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PLANT SPECIES IDENTIFYING USING LEAF THERMAL IMAGE SEGMENTATION METHODS

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ABSTRACT

Thermography creates thermal images that help to determine color intensity. Color intensity helps to identify meaningful object in the color, image segmentation plays an important role in discovering the area of interest in the leaf image. In the middle part of the leaf, the average temperature is 0.94°C above the apex of the leaf and 0.81°C above the base of the leaf. The results showed that the temperature of the leaf was lower than the temperature of the plant. And the entire blade's average temperature is 24.07°C, which is higher than the soil temperature in the past (19.53°C). For the same maize type, drought stress treatment leaf temperature is higher than normal water treatment temperature. It has also been found that the temperature of maize with good resistance to drought is higher than the temperature of the bad, the higher the better. The above results showed that the temperature distribution characteristics in crops could be effectively obtained through the use of thermal infrared images, which also provided the potential for rapid identification of plant drought resistance.

The segmentation aim is to decompose an image into different areas for further study, while another is to adjust the representation of an image for faster analysis. A single or a combination of segmentation techniques can be applied on the basis of application to efficiently solve the problem. Segmentation is done using pixel-level or object-level properties of the object by marking off an object on an image. Such properties can be distinguishing edges, texture, pixel strength, form, width, and orientation within the object. There are many techniques available for segmentation that segment the thermal picture. Particularly the segmentation techniques are watershed segmentation, segmentation of thresholds, segmentation based on clusters and neural artificial network. These techniques of segmentation use algorithms including global thresholding, transformation of the watershed, K-medoids, clustering of K-means, Otsu thresholding, Kapur thresholding. This paper includes a review of literature on pioneering segmentation techniques and applicable algorithms used for thermal image segmentation.

KEYWORDS: *Global Thresholding, Watershed Transform, K-Medoids, K-Means Clustering, Otsu thresholding, Kapur Thresholding*

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INTRODUCTION

The main aim of this study is to create a computer-aided classification to identify leaves and assign plant names, if only the leaf picture is given as an input. This goal is accomplished through a series of sequential steps, including image enhancement, the elimination and identification of ROI area. In each of these steps, several researchers are contributed and proposed various algorithms. Each chapter discusses several significant publications in these phases to understand the current state of science.

Image Enhancement

Denoising is considered by most of the updated solutions as an important step in enhancing images. Various other methods of preprocessing can also be used to improve the image produced. Types include enhancement of boundary or rim, smoothening and contrast. These approaches may also be used to improve the quality of the image of the leaf (Tzionas et al., 2005). In this analysis, the image of the input leaf is improved by three operations: denoisation, contrast and edge enhancement. This chapter includes the studies in these three fields.

Noise Removal

Noise Removal of an image typically causes three types: 1. Fixed-Valued Impulse noise, 2. Random-Valued Impulse noise and 3. Gaussian noise. Noise removal leaf image is generally influenced by these noises. Solutions have been suggested that represent one of the above noises using different techniques. The paper discusses some of these strategies. In order to achieve translation, scalability and rotation invariance by considering separately the distance between the FD (Fourier Descriptor) magnitude and the Phase Angle to lower discrimination noise, Rui et al. (1996) proposed the Modified Fourier Descriptor (MFD) method. A minimum noise fraction (MNF) transformation was performed by Green et al. (1988) to regulate the noise in the image. El-Helly et al. (2003) says that the enhancement of image is a part of the image processing process and includes techniques for improving the aspect of an image, highlighting important image features and making the image more suitable for subsequent leaf classification tasks. They suggested a three-step image enhancement algorithm. The first move was to make use of HSI transformation to distinguish color data from its intensity information.

In the second step histograms were used to evaluate the intensity channel and the threshold method for increasing image contrast. Finally, the third step employed threshold methods to adjust the image frequency. Pan and He (2008) used a histogram equalization approach to improve the image of the seed. Li et al. (2010) has used a coupling method which combines adaptive local smoothing and wavelet to deal with a noisy leaf image. During the removal of noise, the system was able to preserve the edges while preserving the contrast and visual effect of the image. Ma et al. (2010) used a methodology for the pre-processing of images to minimize leaf image noise and improved areas of interest through the approach of minimal error. The difference between Gaussians has been used by Sathyabama et al. (2011) to increase the edges and other information in the digital images of the plate.

Wang and Wu (2009) claim that noise in an object can be detected to a high level of noise. Using this data, Zhang (2010) implemented an Adaptive Center-Weighted Median Filter (ACWMF), a two-stage noise removal method and a variations method. This approach successfully removed the noise but was sensitive to the filter window’s size and shape. The wider window resulted in the image being smoothed, so smaller sizes did not effectively eliminate the noise. The problem of window size is a common problem that many filtering algorithms share.

Solutions to these noise removal algorithms weaknesses were, they proposed a process based on the entropy application Interval-Valued Fuzzy Sets (IVFS) to denoise an image. By using an IVFS multithresholding technique, the method combined image histograms and spatial information about pixels of different gray levels. The benefit of this approach was that both the pulse and the Gaussian noise were eliminated. Rubio (2010) generalized this approach by using the Iteratively Reweighted Standard (IRN) method to obtain pixel value predictions and calculate the corresponding expected errors and train the noise model with an Expectation, Maximisation (EM) algo. The proposed algorithm can remove impulse noise effectively with a wide variety of noise densities and deliver better results with regard to the quality and quantity of the images.

Contrast and Edge Enhancement

Improving the quality of the edges of leaf images is a critical factor that can enhance recognition and identification efficiency. Whilst a maximum number of recorded works were based on edge detection (Yu and Acton, 2004), few were identified with edge enhancement. Li et al. (2007) notes that edge enhancement is a major operation that helps to identify object boundaries and further identification and classification steps. This helps distinguish the features by enhancing the visual quality of the object and provides insight into the shape and contour and provides the Human Visual System (HVS) with vital information.

One of the first methods for tackling the problem of improved edge performance is the use of anti-aliasing, by detecting the two neighboring pixels in the obliquity direction and using a correcting pixel to smooth the row (Yonezawa et al., 1978). Gupta (1981) has been investigating techniques that (slightly) "manipulate image content to achieve better edge quality, when the pixel intensity is selected depending on the distance between the center of the pixel and the image edge. Ort (1981) suggested a technique for moving diagonal elements by half a position. In Shirasaka (1998), the staircase regions are found by a similar technique. This approach is not very good for areas with complex contours. Another widespread technique of enhancement of edge value, in which the image area is scanned in a piece-by-piece order (windows), refering to a given set of patterns to be corrected (Yao et al., 2006; Lund, 1997; Tung, 1989). This approach requires predefined regions and conditions, which depending on the image complexity, can add to the processing time. Clayton (2006) first transformed the picture into binary (black and white), enhanced edges, added sound and then returned to its original color domain.

Braica (2006) notes a way of improving by increasing the image's contrast on the edges. Chen et al. (1997) moved the frequency value international to boost contrast in the approximation coefficients. Nevertheless, they were not an efficient way to decide the scale of the switch. They also developed a zero-circulating tree which consists of zero-circulation in multi-resolution levels for each node to reflect multiple resolutionary edges used to suppress noise.

Fu et al. (2000) studied the spatial domain downside of the HEQ process. Then they suggested a wavelet-based approach for enhancing contrast. In its process, the output image in the spatial domain was transformed into the wavelet domain after performing the HEQ procedure. All approximation coefficients were then squared. They concluded that the new approach could compensate for the information lost during the HEQ process.

A domain filter based on an LLMMSE filter (Kaun et al., 1985) was investigated by Reeves et al. (1997) to eliminate noise and improve edges. We also used global HEQ in order to increase contrast with the wavelet approximation coefficients at the coarsest stage of decomposition. But further work was needed to understand how selection of the range and histogram bin values of the approximation coefficients affects the reconstituted picture.

Xu et al. (1997) combine the finer scales wavelet phase filter into the wavelet domain to minimize noise, and Bruce and Gao (1996) proposed a semi-soft wavelet retrenchment technique at coarse scales in wavelet domains to further reduce noise and improve edges. However, the proposed method still could not adjust its parameters automatically to achieve an optimal result.

There are other attempts at change. For example, Gong et al. (2000) rationally extended coefficients in the wavelet domain on several scales. Xu et al. (2000) altered the amplitude of the wavelet domain coefficients. Peng et al. (2000) used a non-linear enhancement operator on multi-scale coefficients for the wavelet domain. These attempts, however, only sought to improve image contrast and ignored edges.

Different Segmentation Techniques

In order to remove noise from the background, the region of interest is highlighted by separating it from the background. Different techniques of segmentation are listed in this paragraph.

Global Thresholding

Global thresholding is a technology in which a single threshold value is valid in the whole region in a picture which we define as a global threshold for the image processing. Regional thresholds are used when the reference pixel values over the entire picture are fairly consistent. Recently, this type of technique is used to optimize global thresholds, global thresholds based on boundary selection. Carlos et al.[1] suggested the thresholding method. This segmentation approach replaces black pixels with each image pixel, if the image intensity is smaller than a fixed constant U or a white pixel, if the image intensity is greater than a constant U. For the elimination of false positive areas, U is selected with value 0. The items in the picture are named after thresholding. If the image number of objects (N) is zero, i.e. N = 1 The plant is known as a safe leaf and if there is more than a unit number of objects, i.e. N > 1 The sheet is marked as unsafe. The H and V value of the HSV color space for the image are separated during preprocessing for a clear view of the diseased portion. This study is performed on cherry leaves for powdery meldew. The threshold is used by the Otsu adaptive system and some post-processing techniques are used and the leaf disease is removed. This algorithm shows 99% precision.

Watershed Transform

The first step is to define the markers and segmentation criteria, criterion or feature which are used to separate the regions – it is most often contrasted or gradient and the second step takes place with these two elements to establish marker regulated watersheds. Akash Singh et al.[2] suggested a watershed-based photo segmentation. It is an effective technique to assess the region of an image's value. When a landscape is flooded by water with local minimal troughs, catchment tanks fill with water. Water begins filling when the pinnacle of the landscape hits a picture separated into regions or basins fragmented by reservoirs known as riverbed lines. The catchment basins match the image regions and the watershed rim lines follow the edges of an object. Marker approach is used to prevent problems of river transition over-segmentation.[6] Watershed transform is a popular image segmentation technique. Application of the thermal transformation technique in watershed images provides the desired thermal segmented pseudo-coloured image. The heated areas in the thermal images are mapped into a specified color with each of the gray levels of a black and white image. This algorithm is used to better analyze the segmented thermal image. Unless watershed transform is applied directly to thermal pictures without preprocessing, the thermal image results in over-segmentation. Watershed transforms marker-based approach in order to reduce over-segmentation. This algorithm is built on infra-red thermal images of solar panels and heat batteries. Features derived from binary images of solar panel/battery heated portions are obtained by measuring in image pixels in terms of area, perimeter, high axis length and small axis length. The thermal pictures only show heated region in terms of temperature but to learn the thermal object segmentation depth is used. The extracted features, such as area, perimeter, main axis and minor axis, are also measured from a segmented binary image to indicate the severity of the heated part of the element (in terms of pixels). The result is a decrease in the segmented area with 85% precision.

K-means

K-means clustering algorithm is an algorithm that has not been supervised. The field of focus in this approach is scattered from the context. K-Means is a method of partitioning the lowest quadracy that divides object accumulation into K classes. The algorithm is divided into two sections. The first step is to calculate each cluster's mean. The second step involves calculating the distance between each point and each cluster, calculating the distance between the cluster mean and the cluster nearest to each point. In K-means, a member function is used for distance measurement and it lies from 0 to 1 – data object belongs to one cluster or does not belong to the cluster, is priced at 0, and should it belong to the cluster, it is assigned to 1. In the following steps, the data points belonging to the array are transferred to the nearest center so that no point remains unmoved. Yung-Yao et al.[3] suggested a K-means clustering strategy. In this method, the initial image segmentation is carried out in the thermal grayscale frame. A function space is built based on the pixel value in this segmentation process. A K-means algorithm is used to classify all samples in the K clusters function space. The value of K is three to six times the number of groups available. For example, the desired number for two foreground objects and one background is three. After that each pixel is marked with the result K-means in the thermal image. The thermal image is labelled with a cluster index based on temperature data. The K-means cluster algorithm is used to combine the area with the highest similarity to minimize the over-segmentation issue in a thermal image, effectively segmenting the object from the background. The runtime of the K-means algorithm depends on the data volume. The K-means clustering algorithm is 50% effective.

K-Medoids

The absolute difference between the centroid selected is minimized by K-medoids. We are based on centroids (or medoids). The medoids are derived from the components of the cluster. As its name says, Centroid is the most central entity in the cluster, with a minimum amount of distances from other points. A medoid is a cluster unit. Therefore, the average difference between the objects in the cluster is small. The algorithm was firstly designed to measure symbolic K entities known as medoids. That data set object is allocated to the next medoid only if a set of medoids has been identified. K-medoid algorithm has a higher average distribution time than the average distribution time. The advantage of this algorithm is that it needs only the distance between each pair of objects once, so that at each point of iteration it uses this distance. Arti et al.[4] have proposed a K-medoid segmentation approach for the identification of the area of concern to detect leaf disease. In the segmentation of K-medoids images are segmented using K-medoids. Clustering K-medoids is a method of partitioning based clustering. K-medoids also known for PAM (medoid partition). Each cluster in the medoid partition is represented by one of the objects in the cluster. K-medoids reduce noise and contours, since medoid contours or other extreme values are less important than normal. K-medoids works much better than the K-means algorithm. Compared to K-means, K-medoids are not sensitive to noisy data, contours and also to gray scale. For large data, the runtime of the K-medoid algorithm is stronger. This approach is used to detect diseases on the leaf photos or to identify infected areas of the plant diseases. Late sparkle, cotton mold, late sparkle, brown spot, and bacterial-fungal are the diseases encountered. The experimental results show that it helps an effective 60% accurate identification of leaf diseases.

OTSU Threshold

This kind of threshold is a regional threshold. The pixel intensities are stored in an array. It is determined by using the cumulative mean and threshold value. Pixel's threshold value is set at either 0 or 1 i.e. background or foreground. Therefore, the vicissitude of the picture only happens once here. It is used to perform histogram-based image thresholds mechanically or to which the gray image in a binary image. It is taken for granted, that the image to be kept by the algorithm consists of two pixel groups or bi-modal histograms (i.e., foreground and background) and then evaluates the optimum dividing threshold of both classes so that the joint propagation (intra-class variance) is negligible. Salvador et al.[5] advocated Otsu's most common thresholding method [9]. This unattended software segments the picture by minimizing the difference between different groups. Otsu's threshold method iterates all potential threshold values, measuring a scatter calculation of pixel levels on either the front or the rear of each side of the threshold pixels. The main objective is to determine the minimum value by measuring the front and bottom quantities. Otsu's thresholding is used on the basis of the specification criteria with other segmentation techniques.

Kapur Thresholding

Kapur thresholding Professional image segmentation techniques are based on entropy maximization methods[6] and cross entropy miniization methods[7]. Kapur et al.[8], known as Kapur's entropy, are proposing the maximum entropy criterion approach. Kapur et al.[8] implemented the entropy-based method of optimizing entropy in the segmented histogram to ensure a more centralised distribution in each separate field. In the earlier stage, a two-tier approach is introduced in order to identify the thresholds in the histogram to remove the object from the context. Salvador et al.[5] suggests a model based on entropy. The selection criteria for thresholds in this approach is the optimization of the entropies of the Kapur based on the gray histogram. Kapur's original approach is very time-consuming due to inadequate entropy formulation and a detailed multi-level threshold search. The entropy method increases the overall entropy by maximizing the segmentation phase threshold. It is used to seek optimal threshold values that Kapur presents[8]. Each entropy is generally calculated independently based on the specific threshold value. The method is based on the distribution of probability of the histogram and entropy. This approach is used to analyze the FLIR object threshold problem. The Kapur method statistical data applied to selected evolutionary calculation techniques. The evaluation of the effect is a higher value, which indicates a good segmentation, of the mean objective variable. Kapur thresholding is a technique that is seldom used. The entropy procedure is extended to multilevel thresholding

CONCLUSIONS

The various segmentation techniques used for thermal image segmentation are defined in this text. Thermal photography helps to identify the artifact defects. The segmentation approach is used to explain the region of interest of the object. The segmentation methods can be used for the thermographic image in this study. Based on threshold value, gray picture size, the Color picture is different. This work helps to identify the correct thermal image segmentation process. K-means and K-medoids clustering technology – both methods recognize clusters from the picture. K-means drawback is the vulnerability to bright information, where K-medoids are capable of solving this type of problem. In Otsus's threshold techniques, two best threshold methods have been shown by Otsu's method, which works on the theory of inter-class variability and Kapur's method, which works on the entropy principle. In the Otsu method, maximization of between class variances of the gray histogram levels is used for the choice of optimal threshold values, while in the Kapur method maximization of the histogram entropy is used. Yet segmenting techniques are good if the global threshing with Otsu and watershed transformation methods are accurate, and based on their measured precision, could be the most suitable techniques for the segmentation of thermal images.

REFERENCES

1. *Carlos M.Travieso, Jesús B. Alons, Varun Gupta, Namita Sengar, Malay Kishore Dutta, o"Automated Segmentation of Powdery Mildew disease from Cherry Leaves using Image Processing," IEEE, 2017, p. 301, 1982].*
2. *Akash Singh Chaudhary, D.K. Chaturvedi, " Efficient Thermal Image Segmentation for Heat Visualization in Solar Panels and Batteries using Watershed Transform,",MECS press,2017, p.13–14.*
3. *Yung-Yao Chen□, Wei-Sheng Chen, and Hui-Sheng Ni. "Image Segmentation in Thermal Images", IEEE,2016, p.1507–1508.*
4. *Arti N. Rathod, Bhavesh A. Tanawala, Vatsal H. Shah, "Leaf Disease Detection Using Image Processing And Neural Network,"ijaerd,2014,p. 4–5.*
5. *Salvador Hinojosa, Gonzalo Pajares, Erik Cuevasand Noé Ortega-Sanchez" Thermal Image Segmentation Using Evolutionary Computation Techniques",Researchgate, January 2018, p.65–68.*
6. *Mon, K.L., "Automatic Image Segmentation Using Edge and Marker-Controlled Watershed Transformation", Inter. Conference Advances in Engineering and Technology (ICAET'2014), Singapore, pp. 100–104, 2014.*
7. *Akay, B.: A study on particle swarm optimization and artificial bee colony algorithms formultilevel thresholding. Appl. Soft Comput.* ***13****,3066–3091, 2013.*
8. *Kapur, J.N., Sahoo, P.K., Wong, A.K.C.: A new method for gray-level picture thresholding using the entropy of the histogram. Comput. Vis. Gr. Image Process, 1985.*
9. *Otsu, N.: Threshold selection method from gray-level histograms. IEEE Trans. Syst. Man Cybern. SMC-9, 62–6,1979.*
10. *H. G. Jones, S. Rachid, R. Brian. Loveys, et al. Thermal infrared imaging of crop canopies for the remote diagnosis and quantification of plant responses to water stress in the field [J]. Functional Plant Biology, 2009, 36: 987–989.*
11. *Xavier R. R. Sirault, Richard A. James et al. A new screening method for osmotic component of salinity tolerance in cereals using infrared thermography [J]. Functional Plant Biology, 2009, 36, 970–977.*
12. *Qiu Guoyu, Kenji Omasa et al. An infrared-based coefficient to screen plant environmental stress: concept, test and applications [J]. Functional Plant Biology, 2009, 36, 990–997.*
13. *Toshiyuki, Masahiro Yano et al. Canopy temperature on clear and cloudy days can be used to estimate varietal differences in stomatal conductance in rice [J]. Field Crops Research, 2009.*

14. *Li Zhuang, Xu Wenjuan et al. Discuss on Evaluating Method to Drought-resistance of Maize in Seedling Stage [J], Journal of maize Science, 2004, 12(2):73–75.*

15. *Huang Shengmou. Harm by drought and mechanism of drought resistance of plant [J]. Xiangfan: Journal of Anhui Agriculture Science, 2009, 37(22): 10370–10372.*