RESEARCH ARTICLE

DETECTING PLANT LEAF DISEASES USING IMAGE PROCESSING TECHNIQUES: A SURVEY

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Abstract: Most developing countries that rely on agricultural resources, such as India and Malaysia, still employ traditional techniques which are visual inspection to detect plant leaf diseases. Image processing is relatively new, cutting-edge technology in agriculture field to detect plant leaf diseases and the most important approach is through image segmentation. It works by segmenting meaningful information from diseased plant leaf image to be analysed and it is much simpler than traditional techniques. This article covers a survey on various image segmentation techniques such as K-Means, Otsu's, Edge-based, Watershed and Region Growing. It also includes the discussion of advantages and disadvantages of each technique. Aside from that, the accuracy of segmentation achieved by each technique is also reviewed to describe their performance in detecting plant leaf diseases.

Keywords: Plant leaf diseases, Agricultural resources, Image processing, Image segmentation

INTRODUCTION

Because India is an agricultural country, agriculture is very important sector of the Indian economy and it accounts for more than 80% of people's income (Patel & Joshi, 2017). In Malaysia, agriculture continues to be a major part of economy, producing 12% of the country's GDP and employing 16% of the population (Adnan & Nordin, 2021). Therefore, detection of leaf diseases in these countries is essential because diverse types of diseases in the crop relatively lower yields. It also is challenging for farmers to distinguish a specific disease.

Farmers adopted visual inspection methods to detect plant leaf diseases in the past. Visual inspection of plant leaf diseases, on the other hand, is inefficient since it necessitates the expertise of professional botanists as well as prepared disease specimens, which takes a long time. In contemporary times, farmers begin to embrace technology to help them accomplish their jobs more efficiently.

Hence, we looked at several different types of plant leaf diseases, as well as various modern techniques for detecting them through image processing.

Three most common plant leaf diseases are leaf blight, gray spot and rust. This paper covers a variety of techniques to detect plant leaf diseases. At the end, the accuracy of detection of each technique is reviewed to determine their performance.

MATERIALS AND METHODS

Detection of plant leaf diseases through image processing fundamental steps are image acquisition, image pre-processing, image segmentation, feature extraction and lastly image classification of the diseases. Image segmentation is highlighted in this survey, with the technique being centered on segmenting the infected from the uninfected parts in order to determine disease types.

There are five image segmentation techniques reviewed in this survey which are:

- K-Means
- Otsu's
- Edge-based
- Watershed
- Region Growing

RESULTS AND DISCUSSION

Table 1 summary the overview of image segmentation techniques utilised in various papers. The source of diseased plant leaf and detection accuracy of the techniques is also listed.

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Table 1. Comparative study of the performance of image segmentation techniques to detect plant leaf diseases

Image Segmentation Techniques	Source of Diseased Plant Leaf Image	Detection Accuracy (%)
K-Means (Sankareswari & Sivakamasundari, 2015)	PlantVillage Image website	**94.30**
Otsu's (Sibiya & Sumbwanyambe, 2019)	PlantVillage Image website	60.0
Edge-based (Fadzil et al., 2014)	Digital camera (resolution of 14Mega pixels)	86.36
Watershed (Al-shakarji et al., 2017)	Digital camera	73.35
Region Growing (Chuanlei et al., 2017)	Charge-coupled device (CCD digital camera)	90.0

From the tabulated survey, K-Means technique shows the best detection accuracy followed by Region Growing, Edge-based, Watershed and Otsu's technique. Several reasons that influenced the performance of each technique also being reviewed Table 2 summaries the advantages and disadvantages of each technique presented in Table 2.

Table 2. Advantages and disadvantages of image segmentation techniques

Image Segmentation Techniques	Advantages	Disadvantages
K-Means (Sankareswari & Sivakamasundari, 2015)	•Works well in real world application. •L*a*b represents infinite number of chromatics.	•Centroid value remains uncertain. •L*a*b is complex.
Otsu's (Sibiya & Sumbwanyambe, 2019)	•Simple implementati-on.	•Sum of probabilities of target and background is inaccurate. •Neighbourhood image are not obvious.
Edge-based (Fadzil et al., 2014)	•Able to segment image with noise because it has morphologic-al handling.	•Underperform when images have smooth boundary.

Watershed (Al-shakarji et al., 2017)	•Boundaries able to form a closed connected area.	•Over-segmentation.
Region Growing (Chuanlei *et al*., 2017)	•Offers images with clear edges.	•Unavailable spatial information in the histograms result. •Complex fine-tuning of algorithm.

Therefore, the causes for the low and high performance of each technique can be linked and determined using the list of advantages and disadvantages that have been reviewed.

The working method of each technique in detecting plant leaf diseases is also explored to make this survey relevant for future research. Table 3 summaries the working methods of each technique.

Table 3. Working method of image segmentation techniques in detecting plant leaf diseases

Image Segmentation Techniques	**Working Method**
K-Means (Sankareswari & Sivakamasundari, 2015)	Affiliate and gather the disease pixels and assigned them to the closest centroid to segment them from uninfected part.
Otsu's (Sibiya & Sumbwanyambe, 2019)	Iterate each pixel of infected and uninfected as background and front for segmentation.
Edge-based (Fadzil et al., 2014)	Discover the beginning of different line of leaf and segmenting edges denoted following pixels by pixels.
Watershed (Al-shakarji et al., 2017)	Transform the indulgences (centroid point of difference between the diseased and non -diseased parts of the image) and the segmentation is operating like a topographic map.
Region Growing (Chuanlei et al., 2017)	Plot the histogram of segmented images, identify maximum peak value, remove green pixels and connect the component labelling to pop diseases spot from stack. Then, quality metric analysis parameters which analyse the grey level energy of disease spots is used to find the segmentation point to start segmenting.

The summary of working method of each technique is done to make it easier for future researchers to use the best techniques to detect plant leaf diseases based on everything that is evaluated in this paper, such as the performance of each technique, their advantages and disadvantages, and how each technique works.

CONCLUSION

Various researchers employed various image processing techniques to detect plant leaf diseases.

Each of the technique has their own advantages and disadvantages. In conclusion from this survey, K-Means technique is more accurate than other image processing techniques.

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