

Soft Computing

Utilizing Technology for Agriculture and Crop Disease Detection



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1 Introduction & Motivation

Soft computing is a paradigm for solving complex problems by using techniques inspired by human intelligence, such as fuzzy logic, neural networks, and evolutionary algorithms. It is used in various fields, including agriculture, for crop disease detection. The project aims to develop a system that can detect and classify crop diseases using soft computing techniques.

2 Objective

Developing a system using deep learning techniques for crop disease detection. The system will be able to identify and classify different types of crop diseases, such as fungal diseases, bacterial diseases, and viral diseases, based on leaf images. The system will also be able to provide recommendations for disease management based on the detected disease.

3 Work Flow

The workflow of the system is as follows: 1. Data Collection: Collecting a large number of leaf images with various diseases. 2. Data Preprocessing: Preprocessing the images to extract features. 3. Model Training: Training a deep learning model using the preprocessed images. 4. Model Evaluation: Evaluating the performance of the trained model. 5. Deployment: Deploying the trained model for real-time disease detection.

4 Image Processing

The image processing technique involves extracting the infected area of a leaf, analyzing different patterns, and isolating the background and healthy leaf parts for accurate disease detection.

5 Fuzzy Logic

Fuzzy logic is a form of logic that deals with the concept of partial truth or degrees of truth. It is used in the system to handle uncertainty and imprecision in the data. The fuzzy logic rules are defined based on the expert knowledge of the domain.

6 Confusion Matrix

The confusion matrix is a table that compares the actual versus the predicted results. It is used to evaluate the performance of the classification model. The matrix shows the number of true positives, true negatives, false positives, and false negatives.

7 Future Work

Future work includes: 1. Larger Dataset: Collecting a larger dataset of leaf images to improve the model's performance. 2. Real-time Detection: Implementing the system for real-time disease detection. 3. Integration with IoT: Integrating the system with IoT for automated disease detection and management.

8 Conclusion

The project built by artificial neural network and fuzzy logic system for detecting diseases on the leaf and giving the leaf according to the amount of the infection detected on it. The system is able to detect and classify different types of crop diseases, such as fungal diseases, bacterial diseases, and viral diseases, based on leaf images. The system will also be able to provide recommendations for disease management based on the detected disease.

Introduction & Motivation

In today's world, identifying and addressing microscopic organisms is crucial for maintaining plant health, specifically in the agricultural sector. The focus is on detecting and managing crop diseases to support plant growth and productivity.

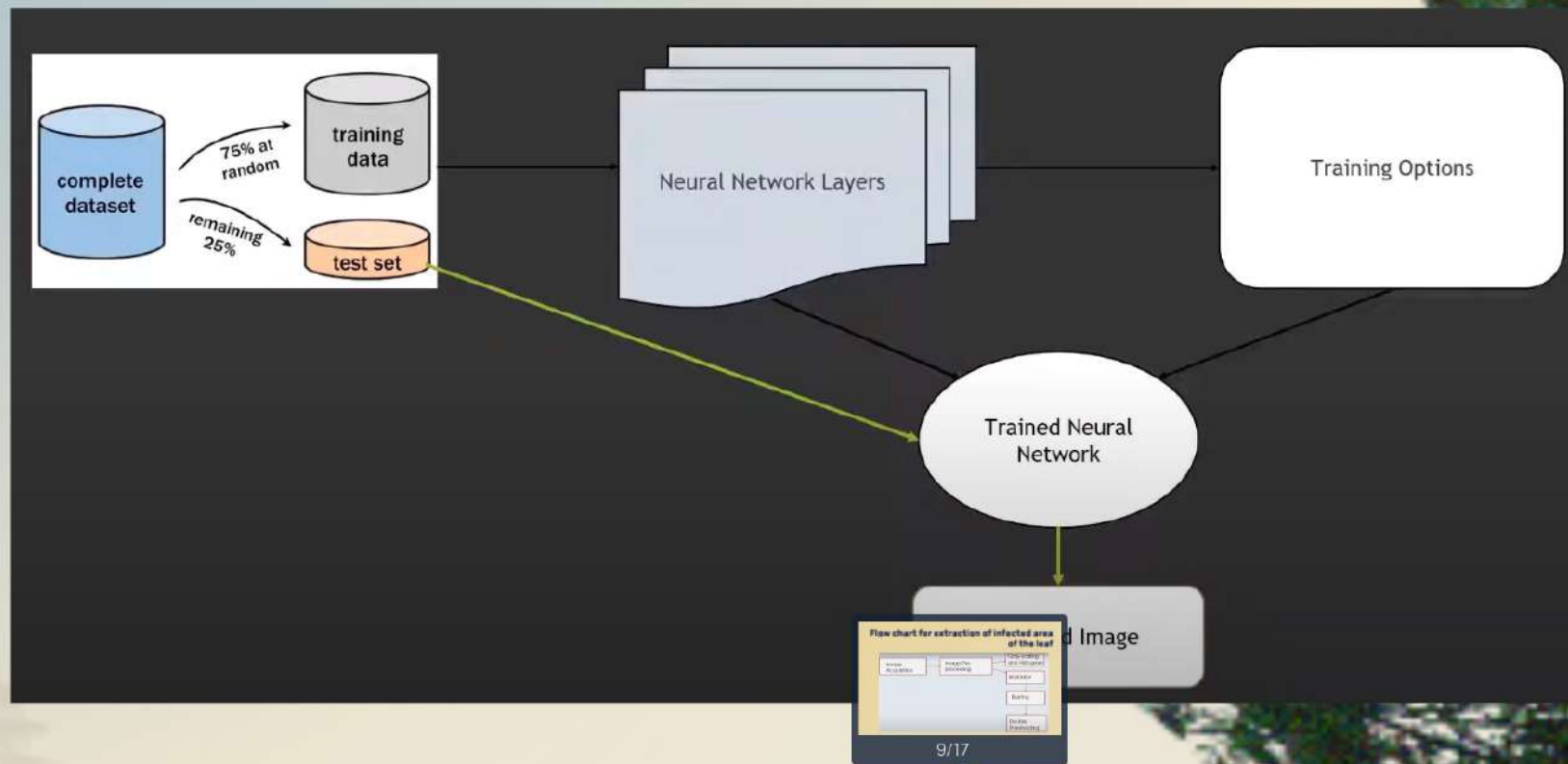
1

Objective

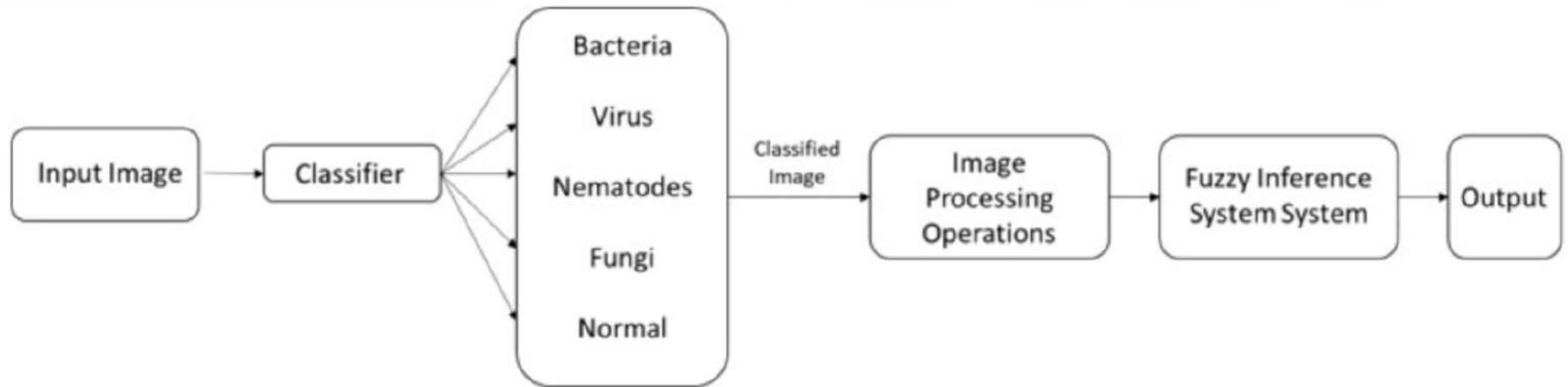
Developing an algorithm using deep learning for precise identification and grading of plant leaf diseases, including bacteria, fungi, nematodes, and viruses, based on leaf images. And also utilizing the fuzzy inference system with well defines Fuzz rules for finding the health of the leaf of that particular plant.

2

3 Work Flow

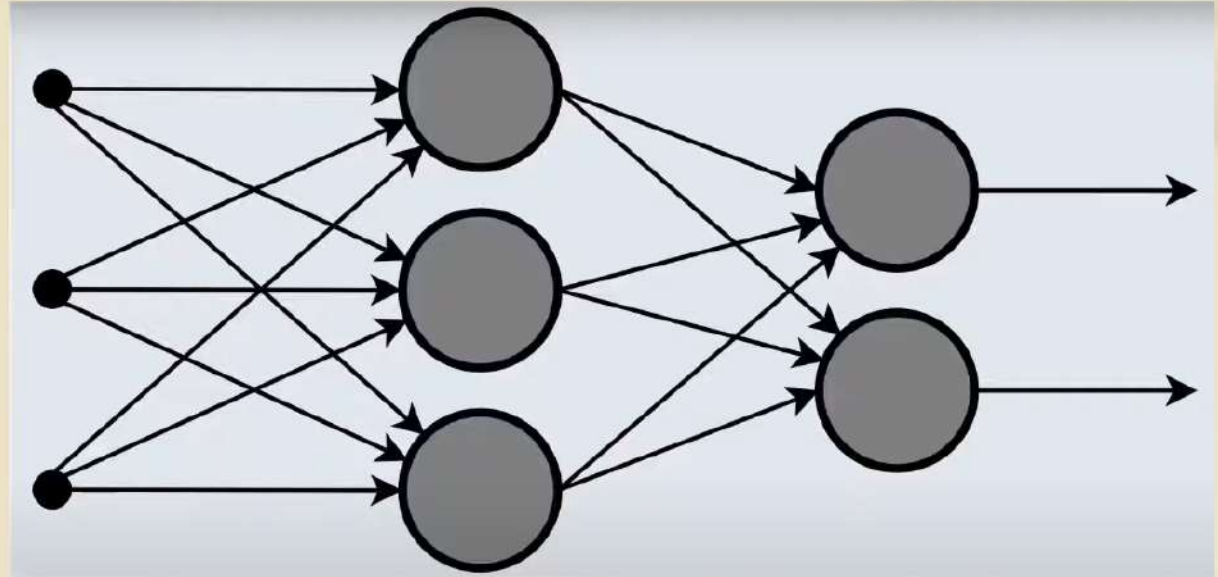


Complete workflow



ANN

An Artificial Neural Network (ANN) is a collection of connected artificial neurons, modeling the biological brain's neural connections to facilitate complex computations and decision-making.



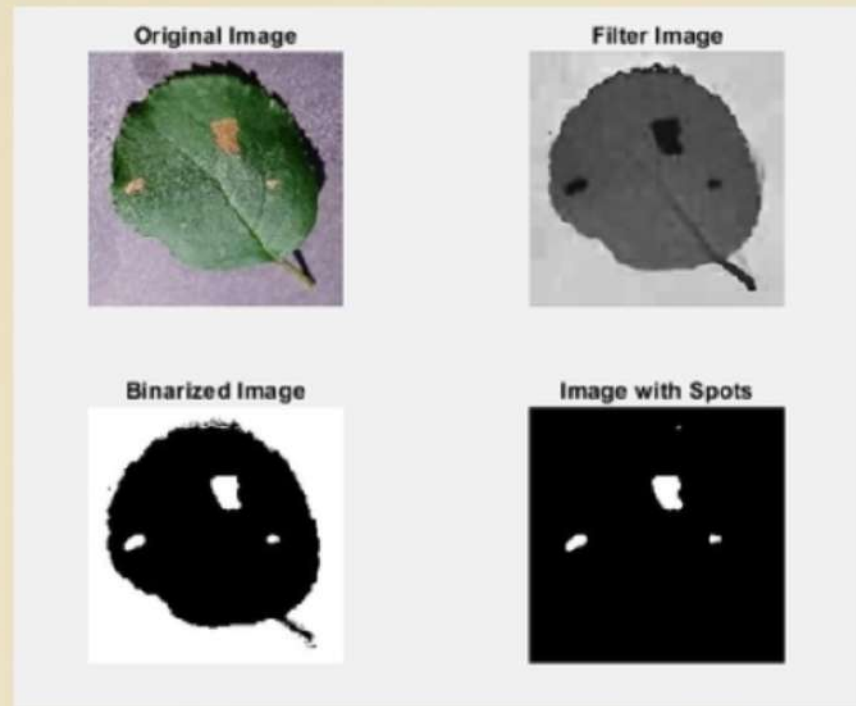
Leaf Disease Detection

```
1 %Step 1
2 %Creating a datastore
3 - imds = imageDatastore('Leaf_Disease_Dataset','IncludeSubfolders',true,...
4     'LabelSource','foldernames');
5
6 - disp(imds);
7
8 % %Step 2
9 % %Splitting the data
10
11 - [traindata,testdata] = splitEachLabel(imds,0.8);
12
13 %Step 3
14 - layer = [imageInputLayer([256 256 3])
15     convolution2dLayer(5,20)
16     reluLayer
17     maxPooling2dLayer(2, 'Stride', 2)
18     fullyConnectedLayer(5)
19     softmaxLayer
20     classificationLayer
21 ];
22
```

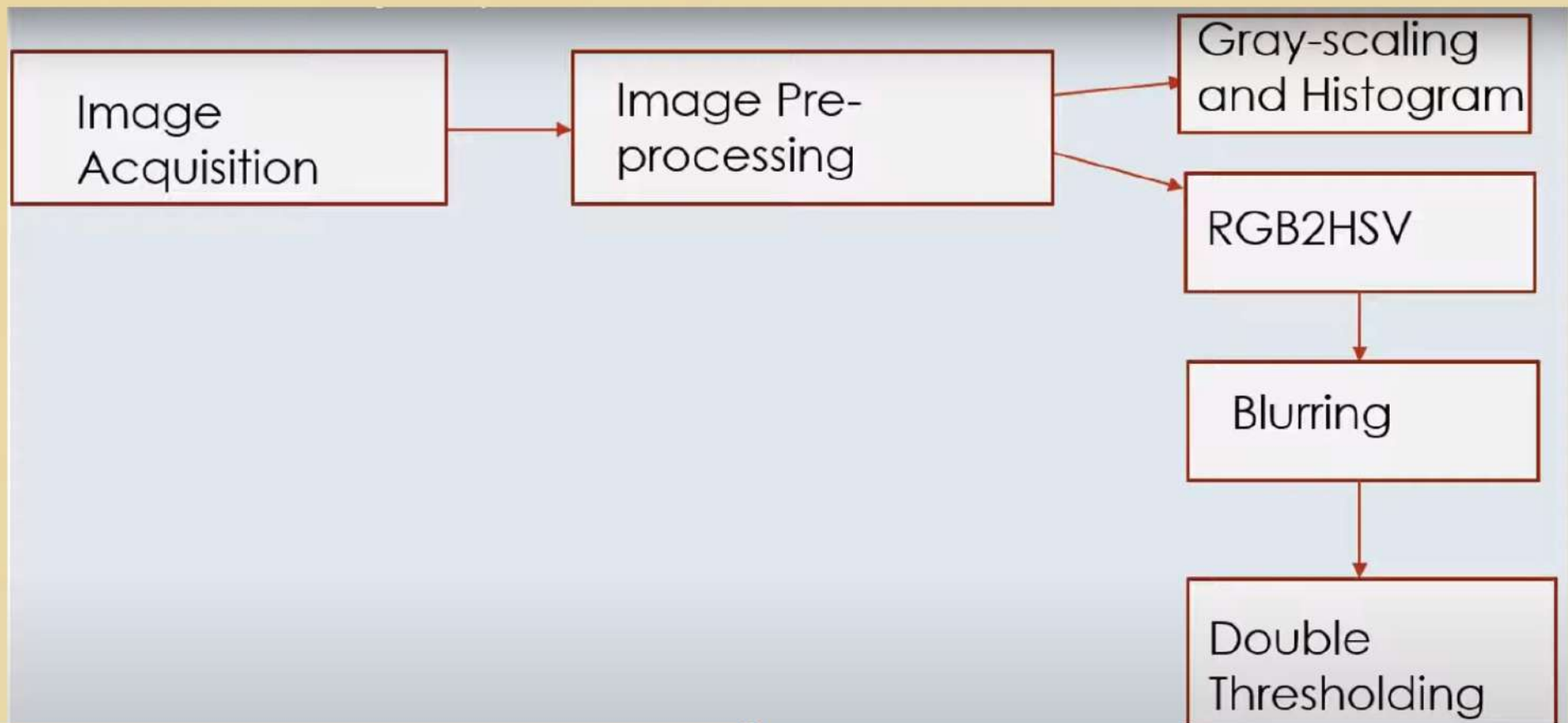
```
23 %Step 4
24 %Training options
25
26 - options = trainingOptions('rmsprop', ...
27     'Plots', 'training-progress', ...
28     'LearnRateSchedule', 'piecewise', ...
29     'MaxEpochs',30, ...
30     'LearnRateDropFactor', 0.4, ...
31     'LearnRateDropPeriod',7, ...
32     'MiniBatchSize', 300);
33 %options.MaxEpochs = 30;
34
35 %Step 5
36 %Training the network
37
38 - [net,info] = trainNetwork(traindata,layer,options);
39
40 - save net net
41
```


4 Image Processing

The image processing technique involves extracting the infected area of a leaf, analyzing different patterns in which organisms infect the leaf, and isolating the background and healthy leaf parts for accurate disease detection.



Flow chart for extraction of infected area of the leaf



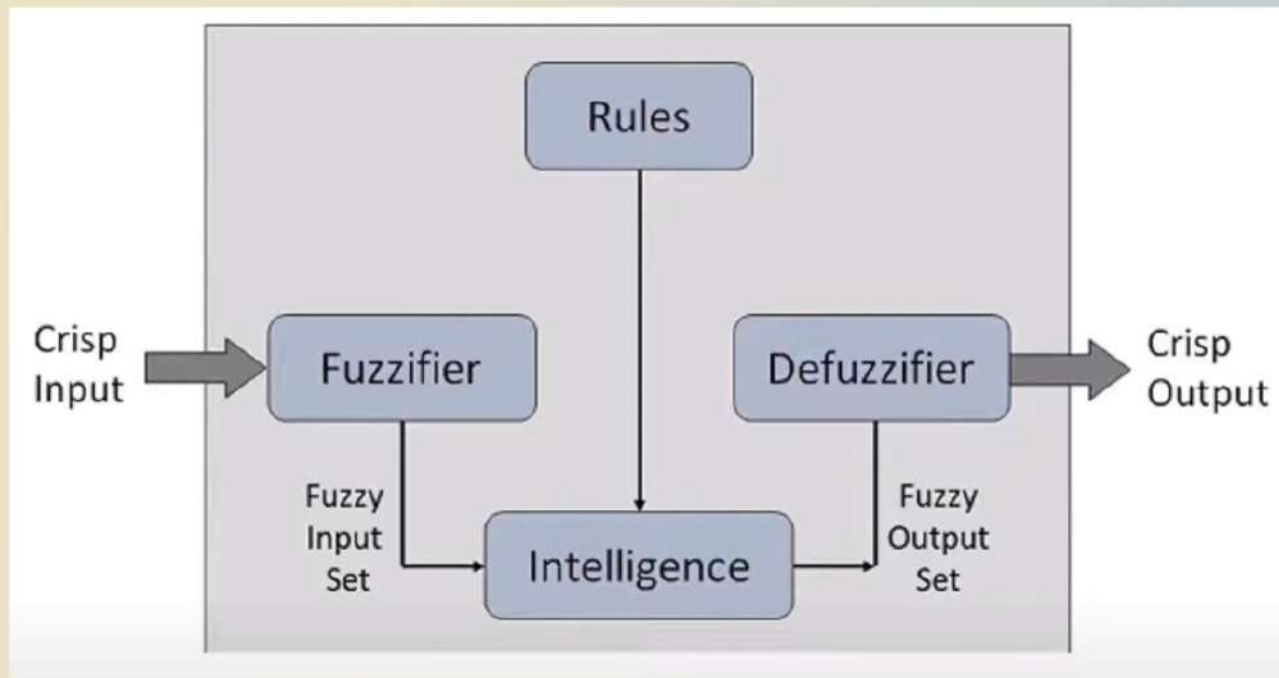
Blurring

- A Gaussian blur is applied to the hue image for the image enhancement.
- The gaussian filter helps to eliminate noise and gives a smother image

Double Threshold

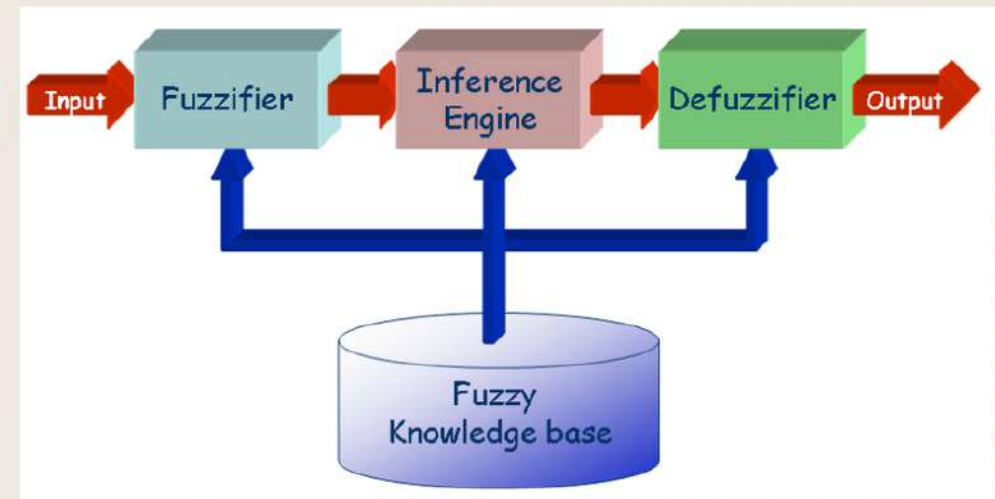
- The method of double thresholding converts the image to a binary image.
- There are two values of the thresholds used where if the pixel lies between it, it is converted to 1(white) and otherwise 0(black)

Fuzzy Logic 5



Steps to generate Fuzzy Inference System

- Specifying input and output
- Specifying the membership function
- Specifying Fuzzy rules
- Reading and Evaluating fuzzy system



Fuzzy Rules used

- If (spots is less/No) then (health severity is very good) (1)
- If (spots is many) then (health_severity is very_bad) (1)
- If (spots is less/No(Inverse)) then (health_severity is good) (0.5)
- If (spots is many(inverse)) then (health_seventy is bad) (0.5)
- If (spots is medium1) then (health_severity is good) (0.5)
- If (spots is medium1(inverse)) then (health_seventy is bad) (1)

6

Confusion Matrix

		Confusion Matrix					
Output Class	Bacteria	7 14.6%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	100% 0.0%
	Fungi	0 0.0%	8 16.7%	0 0.0%	2 4.2%	0 0.0%	80.0% 20.0%
	Nematodes	1 2.1%	1 2.1%	9 18.8%	0 0.0%	0 0.0%	81.8% 18.2%
	Normal	1 2.1%	1 2.1%	1 2.1%	6 12.5%	0 0.0%	66.7% 33.3%
	Virus	1 2.1%	0 0.0%	0 0.0%	0 0.0%	10 20.8%	90.9% 9.1%
	70.0% 30.0%	80.0% 20.0%	90.0% 10.0%	75.0% 25.0%	100% 0.0%	83.3% 16.7%	
		Bacteria	Fungi	Nematodes	Normal	Virus	
		Target Class					

Future Work

7

Larger Dataset

Gathering huge amount of images which would be accurately labelled by experts to create a larger and better Dataset.

Robust Neural Network

The future work will mainly focus on implementing a robust neural network in training of a better data set to give as accurate results as possible.

Image Segmentation

In future various techniques for image segmentation will be applied to get accurate estimation of the area infected.

Conclusion 8

The project built by artificial neural network and fuzzy logic is very useful for detecting diseases on the leaf and grading the leaf according to the amount of the infection detected on it. The estimated disease severity of the leaves were successfully measured by the use of artificial neural network, basic image preprocessing and Fuzzy logic decision rules.

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