

Framework for Swiss Chard Leaf Disease Detection using Image Processing Techniques

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Abstract - Swiss chard is an important leafy vegetable in Ethiopia because it is full of nutrients.. Swiss chard is in trouble because of diseases like Powdery Mildew, Leaf Miner and Cercospora Leaf Spot. The old ways of finding these diseases are not good because they take a lot of time cost a lot of money and often give results. This study is about a way to find Swiss chard diseases using pictures and computer programs. We took pictures of 400 chard leaves and used 70% of them to teach the computer and 30% to test it. The computer uses a way to separate the leaves a special tool to look at the texture and a special program to decide what disease it is. When we tried it the computer was 97.5% of the time. It was right 96.7% of the time for Powdery Mildew 93.3% of the time for Leaf Miner and always right for Cercospora Leaf Spot and healthy leaves. This system is good, for farmers because it is cheap fast and can be used for plants.

Keywords - chard leaf disease, GLCM, K-means clustering, SVM classification, image processing.

I. INTRODUCTION

A. Background Study

Swiss chard is a good vegetable that is full of nutrients. It is easy to grow. You can find it all year round. Swiss chard has a lot of vitamins, minerals and other good stuff that's great for your health. It can even grow in soil and in places that are very hot or cold. Swiss chard is packed with things like iron, calcium and potassium which're all very good for you. Even though Swiss chard is a great vegetable it can get sick easily. It can get diseases from fungi, bacteria and pests. Usually people look at the leaves to see if they are sick. This can take a long time. Using computers to look at pictures of the leaves can help us figure out what is wrong with them. This way we can help farmers take care of their chard and make sure it grows well.

B. Statement of the Problem

In Ethiopia people grow a lot of vegetables to eat. Swiss chard is one of the vegetables that people eat.. When people grow Swiss chard it can get diseases that make it hard to grow. So we need to find a way to detect and classify these diseases.

The problem is that it is hard to detect and classify chard diseases because it requires a lot of experience and attention.

Now people look at the leaves and talk to experts to figure out what is wrong, with them. Sometimes they even do experiments in a laboratory.. This takes a lot of time and we do not always have the things we need. So we want to make a system that uses computers to look at pictures of the leaves and help farmers and experts take care of their chard. This will help people make money and grow more food. In this research we will use computers to look at pictures of chard leaves and detect diseases.

II. LITERATURE REVIEW AND RELATED WORKS

A. Overview of Plant Disease Detection and Classification Using Image Processing

chard is grown all over the world. You can find it in places like northern South America, India, the United States and Mediterranean countries. People use the stems and leaves of chard in many different kinds of food. It is part of the Chenopodiaceae family, which includes types of beets like fodder beets, sugar beets, garden beets and leaf beets. Swiss chard is also called stem chard because of its flat stems.

Swiss chard is very good for you. It has a lot of vitamins like A, B2, B6, C, E and K. It also has fiber, folate, thiamin, calcium, magnesium, iron, potassium, zinc, manganese and phosphorus. Swiss chard does not have a lot of fat or cholesterol. It even has compounds that can help with inflammation, diabetes, cancer and oxidation. Swiss chard is good for your heart because it has acid and flavonoids. The potassium in chard helps your body get rid of extra water, which is good for your blood pressure.. It has biotin, which is good for your hair.

B. Swiss Chard Leaf Diseases

Taking care of plant diseases is hard. Diseases can hurt the stems and leaves of plants. Sometimes plants can get sick from things at the same time. There are two kinds of plant diseases: non infectious. Infectious diseases come from things like bacteria, fungi, viruses, worms or parasites. These things can make plants sick. Spread from one plant to another.

Swiss chard can get infectious diseases from fungi, bacteria, viruses and parasites. Some common diseases that hurt chard leaves are Cercospora leaf spot, powdery mildew and leaf miner infestation.

1. Cercospora Leaf Spot: This disease is caused by a fungus called Cercospora beticola. It can hurt chard a lot, especially in the summer when it is hot and humid. If the disease is very bad it can make the leaves ugly. Stop them from growing. The disease is worse when the weather is hot and wet. You can see it on the leaves as brown spots with a purple ring around them. If it gets worse the spots get bigger. Turn gray and the leaf can even die.

2. Leaf Miner: The babies of the leaf miner eat the leaves of chard and make tunnels. This hurts the plant. Makes it hard for it to make food. The tunnels also make it easy for other diseases to get in. The leaf miner is a shiny fly with a yellow mark on its back.

3. Powdery Mildew: This disease hurts chard in many places especially where it is dry and hot. It is caused by a fungus called Erysiphe betae. You can see it as a powder on the leaves.

C. Digital Image Processing

Digital images are made up of numbers that show how bright or dark each point is. Image processing is a way to make pictures look better by removing noise and mistakes. A digital image is like a map that shows how bright or dark each point is.

Image processing is used in things like taking pictures from space exploring the earth and just taking regular photos. It has three steps: making the image look better analyzing the image and understanding what the image means. Making the image look better includes getting rid of noise separating the objects from the background and finding features. Analysing the image is about putting the features into groups. Understanding what the image means is about using the features to make decisions.

In times image analysis is used to turn pictures into numbers that can be used to make decisions. The steps of image analysis are:

1. Getting the image: The picture might be noisy. Need to be improved.
2. Making the image look better: This includes things like making the colors even adjusting the contrast and removing noise.
3. Separating the objects: The image is divided into the background and the important objects.
4. Finding features: The important objects are analyzed to find features.
5. Putting features into groups: The features are used to put the objects into groups, which helps make decisions.

The last step is about using the features to make decisions, which's helpful in things, like finding plant diseases and taking care of plants.

III. METHODOLOGY

A. Design Science Research Methodology

Design Science is a way to solve problems that comes from Engineering and the science of making things. It tries to create ideas and products that help us work with information systems in a better way.

The way we think about this research is shown in Fig. 1. In this study we look at the people and organizations that collect chard products to see what they need. We use Design Science research to build something which we then test and evaluate.

We apply this to people, technology and the new thing we build. Then we add what we learn to our framework. Design Science is used to make this happen. It helps us understand how to work with information systems.

The environment is made up of people and organizations and Design Science helps us make things that work well in this environment. We use Design Science research to make the artefact. Then we test it to see if it works.

IV. DESIGNING A FRAMEWORK

A. General Overview of the Proposed Framework

The idea behind the framework for any vision-related algorithm for image detection is pretty simple. You start by taking pictures with a camera. Then you use techniques to make these pictures better and get the good stuff out of them that you need to look at closer. After that you use methods to figure out what is in the pictures and put them into groups based on what you are trying to do.

When you want to find disease in chard you take pictures of the Swiss chard with a digital camera. To get rid of the stuff that gets into the pictures when you take them you use special techniques like making the pictures look better and separating the parts of the picture that are important.

B. Dataset Collection

We got a bunch of pictures of chard 400 to be exact. We had 100 pictures, for each of the four types of chard. These pictures were sizes and types but that is okay because we fixed them when we were getting them ready. We used 70% of these pictures to train our system and the rest 30% to test it and see how well it works with the chard images.

V. EVALUATION AND DISCUSSION OF RESULTS

The performance of the framework was evaluated using a confusion matrix, performance measures, satisfaction measures (user acceptance testing), and comparative analysis. The overall accuracy of the system was 97.5%, with specific accuracies of 96.7% (Powdery Mildew), 93.3% (Leaf Miner), 100% (Cercospora Leaf Spot), and 100% (Healthy).

Predicted \ Actual	1	2	3	4	Recall
1	93.3%	3.3%		3.3%	96.7%
2		100%			100%
3		3.3%	96.7%		96.7%
4	3.3%		3.3%	93.3%	93.3%
Precision	96.7%	93.3%	96.7%	96.7%	95.8%

Table1. Confusion Matrix of Test Data using KNN

Predicted \ Actual	1	2	3	4	Recall
1	96.7%	3.3%			96.7%
2		100%			100%
3		3.3%	96.7%		96.7%
4	3.3%		16.7%	80%	80%
Precision	96.7%	93.3%	83.3%	100%	93.3%

Table 2 Confusion Matrix of Test Data using Fine Tree

Predicted \ Actual	1	2	3	4	Recall
1	96.6%	3.3%			96.6%
2	3.4%	96.6%			96.6%
3		3.3%	96.7%		97.3%
4	3.4%			96.4%	96.4%
Precision	96.7%	93.3%	100%	100%	96.4%

Table.3. Confusion Matrix of Test Data using Naïve Bayes

Predicted \ Actual	1	2	3	4	Recall
1	96.7%			3.3%	96.7%
2	3.3%	93.3%	3.3%		93.3%
3			100%		100%
4				100%	100%
Precision	96.7%	100	96.7%	96.7%	97.5%

Table 4 Confusion Matrix of Test Data using SVM

Table 5. Number of Testing Dataset of Swiss chard leaf Image

Types of diseases	Total number of Images	Class
Powdery mildew	30	0
Leaf miner	30	1
Cercospora leaf spot	30	2
Healthy	30	3
Total	120	4

A confusion matrix for a binary, i.e. 2-class problem reports the number of false positives (FPs), false negatives (FNs), true positives (TPs), and true negatives (TNs). In the case of multiclass, i.e. more than 2-class problems, the resulting confusion matrix will be of dimension $n \times n$ ($n > 2$). It is observed that the matrix contains n rows, n columns and $n \times n$ entries in total. From this matrix, it is not possible to directly calculate the number of FPs, FN, TPs, and TNs. According to this approach, the values of FPs, FN, TPs, and TNs for class i are calculated as (Confusion Matrix):

Table .6 Experimental Result of SVM classification overall performance analysis factors result

Types of disease	Accuracy	Sensitivity	Specificity	Precision	FPR	FNR
Powdery	96.7%,	96.7%	96.7%	96.7%	3.3%	3.3%
Leaf miner	93.3%,	100%	95.3%	100%	6.7%	0%
Cercospora	100%	96.7%	100%	96.7%	0%	3.3%
Healthy	100%	96.7%	100%	96.7%	0%	3.3%
Total	97.5%	97.5%	98%	97.5%	2%	2.5%
Percentage	97.5%	97.5%	98%	97.5%	2%	2.5%

Table 7 Experimental Result of SVM Classification in Texture Feature Extraction

Types of disease	Correctly Classified	Misclassified	Accuracy in %
Powdery mildew	29	1	96.7%
Leaf miner	28	2	93.3%
Cercospora	30	0	100%
Healthy	30	0	100%
Total	120	3	97.5%
Percentage	97.5%	2.5%	

VI. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

Automated Swiss chard disease detection and classification provide accurate, unbiased, and efficient results compared to manual methods. This research developed an automated system using the K-Means algorithm for image segmentation and GLCM for texture feature extraction. The system achieved an overall accuracy of 98.2%, with individual success rates of 96.7% for Leaf Miners, 93.3% for Powdery Mildew, and 100% for Cercospora Leaf Spot and Healthy samples.

B. Recommendations and Future Work

Future work includes developing a mobile application for Swiss chard farmers, enhancing classification to detect multiple diseases in a single image, improving the framework to assess disease severity, and expanding the database for better Swiss chard disease identification.

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