Classification of Thrips-infected Chili Plant Using Image Processing on Embedded System

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in partial fulfillment of the requirements for the degree of
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2021

DECLARATION

I declare that this thesis entitled “Classification of Thrips-infected Chili Plant Using Image Processing on Embedded System is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature : 

Name : MAJDADEEN HAZAA SAAD AL-MASWARI

Date : 05/07/2021

APPROVAL

I hereby declare that I have checked this report entitled “Classification of Thrips-infected Chili Plant Using Image Processing on Embedded System” and in my opinion, this thesis complies the partial fulfillment for awarding the award of the degree of Bachelor of Mechatronics Engineering with Honors

Signature : 

Supervisor Name : DR. NURDIANA BINTI NORDIN@MUSA

Date : 5/7/2021

DEDICATIONS

To my beloved mother and father

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ABSTRACT

In chili plantations, infestation by insects bacterial, and fungal diseases are the major constraints in chili production. The infestation by thrips for example can cause curling on the leaves which can be monitored remotely using cameras. Thus, this project will embark on classifying the leaves infested by thrips from healthy leaves. Previous works have shown the possibility of using texture features, shape features and various combinations of K-means clustering algorithms to highlight the pathological differences. Images were captured using the camera and processed onboard the Raspberry Pi. The images were processed with the help of Open-CV libraries and in the Python environment. Texture features and shape features were computed from the processed images before it is fed to Linear Support Vector Machine algorithm (SVM) for supervised learning. The output model was used to test images for accurate classification. The results were analyzed in the form of a confusion matrix. So, the Linear SVM classifier shows an accuracy of 80%, specificity of 75%, precision of 78% and Sensitivity of 84%.

ABSTRAK

Di ladang cili, serangan oleh bakteria dan penyakit kulat serangga adalah kekangan utama dalam pengeluaran cili. Kutu oleh thrips misalnya boleh menyebabkan keriting pada daun yang dapat dipantau dari jarak jauh menggunakan kamera. Oleh itu, projek ini akan memulakan untuk mengklasifikasikan daun yang diserang oleh thrips dari daun yang sihat. hasil kajian selodum ini telah menunjukkan kemungkinan menggunakan ciri-ciri tekstur ciri bentuk dan bersama dengan pelbagai kombinasi algoritma pengelompokan “K-means” untuk mengbezakan perbezaan patologi. Imej akan diambil menggunakan Kamera dan diproses di dalam medium Raspberry-Pi. Imej akan diproses dengan bantuan koleksi algoritima Open-CV dan dalam persekitaran Python. Ciri tekstur dan ciri bentuk akan dihitung dari gambar yang diproses sebelum diumpankan ke dalam algoritma mesin vektor (SVM) untuk pembelajaran terselia. Model keluaran akan digunakan untuk menguji gambar untuk klasifikasi yang tepat. Hasilnya akan dianalisis dalam bentuk matriks kebingungan. Jadi, pengkelasan Linear SVM menunjukkan ketepatan 80%, Kekhususan 75%, ketepatan 78% dan Sensitiviti 84%.

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LIST OF SYMBOLS AND ABBREVIATIONS

SVM	-	Support Vector Machine
RGB	-	Red, Green, Blue
CNN	-	Convolutional Neural Networks
BPNN	-	Back Propagation Neural Networks
ANN	-	Artificial Neural Network
	-	
	-	
	-	

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CHAPTER 1

INTRODUCTION

1.1 Motivation

As the world's population has grown, so needs for food, which has led to increasingly intensive farming techniques by farmers. Due to the scarcity of agricultural land, farmers are now forced to produce more food per acre. With the occurrence of plant diseases, both the quality and quantity output of food production is jeopardized [1].

Chili plants make a great contribution to the Malaysian economy. Malaysia is considered the world's fifth-largest chili producer, with 14040 tones costing RM 190 million in 2010 with an increment of 7% in comparison with 2009 (RM 156 million) [2]. The consumption of chili in Malaysia is 1.82kg – 0.45kg per capita per year for both fresh and dried chili. Chili plants are one of the most frequent plants that farmers grow in response to culinary needs.

Malaysia is one of the well-known countries that are popular with agriculture. Due to heavy rains and high degrees of humidity, plants are encountering different types of diseases that affect the leaves. Globally, the percentage of the losses in crops is approximately from 20% - 40% from the total crops [3], these affected crops are due to several reasons like thrips, pests, animals, and weeds. For instance, thrips are minute, slender insects with fringed wings and unique asymmetrical mouthparts. Different thrips species feed mostly on plants by puncturing and sucking up the contents. Moreover, Thrips are a major chili plant pest that causes leaves to curl shape and reduces their size.

All the mentioned above have motivated me to make this report which can make a contribution in the field of research that is concerned with the chili plant health problem.

1.2 Problem Statement

In this project, distinguishing between the healthy leaves and the infected ones is challenging especially if it is far away. Sometimes the leaves are overlapped, this problem makes the curled leaves hide behind the healthy ones and make them difficult to be distinguished. Moreover, the color of the healthy leaves and the infected ones are the same, while the difference is with the shape and texture. If this similarity between the healthy leaves and infected ones makes it difficult for the human eye, it is a challenging task from the point of view of machine vision. Figure 1.1 illustrates the similarity between the healthy leaves and the infected ones. Hence, the problem statements of this report are:

- Infected leaves are difficult to be recognized due to the color of the infected ones are similar to healthy ones.
- Sometimes the leaves are overlapping which means curled leaves overlapped with healthy leaves which causes difficulty in segmenting the infected leaf.
- The curled leaves are not obvious from far away.

Figure 1.1 Thrips-Infected Chili leaves (left) and healthy ones (right)

1.3 Objectives

The objectives of this study focused on several objects that are regarding classify thrips-infected chili leaves using image processing, these objectives are summarized as follows:

1. To determine the features that differentiate between thrips-infected leaves and healthy leaves.
2. To classify the thrips-infected leaves from the healthy leaves.
3. To evaluate the classification performance with four parameters, specificity, accuracy, sensitivity, and precision.

1.4 Scope of the project

The scope of this research focused on several points that are related to classifying thrips-infected chili leaves using image processing, these points are summarized as follows:

1. The images were processed with the help of Open-CV libraries and in the Python environment by using K-Means clustering and Support Vector Machine (SVM).
2. Only curled type damages were inspected for features.
3. Images were captured using the camera and processed onboard the Raspberry Pi.
4. The resolution of the images taken were limited by the camera resolution.
5. Only the leaves of a single plant were monitored.
6. Performance evaluation for the classification is determined by specificity, accuracy, sensitivity, and precision.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, relevant works are analyzed to determine the classification of thrips-infected chili plants using image processing. However, the process of classifying the leaves infested by thrips from healthy leaves goes through several stages to achieve intended results. As the impact of the diseases differs in its shape, size, and color the method of disease classification changes as well. Hence, to classify the disease through image, the most important point is using the correct algorithm to find the infested chili leaves. From the conventional literature, the most suitable and practical method was determined to produce reliable outcomes. Thus, acquisition of image, image preprocessing (enhancement), segmentation of image, and feature extraction are the main steps that will be used to classify the infected leaves from healthy leaves.

2.2 Overview of diseases on chili leaves

Chili is a popular plant and cultivated worldwide. It notifies that chili is grown on an area of 1,776,000 hectares in the world, with a production of 7,181,000 tons. Chili is recognized in many countries as a highly economically important and precious cash crop, for instance, Pakistan. There are approximately 25 types that are grown worldwide. Chili's plant is usually 60-80cm tall. It needs a warm and wet climate for growth and dry weather through maturity[4].

Chili comes from southern tropical Latin American regions (New Mexico and Guatemala) around 7500BC. Mexico is Chilies' native home. Before 1585, the Portuguese had introduced hot chilies to the subcontinent of Indo-Pak from Brazil.

Several pests and diseases affect the chili which causes significant damage. They are classified as follow:

2.2.1 Pests:

Pests are normally able to move more than helpful insects and multiply more rapidly. Several pests affect the chili leaves such as, aphids, thrips, blade hoppers, pigs, mites, mites, pod borers, and fleas which damage the leaves.

2.2.2 Pathogens:

Pathogens pose a significant threat to chili leaves, such as fungi, bacteria, and viruses, in addition to various pests.

i) Fungal Diseases:

Fungal diseases typically do damage more than other pathogens. a lot of fungi cause different diseases in chili leaves. Some fungal diseases exist, such as Cercospora (frogeye) leaf spot, Fusarium wilt, and Powdery mildew.

ii) Bacterial Diseases:

Chili leaves are also infected by bacterial diseases. Bacterial leaf spot, Bacterial wilt, and Syringae seedling blight are several bacterial diseases.

iii) Viral Diseases:

Various viruses cause chili leaf disease. largely, the infected seeds, insects, and mechanical equipment disperse or transfer viruses. Most viral diseases are complex to analyze because of the extreme overlap of symptomatology. So, the various viruses produce Symptoms for chili leaves such as curling of leaves, the mosaic pattern on leaves, leaf deformation, ring spots, and yellowing [4].

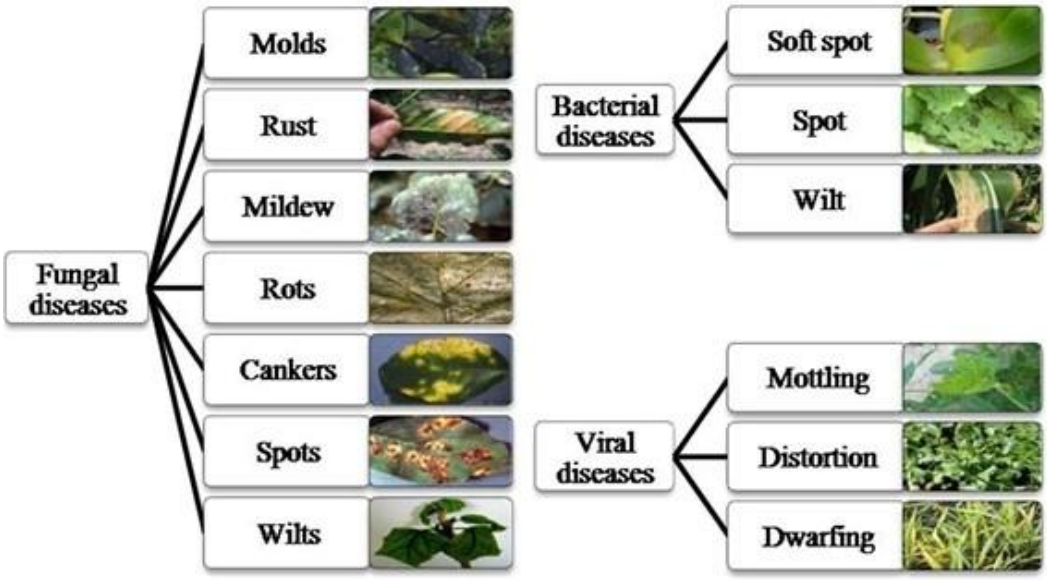

Figure 2.1 Various types of plant leaf diseases [5]

2.2.3 Overview of thrips infection on chili leaves:

Thrips are a very small class – almost microscopic – of insects that were found on many plants which consequently destroy the plants. Besides, thrips are a major chili plant pest. Thrips infect the buds, leaves, and flowers of chili plants. Attacks by thrips will curl up chili leaves. The thrips assault on chili plants begins with a medium to intense attack. The mild attack on a leaf marked with silver-white paint symptoms. Moreover, the color of the leaf was silvery. Paroxysm attack happens when thrips work as virus vectors to cause chili diseases [6].

The thrip's mouth pierces and absorbs the cells of chili leaves, causing the necrosis of tissue. This changes the color of the tissue from silvery to brown or black. Thrips of chili produce harmful feeding scars, leaves deformed and discolored buds, flowers, and young fruits by feeding on the meristems of the terminals of the host plant and other tender portions above the ground. The cell sap of leaves is sucked by adult and nymphs of scirtothrips dorsalis that causing the leaf to wind upward and reduce the size of the leaf. For example, the appearance of the pepper plants changes to called "chili leaf curl" when the scirtothrips dorsalis invade them. The occurrence of

discolored or deformed on the plant parts indicates the presence of the scirtothrips dorsalis [6].

The following pictures are for some of the symptoms of damage on chili leaves, for example, figure 2.2 shown silvering of the leaves surface caused by pests, figure 2.3 depicts the curling of leaves caused by thrips, figure 2.4 clarify brown grass markings on leaves caused by bacterial diseases, figure 2.5 shown Cercospora leaf spot caused by fungal diseases and figure 2.6 illustrate white powder on.

Figure 2.2 Silvering of the leaves surface [7]

Figure 2.3 curling of leaves [8]

Figure 2.4 Brown Grass Markings on Leaves [9]

Figure 2.5 Cercospora Leaf Spot [10]

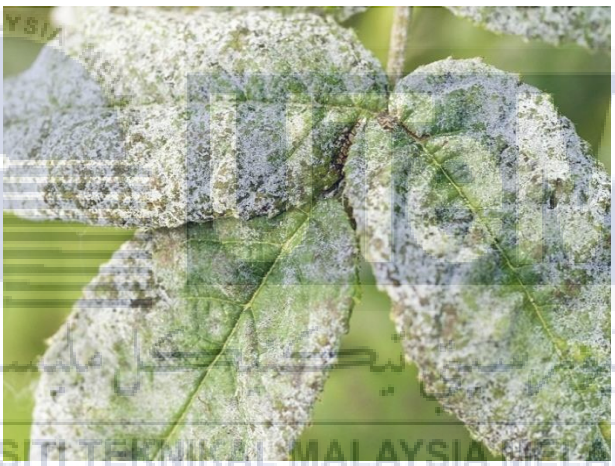

Figure 2.6 White Powder on Leaves [11]

2.3 Overview on previous works on disease detection from leaves

The technology of image processing is a new sophisticated technology that has been studied for over a decade ago. Image processing is a mechanism that carries out a process of analyzing the captured image to extract out some useful information to reach desired goals.