation using K-means clustering is performed to discover the actual segments of the leaf in the image. Later on, feature extraction for the infected part of the leaf is completing based on the specific properties among pixels in the image or their texture. After this step, certain statistical analysis tasks are completed to choose the best features that represents the given image, thus minimizing feature redundancy. Finally, classification is completed using neural network based algorithm.

The detail step-by-step account of the image acquisition and classification process is shown in figure 3.2. In the initial step, the RGB images of all the leaf samples were obtained. Some samples of diseased leaf images are taken.

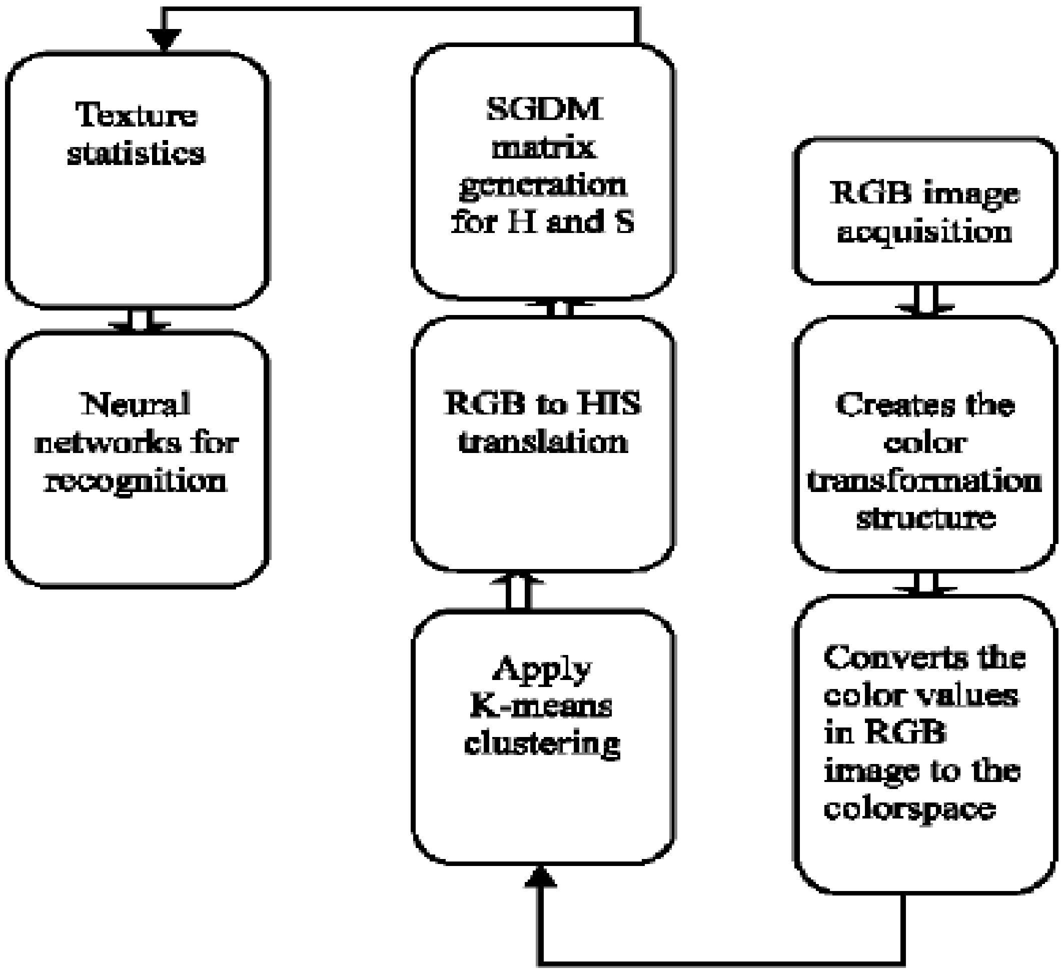

Figure 3.2: Image acquisition and classification

Once the infected objects is determined. The image is then converted from RGB format to HSI format. The SGDM matrices are then generated for each pixel map of the image for only H and S images. The SGDM is a measure of the probability that a given pixel at one particular gray-level will occur at a distinct distance and orientation angle from another pixel, given that pixel has a second particular gray-level. From the SGDM matrices, the texture statistics for each image were generated. A software routine is written in MATLAB that would take in .mat files representing the training and test data, train the classifier using the train files and then use the test file to perform classification task on the test data. Consequently, a MATLAB routine will load all the data files (training and test data files) and make modifications to the data according to the proposed model chosen.

We propose an image processing - based software for the automatic leaf diseases identification and classification. We test our software on five diseases which effect on the plants. They are cassava bacterial blight, cassava leaf spot, phoma blight, bacterial canker, red rust and sooty mould. Identification and recognition of leaves diseases are likely to give better performance and provide solutions to treat the diseases in its early stages. Visual interpretation of plant diseases manually is both inefficient and difficult, also it requires a trained botanist. A closer inspection of the plant diseases images reveals several difficulties for the possible leaves diseases identification. The developed system classifies the leaves into infected and non-infected classes.
The proposed system can:

- Identify disease type
- Deal with other diseases
- Identify and classify diseases that infect plant leaves
- Provide advice to treat the diseases in its early stages

First, the images of various leaves are acquired using a digital camera. Then image-processing techniques are applied to the acquired images to extract useful features that are necessary for further analysis. The steps involved in recognition and classification are image acquisition, pre-processing, feature extraction, segmentation and classification.

4. RESULTS AND DISCUSSION

Following are the screenshots of the plant leaf disease detection techniques

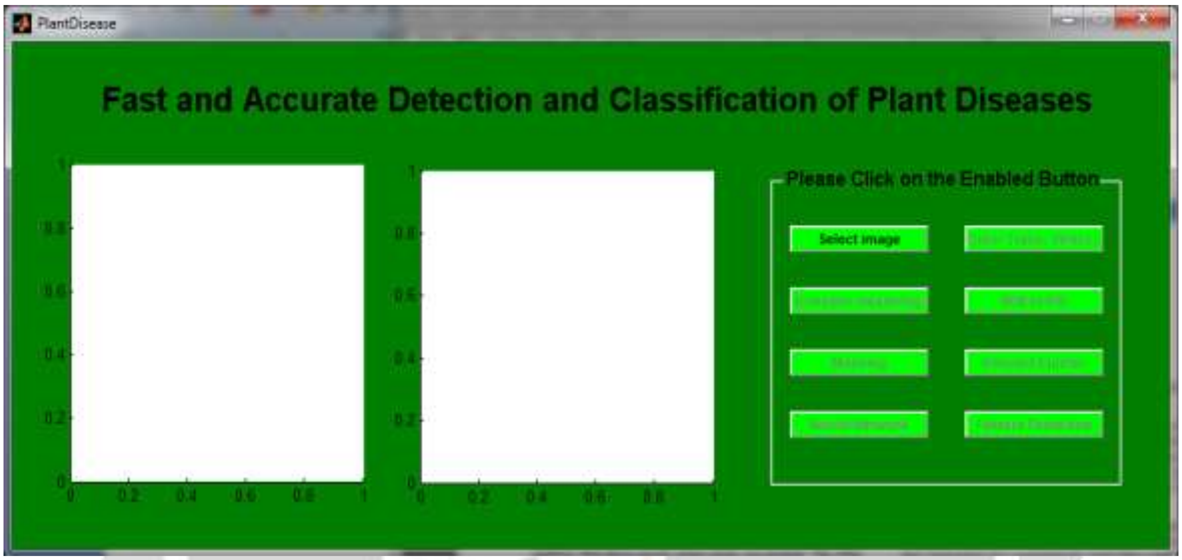

Fig 4.1: GUI File

Fig 4.2: Data Sets

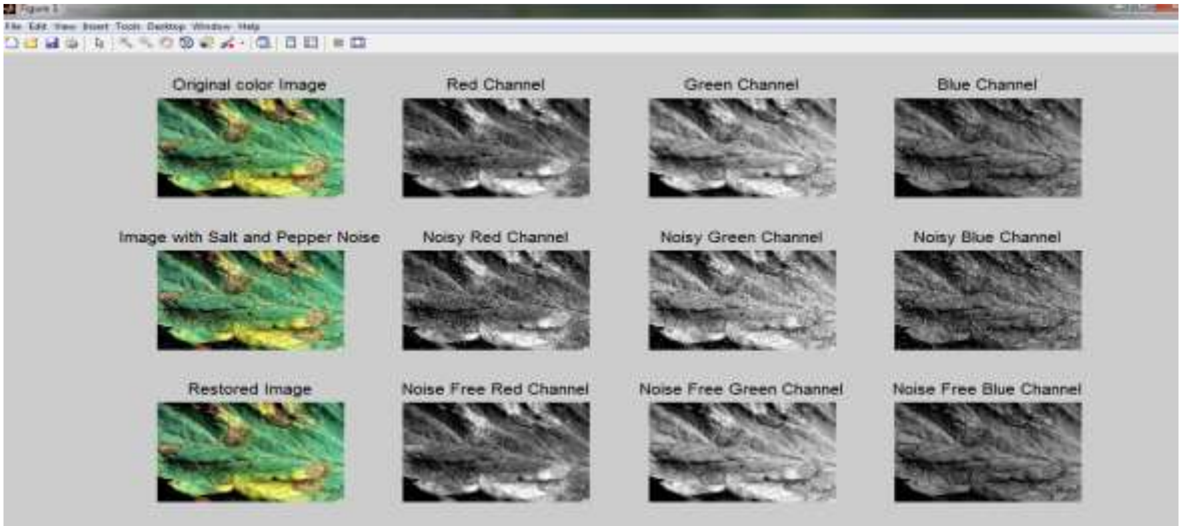

Fig 4.3: Filter results with Red, Green and Blue Channel color transformation structure from RGB

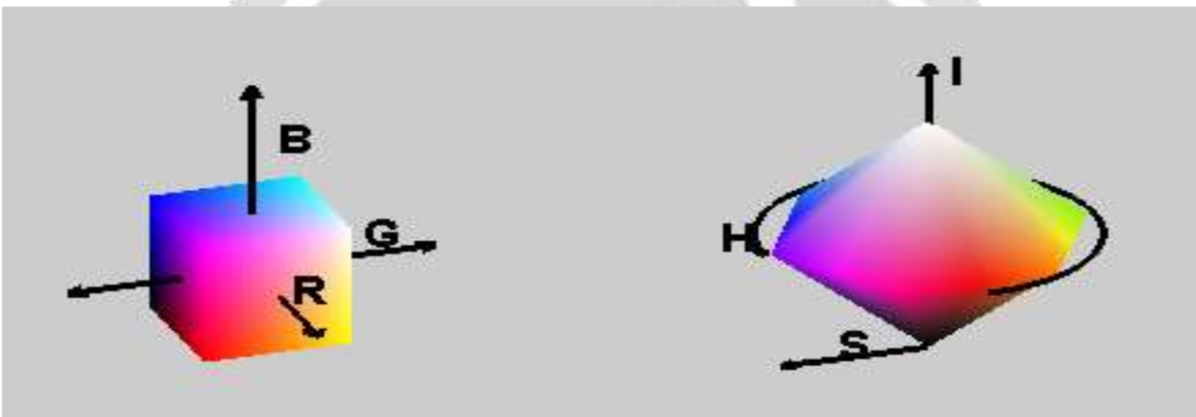

Fig 4.4: RGB and HIS representation

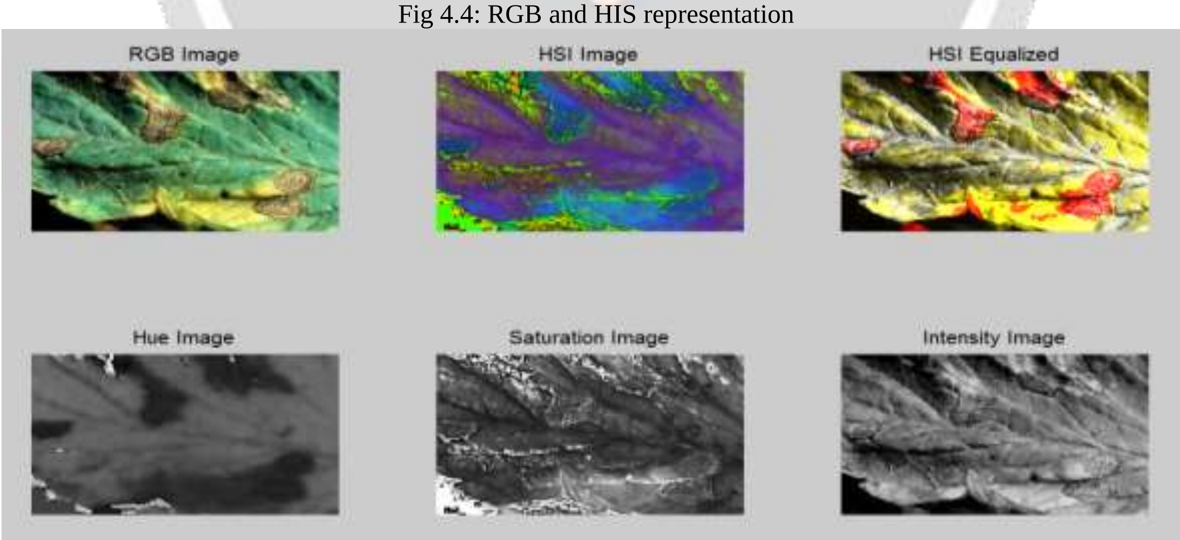

Fig 4.4: HIS Image and HIS Equalized representation

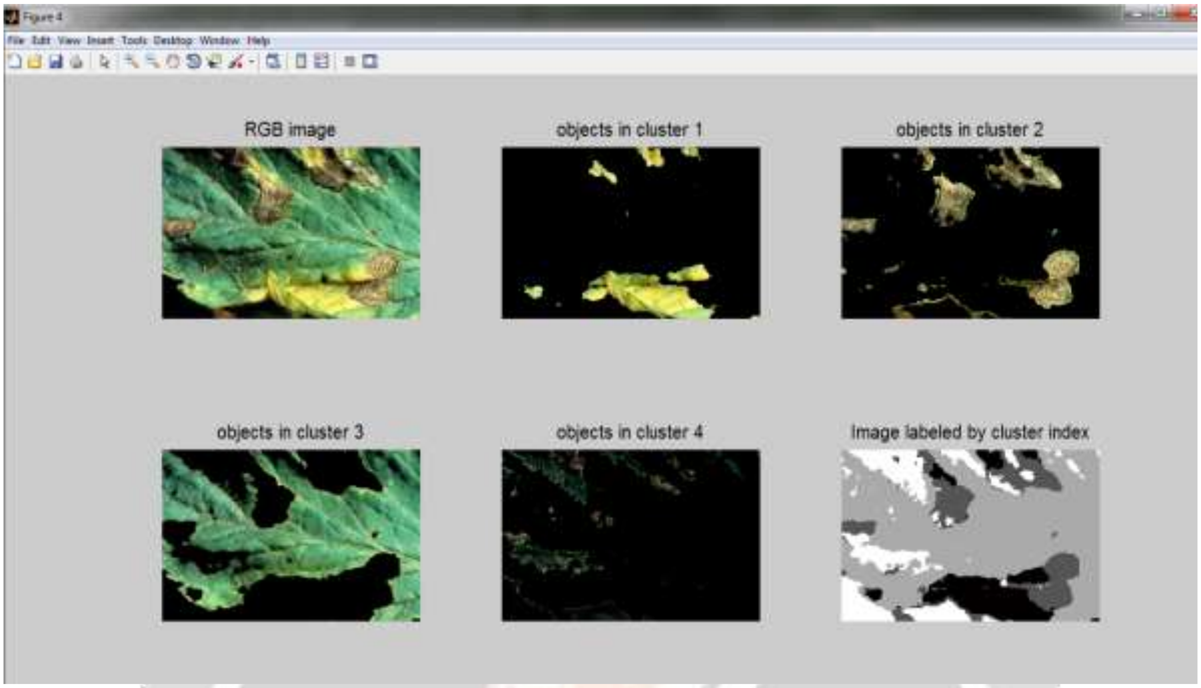

Fig 4.5: Cluster representation of RGB Image

Fig 4.6: Hue, Saturation and Intensity results of Infected Image

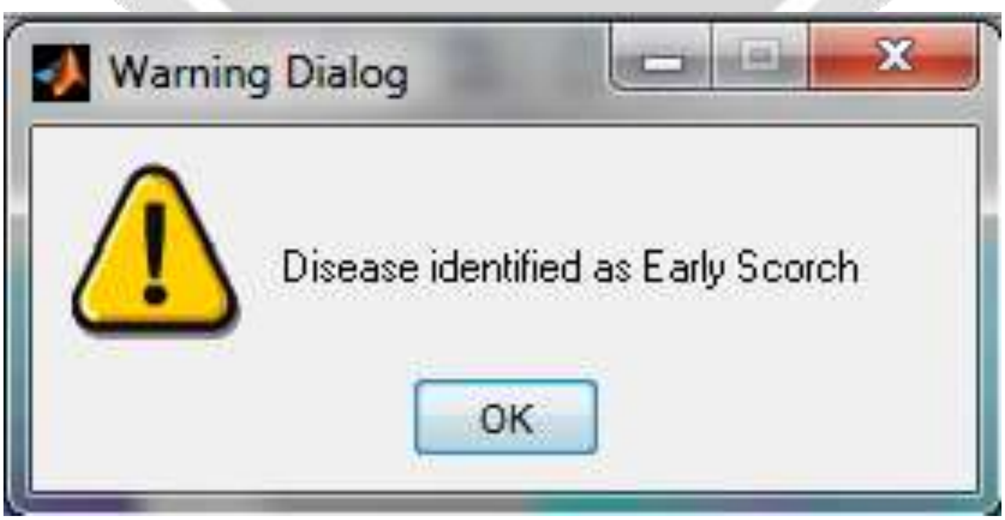

Fig 4.6: Leaf Disease Result in Dialog Box

5. CONCLUSION

In this paper, respectively, the applications of K-means clustering and Neural Networks (NNs) have been formulated for clustering and classification of diseases that effect on plant leaves. Recognizing the disease is mainly the purpose of the proposed approach. Thus, the proposed Algorithm was tested on five diseases which influence on the plants; they are: Early scorch, Cottony mold, ashen mold, late scorch, tiny whiteness. The experimental results indicate that the proposed approach is a valuable approach, which can significantly support an accurate detection of leaf diseases in a little computational effort. An extension of this work will focus on developing hybrid algorithms such as genetic algorithms and NNs in order to increase the recognition rate of the final classification process underscoring the advantages of hybrid algorithms; also, we will dedicate our future works on automatically estimating the severity of the detected disease.

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