Journal of Engineering and Applied Sciences 13 (Special Issue 5): 4588-4591, 2018
ISSN: 1816-949X

Optimized Grayscale Conversion in Images for Leaf Disease Detection

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Abstract: Grayscale conversion of images is an important step in all image processing tasks. It is done to minimize the complexity of processing a color image. Moreover, grayscale images preserves the brightness, contrast, edges, shape, texture and structure of color images. Traditional methods use standard NTSC coefficients for color to grayscale conversion. However, previous studies have revealed that the standard NTSC coefficients are not optimal for all types of image classification problems. This study presents a study on color to grayscale image conversion for classifying disease affected regions in a leaf from normal regions. We present an optimization technique using Genetic Algorithm (GA) for color to grayscale image conversion. By using GA, the coefficients for grayscale conversion are optimized to get minimum error in classification.

Key words: Grayscale conversion, Genetic algorithm, leaf disease detection, classification, k-means, clustering, optimized

INTRODUCTION

Grayscale images play an important role in simplifying the image processing task. Conversion of a color image to grayscale involves the conversion form 24 bit RGB values to 8 bit grayscale values. Many grayscale conversion methods exist such as lightness method, average method, weighted average, desaturation, decomposition, etc. The lightness method averages the maximum and minimum of red, green and blue values:

$$I = \left(\mathrm{Max}(R, G, B) + \min(R, G, B)\right)/2 \quad (1)$$

Average method computes grayscale value using the following Eq. 2:

$$I = (R+G+B)/3 \quad (2)$$

Weighted average method uses National Television Standards Committee (NTSC) coefficients for color to grayscale conversion:

$$I = 0.299 * R + 0.587 * G + 0.114 * B \quad (3)$$

Since, green color gives more soothing effect to our eyes, the coefficient of green channel is given higher value. But this contribution may not prove to be good for all kind of classification tasks. Lu and Plataniotis (2009) conducted studies on color to grayscale conversion for face detection and found out a more optimized coefficient that gives higher value to red channel than that of the green channel as in case of NTSC coefficients. Hence, different coefficients have to be selected for different classification tasks.

In this research, we study the RGB to grayscale conversion using weighted average method for leaf disease detection. We attempt to find new color conversion coefficients using Genetic algorithm which are optimal for classifying disease affected regions in the images of a leaves. The proposed algorithm is implemented on images of leaves taken using camera of mobile phones. The proposed approach is useful especially for farmers who could detect disease affected region by taking the photographs of affected leaves using their mobile phones and upload it in some apps that implements the proposed algorithm.

Literature review: Many algorithms were proposed by researchers for the conversion of color image to grayscale. Saravanan (2010) has proposed a method for grayscale conversion that preserves the salient features of image such as contrast, sharpness, shadow and structure. This algorithm performs RGB approximation, reduction and addition of chrominance and luminance to convert RGB image to grayscale. Gunes *et al.* (2016) proposed an approach for grayscale conversion that generates optimized coefficients using Genetic algorithm. The coefficients obtained by their method gave lower classification error when compared with NTSC, equal and

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KL coefficients. The result obtained by them confirmed that the NTSC coefficients were not optimal, since, the output showed an increased value for red component and decreased value for green and blue component. Lu and Plataniotis (2009) presented a study on grayscale conversion of images for face detection. They conducted experiments using two AdaBoost based face detection systems, i.e., EFD gray and open CVFD. They found out that standard NTSC coefficients are not suitable for face detection tasks because in NTSC coefficients green channel is given higher value whereas for face detection the red channel should be given higher value. Jones and Abbott (2004) has proposed conversion of color images to monochromatic form for task oriented approaches like face detection. They have explored three approaches, i.e., Karhunen-Loeve analysis of the color pixel distributions, a least-squared-error line fit in RGB space and a Genetic algorithm. Singh and Misra (2017) has proposed an algorithm that uses Genetic algorithm for segmenting color images to detect leaf diseases. They have chosen every chromosome to be a sequence of cluster centers and the best chromosome survives in each round for further processing. After segmentation, features were computed with the help of color co-occurrence method and the classification is done using SVM classifier. Zhang *et al.* (2015) has proposed a method for detecting plant diseases based on the images of leaves. As the initial step they have converted the RGB image to HSV format and then the green pixels were masked in order to obtain regions having disease spot. Color, shape and texture features were extracted from this region and it is classified using K nearest neighbor classifier. Dhanachandra *et al.* (2015) has proposed an algorithm for segmenting an image using k means clustering algorithm. They have used a method called subtractive clustering for obtaining the initial centroids. The researchers by Al-Bashish *et al.* () had put forward a method that segments the image using k-means clustering and classify the diseases using Artificial Neural Networks (ANN). They were able to identify diseases such as early scorch, cottony mold, late scorch and tiny whiteness with 93% accuracy. Asuntha *et al.* (2016) has proposed a method for detecting lung cancer from CT, MRI scan and ultrasound images. They have used particle swarm optimization for obtaining an appropriate threshold to segment the image. The cancerous cells were detected by using SVM classifier. Samarraie *et al.* (2015) has conducted studies on texture classification using random forest and SVM classifier. They had used bi-orthogonal wavelet transform, gray level histogram and co-occurrence matrices for extracting the texture features and compared the precision rate in classifying images using SVM and random forest. Their analysis had revealed that SVM classifier gave higher precision rate when compared with random forest. A new method for image segmentation called fuzzy Genetic algorithm was proposed by Sesadri and Nagaraju (2016). Kim *et al.* (2015) has presented a comparative study of grayscale conversion methods for distinguishing malaria affected red blood cells from normal ones. They have compared colorimetric conversion, luma coding, conversion using green channel and principal component analysis. The performance of each method were evaluated using histogram intra class variance as the criteria. The result showed that principal component analysis is the best method for grayscale conversion.

MATERIALS AND METHODS

Proposed system: The main objective of this study is to generate optimal color conversion coefficients to accurately identify the disease affected regions in images of leaves. The flowchart of the proposed algorithm is shown in Fig. 1.

As the first step images are acquired using mobile phone cameras. The dataset used for this study includes image acquired using cameras of mobile phones with good resolution. A sample image used for the experiment is shown in Fig. 2.

After obtaining the images we convert the color image into grayscale. The input to the proposed algorithm

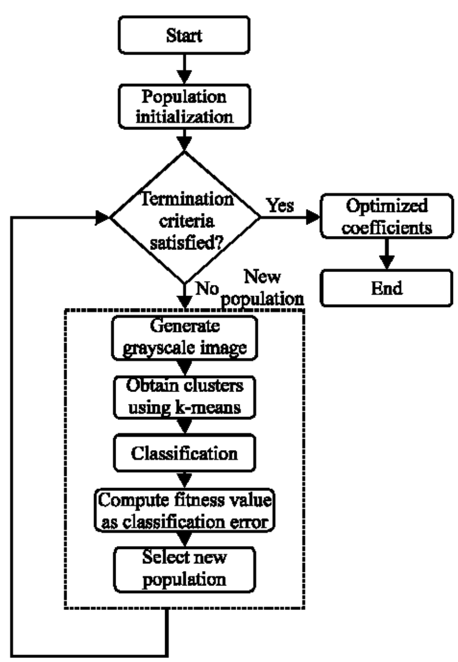

Fig. 1: Flowchart of proposed system

is pixel values. Initially a population of randomly generated chromosomes is constructed. A sample chromosome structure is:

R-11010101G-11111110B-10001010

The next step involve normalization of weights of chromosomes:

$$a = r/(r+g+b), b = g/(r+g+b), c = b/(r+g+b) \quad (4)$$

The normalized weights are used to generate grayscale images:

Fig. 2: RGB image

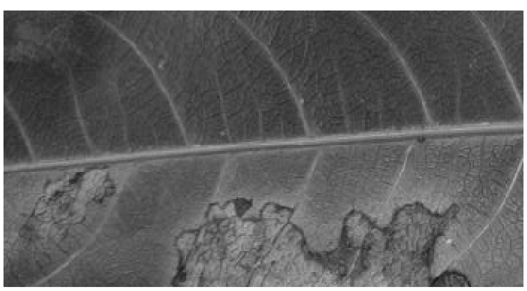

Fig. 3: Grayscale image

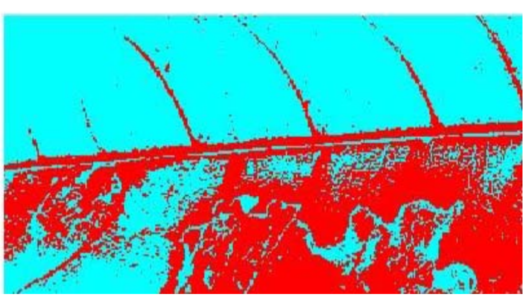

Fig. 4: Clustered image

$$Gray = a*R+b*G+c*B \quad (5)$$

After segmentation the images are clustered using k-means clustering algorithm. k-means is used because it is computationally faster than other clustering algorithms. The resulting clusters are validated by computing connectivity, Dunn index and Silhouette coefficient (Fig. 3 and 4).

The clustered result is used to train the classifiers. We use one linear classifier SVM and an ensemble classifier random forest for detecting the fitness value. Each chromosome is assigned a fitness value that corresponds to classification error. After assigning the fitness value, Roulette wheel selection is used to select chromosomes having minimum fitness value. The selected parent chromosomes undergo crossover to generate new child chromosomes fo the next generation. The newly generated chromosomes are mutated to generate genetically diverse individuals. After mutation individuals for the next generation are selected. This process is continued until the termination criteria is satisfied such as a specified number of generation or when there is no change in the value of output obtained.

RESULTS AND DISCUSSION

The proposed system is implemented on leaf dataset having images taken using mobile camera. The result of k-means clustering is used to train the classifiers. We use a linear classifier support vector machine and an ensemble classifier random forest for classifying the image to obtain the mean classification error. The detected color coefficients are compared with the results obtained with equal coefficients and NTSC coefficients. The optimal coefficients and classification results are shown in Table 1-3.

Table 1: Optimal coefficients and classification results of leaf data set

Classifier	Optimized coefficients	Mean absolute error
SVM	0.4117647, 0.482359, 0.396078430	0.2759
Random forest	0.4917647, 0.5023529, 0.33607843	0.2279

Table 2: Equal coefficients

Classifier	Optimized coefficients	Mean absolute error
SVM	0.33, 0.33, 0.33	0.42
Random forest	0.33, 0.33, 0.33	0.38

Table 3: NTSC standard coefficients

Classifier	Optimized coefficients	Mean absolute error
SVM	0.29; 0.58; 0.11	0.44
Random forest	0.29; 0.58; 0.11	0.32

CONCLUSION

In this study, we proposed an algorithm for optimizing grayscale conversion in images for detecting disease affected regions in leaves. Rather than the traditional coefficients we were able to compute better conversion coefficients using Genetic algorithm. The proposed algorithm is tested on a dataset having images of leaves taken using mobile phones. The experimental result showed that using SVM classification the coefficients obtained are 0.411, 0.482, 0.396 and with random forest the values obtained are 0.491, 0.502 and 0.336.

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