Pattern Recognition

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Introduction

Over the years, technology has fundamentally changed farming and has impacted agriculture in more ways than one. Agricultural cultivation is the primary occupation in many countries around the globe. The search for more efficient and reliable means to reduce the environment's negative impact, improve growing demands, increase resistance to diseases and parasites, and strive for sustainable agriculture. This paper discusses pattern recognition in image processing to achieve an efficient means in the agricultural industry. The field of pattern recognition is concerned with the automatic discovery of regularities in data through the use of computer algorithms and with the help of these regularities to take actions such as classifying the data into different categories.[3]

Problem

Plant diseases have turned into a dilemma as they can cause significant reductions in both the quality and quantity of agricultural products. Identifying plant's leaves, stems and finding out the pest or diseases symptoms of the pest plays a crucial role in the successful cultivation of crops. Precise categorization of these visually observed diseases, pests, is necessary because of the complexity of varying visual patterns. Visual observation has three critical drawbacks: subjective where multiple experts may have different ratings for the same plant, laborious where it requires enormous time from experts for frequent and large-scale rating, and relatively insensitive where the human eye is not sufficiently sensitive to the subtle variation of leaf appearances[7]. Disease management is a challenging task. Therefore, developing methods for the automatic classification of leaf diseases based on high-resolution multispectral images impacts crop yields and assists farmers and agronomists with their high throughput and precision. Our primary goal here is that given an image, or a region within an image, generating the features that will subsequently be fed to a classifier to describe what patterns describe the image.

A feature generation process is necessary because we cannot use raw data as it is too big to maintain and also does not convey to the classifier the same interpretation of the image as what people feel about it[6]. As a result, feature generation is aimed to exhibit high information packing properties from the class separability point of view. So here, we can decompose our problem into one of the image classifications; this decomposition will be almost the same for all algorithms related to image classification.

Dataset, Image Acquisition, Preprocessing and Segmentation

Beginning with appropriate datasets is required at all stages of object recognition research, starting from the training phase to evaluating recognition algorithms' performance. Image acquisition is the creation of a digitally encoded illustration of the visual characteristics of an object in image processing known as RAW data[8]. Image acquisition can bring remaining steps for disease identification and classification, Image Preprocessing, and Image Segmentation. Image Preprocessing consists of image reorientation, cropping, gray scaling, noise removal, contrast stretching, threshold inversion, and edge recognition. Image reorientation is aligning the input image to a standardized position, with the leaf aligned to either the x-axis or y-axis. Grayscale conversion of the image into geometrical data is implemented to optimize the contrast and intensity of images. Later, the thresholding process creates a binary image from the grayscale image to translate the value of the image to its closest threshold.[1]

Different types of noise patterns can be observed in digital images, e.g. grains and holes. Erosion and dilation are procedures implemented to eliminate background noises. The photos are considered homogenous if they do not exhibit substantial differences between one another in terms of contrast stretching[1].Image preprocessing can also be decomposed into problems regarding efficiency and accuracy, for example as a *hazier image* is collected to remove grain noise, which could disrupt image processing due to high-frequency properties as a result of grey difference [4]

Image Segmentation, to distinguish healthy leaves from diseased ones, one more class can be added to the dataset containing only healthy leaves. A different type in the dataset with background images can be beneficial to get a more accurate classification. Thus, a deep neural network could be trained to differentiate the leaves from the surrounding.

Feature Extraction

Leaf features such as shape, size, and color are important characteristics in a computational recognition system. The feature extraction can be performed by contour-based or region-based extraction. The contour-based extraction is expressed in length, width, aspect ratio, and leaf diameter as descriptors. [1]. However, a region-based method extracts leaf features to show shape, rectangularity, roundness (ratio of the surface area of the leaf to its perimeter), area (a pixel representing a leaf area), and the specifics of every leaf area.

Lu et al. discovered that leaves usually have diseases or holes, which could reduce the total area of the leaf and thus compromise the segmentation result in feature extraction. This is because holes in leaves will be identified as the background instead of the leaf area. Therefore, it is suggested to use contour extraction with selective area filling to overcome this problem[2].

A machine learning mechanism's accuracy and precision are most strongly influenced by feature extraction because the architecture for machine learning essentially depends on the predetermined feature prompted into the network. As different problems require different modes of analysis and approaches, no single feature extraction technique can be considered the optimal one.

Classifiers

An important view is about the relation between training data and class description/decision criterion. A classifier learns from the training data and has the ability to recognize an unknown pattern. On the other hand, if the training data is not enough, even an excellent learning algorithm could produce a poor classifier. The goal of the combination of training data and learning algorithm is to build a classification mechanism as better as possible especially for a vector which is not one of the training data.[6]

A pattern can also be seen inside the various classification methods according to their category; by combining one or more classification techniques, the process of image analysis for diseased leaf detection can be enhanced to a certain level than using only one classification technique. Using K-means clustering segmented disease portion can be obtained and then ANN can be used for classification [1]. Similarly, among various pattern recognition methods, we can combine statistical pattern recognition methods, which is mainly used for feature recognition but lacks in defining the relations between those features with structural pattern recognition, which relies on segmentation and features extraction. In the case of noisy patterns, the choice of a statistical model is a good solution. The practical importance of a structural model depends upon the recognition of simple pattern primitives and their relationships represented by description language. As compared to statistical pattern recognition, structural pattern recognition is a newer area of research. [5].

Conclusion

Pattern Recognition is a developing yet energizing and quick-creating field that supports improvements in related areas, such as Computer Vision, Content (text) and Record Examination, Radar Processing, Speech Recognition, Text Classification, Image Processing, and Neural Network Systems. A unique and proper combination of preprocessing, feature extraction, feature selection, and classification process are required for each domain or problem to optimize accuracy, speed, and reduce cost by minimizing the feature set used for training and classification.

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