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National Flags Recognition Based on Principal Component Analysis

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ABSTRACT

Recognizing an unknown flag in a scene is challenging due to the diversity of the data and to the complexity of the identification process. And flags are associated with geographical regions, countries and nations. But flag identification of different countries is a challenging and difficult task. Recognition of an unknown flag image in a scene is challenging due to the diversity of the data and to the complexity of the identification process. The aim of the study is to propose a feature extraction based recognition system for Myanmar's national flag. Image features are acquired from the region and state of flags which are identified by using principal component analysis (PCA). PCA is a statistical approach used for reducing the number of features in National flags recognition system.

KEYWORDS: *PCA, texture feature*

1. INTRODUCTION

Flag recognition systems are part of image processing applications and their significance as a research areas are increasing recently. J. Nagi, S. K. Ahmed [2] proposed a new technique for human face recognition that uses an image-based approach towards artificial intelligence by removing redundant data from face images through image compression using the two-dimensional discrete cosine transform (2D-DCT). Feature vectors are constructed by computing DCT coefficients.

A self-organizing map (SOM) using an unsupervised learning techniques used to classify DCT-based feature vectors into groups to identify if the subject in the input image is "present or "not present" in the image database.

Md. Zamilur Rahman and Mohammad Shameemmhossain Kawsar Ahmed [5] proposed an approach based on support vector machine (SVM). This machine is trained with the percentage of different colors in the flag. To train up the SVM have used a package LIBSVM which classify multiple classes and find out an accurate country id (name) as output. The system is designed to detect a flag more accurately and implement a system that is more efficient in this problem domain by reducing the time for flag detection and the visual recognition for man.

K. Sulovská, S. Bělašková, M. Adámek [3] proposed the analytical-statistical method for the face recognition. Although the bases of the face recognition are known by researchers worldwide, the statistical tests of data obtained by measuring chosen anthropometrical points can be found in several articles. Their aim was to show how the data act during the various emotions of one face, which will be helpful for deeper knowledge of how the face behaves. Acquired results reflect the difficulty of describing the face and the applicability of combination of different recognition methods (e.g. methods based on neural networks, recognition of facial contours, distribution of the gray scale in the image, deformation models) to get the best results in the verification/identification of a human.

The aim of this study is to propose flag recognition based on image features extraction with principal component analysis. The proposed system overcomes certain limitation of the existing recognition system. It is based on extracting the texture features of a set of Myanmar's national flags stored in the database and performing mathematical operations on the values corresponding to them. The proposed system is better mainly due to the use of image features rather than the entire flag. Their advantages are in terms of: recognition accuracy and better discriminatory power computational cost because smaller images require less processing to train the PCA. Because of the use of dominant features and hence can be used as an effective means of authentication.

This paper is composed as follows: Methodology of the system is described in section two. In section three, Data Acquisition and in section four includes Result and Discussion. Finally, the paper has been concluded.

2. Methodology

In this section, related methodologies of the proposed system which are discussed with two parts. The first part will explain the texture features in digital image processing. The second part will describe the procedure of principal component analysis for recognizing and detecting of national flags. The block diagram of the proposed flag recognition methods is given in Figure1.

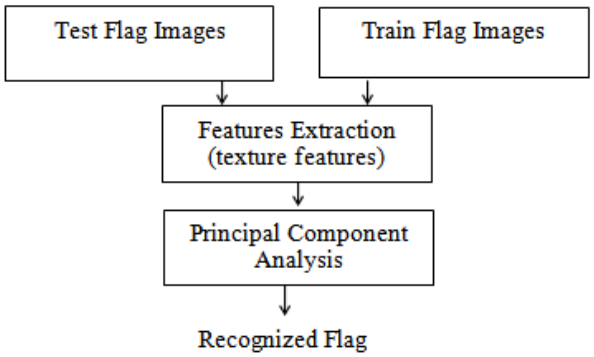

Figure1. Flag Recognition system

The proposed flag recognition system is shown in Figure1, the first step need to extract texture features from the training and testing flag images. In the second step, extracted features from the dataset and testing flag image are recognized by using principal component analysis for dimension reduction.

2.1. Feature Extraction

The feature based methods do not directly work with image intensity values, but use salient features extracted from two images, which has been shown to be more suitable for such situation that intensity changes and complicated geometric deformations are encountered. Texture is a key component of human visual perception. Everyone can recognize texture but, it is more difficult to define. Texture has qualities such as periodicity and scale; it can be described in terms of direction, coarseness, contrast and so on. In this system chose three very different approaches to computing texture features: the first takes a statistical approach in the form of co-occurrence matrices, next the psychological view of Tamura's features and finally signal processing with Gabor wavelets.

2.1.1. Texture feature

Texture is a main component of human visual perception. Everyone can determine texture but it is more difficult to define. Table 1 shows the normalized co-occurrence matrix.

Table1: Features Calculated from the Normalized Co-occurrence Matrix *P(i, j)*.

Texture Features	Formula
Energy	$\sum_i\sum_j P^2(i,j)$
Entropy	$\sum_i\sum_j P(i,j)\log P(i,j)$
Contrast	$\sum_i\sum_j (i-j)^2P(i,j)$
Homogeneity	$\sum_i\sum_j (P(i,j)/1+\|i-j\|$

where P = co-occurrence matrix, μ = mean of the co-occurrence matrix P, σ = standard variation of co-occurrence matrix P.

Co-occurrence matrices

Haralick [1] suggested the use of grey level co-occurrence matrices (GLCM) to extract second order statistics from an image.

Tamura

Tamura et al took the approach of devising texture features that correspond to human visual perception [5]. The first three attained very successful results and are used in our evaluation.

Gabor

One of the most popular signal processing-based approaches for texture feature extraction has been the use of Gabor filters. This system implementation is based on that of Manjunath et al. [3, 6]. Gabor wavelet transform is then defined to be:

$$W_{mn}(x,y)\int I(x,y)\,g^*_{mn}(xx_1-y_1)\,dx_1dy_1 \qquad (1)$$

The mean and standard deviation of the magnitude $|W_{mn}|$ are used to for the feature vector.

Table2: First three Tamura features.

Tamura	Formula
Coarseness	$A_k(x,y)=\sum_{i=x+2^{k-1}}^{x+2^{k-1}-1}\sum_{j=y+2^{k-1}}^{y+2^{k-1}-1}\frac{f(i,j)}{2^{2k}}$
Contrast	$F_{con}=\sigma/(\alpha_4)^n$ where $\alpha_4=\frac{\mu_4}{\sigma^4}$
Directionality	magnitude of the vector, $\|\nabla G\|=\frac{\|\nabla H\|+\|\nabla V\|}{2}$ angle of the vector, $\theta=\tan^{-1}(\frac{\nabla V}{\nabla H})$

2.2. Principal Component Analysis

Principal Components Analysis (PCA) is a dimensionality reduction algorithm that can be used to significantly speed up your unsupervised feature learning algorithm. More importantly, understanding PCA will enable us to later implement **whitening**, which is an important pre-processing step for many algorithms [10]. PCA is mostly used as a tool in exploratory data analysis and for making predictive models. It is often used to visualize genetic distance and relatedness between populations [9].

Standard Principle Component Analysis (PCA) is often useful preprocessing strategy in ICA is to first whiten the observed variables. This transform observed vector x linearly so that obtain a new vector $\tilde{x}$ which is white. Its component are uncorrelated and their variances equal unity.

$$E\{\tilde{x}\tilde{x}^T\}=I \qquad (2)$$

One popular method for whitening is to use the eigenvalue decomposition (EVD) of the covariance matrix $E\{\tilde{x}\tilde{x}^T\}=EDE^T$, where E is orthogonal matrix of eigenvectors of $E\{xx^T\}$ and D is the diagonal matrix of its eigenvalues $D=diag(d_1\ldots..d_n)$. Note that $E\{xx^T\}$ can be estimated in a standard way from the variable sample $x(1)\ldots..x(T)$ whitening can now be done by

$$\tilde{x}=ED^{-1/2}E^TX \qquad (3)$$

For example, rank of D is equal to two for image features, meaning that observed and training features are uncorrelated. On the other hand, if the flag is not recognized, this mixtures are actually the combination of one features only, hence, the rank of D will be reduced to one.

3. Data Acquisition

Flag recognition system is composed of two stages: Data Acquisition and Result and Discussion that consists of two parts: Feature Extraction and Flag Recognition with PCA.

Firstly, an input flag image is required to perform image processing techniques such as resizing, changing resolution and cropping. Table 3 shows the list of different type for flag images. Data are acquired from the 14 National flag of Myanmar. These are represented of Myanmar's 7 states and 7 regions.

Table3. Myanmar's national flags dataset

Division and States	Total images (Resizing, converting resolution, different type of cropping
Kachin State	20
Kayah State	20
Kayin State	20
Chin State	20
Mon State	20
Rakhine State	20
Shan State	20
Yangon Region	20
Mandalay Region	20
Sagaing Region	20
Magway Region	20
Bago Region	20
Ayeyarwaddy Region	20
Tanintharyi Region	20

Table4. Sample Dataset for Ayeyarwaddy Region Flag

Original image	Resizing image	Changing resolution image	Cropping image
			

The input original flag images are cropped, resized about 20 different portions and resizing in the variety range of pixels (1024 x 768 px), (800 x 600 px), (640 x 480 px), (448 x 336 px) and (314 x 235 px) for flag images. In this experiment, MATLAB is used to crop, resize and change resolution of the original image. Table4 and table5 are shown the sample dataset of Ayeyarwaddy Region and Yangon Region flags.

Table5. Sample Dataset for Yangon Region Flag

Original image	Resizing image	Changing resolution image	Cropping image
			

4. Result And Discussion

4.1. Results of Feature Extraction

Extraction of features is made from flag images by using histogram and probability density. If all features in the feature vector were statistically independent, one could simply eliminate the least discriminative features from this vector. Many features depend on each other or on an underlying unknown variable. A single feature could therefore represent a combination of multiple types of information by a single value. Table6 shows sample features for different types of Ayeyarwaddy Division flag.

Table6. Sample features for different types of flag

Flag types	Features
	aye-pdf1 aye-pdf2 aye-pdf3 aye-pdf4 341593 303510 310097 301693 342012 303977 310531 302058 342462 304453 311012 302510 342647 304635 311207 302694 343229 305193 311372 303274
	aye-reso-pdf1 aye-reso-pdf2 aye-reso-pdf3 aye-reso-pdf4 83442 63077 65407 62749 86337 65541 68043 65192 87587 66685 69237 66342 88554 67408 70033 67094 89443 68123 70804 67806
	aye-resize-pdf1 aye-resize-pdf2 aye-resize-pdf3 aye-resize-pdf4 16119 9511 9476 9501 16306 9655 9651 9643 16419 9726 9737 9721 16512 9783 9798 9785 16618 9849 9883 9862
	aye-crop-pdf1 aye-crop-pdf2 aye-crop-pdf3 aye-crop-pdf4 115301 102976 109399 100996 115631 103362 109744 101276 115928 103684 110074 101581 116065 103821 110223 101719 116596 104330 110339 102249

4.2. PCA based flag recognition system

The paper has presented a flag recognition system using PCA in the context of flag verification and flag recognition using photometric normalization for comparison. This system trained above 100 images in many kinds of flag. PCA is very high dimensional nature of many data sets makes direct visualization impossible as we humans can only comprehend three dimensions. The solution is to work with data dimension reduction techniques. When reducing the dimensions of data, it's important not to lose more information than is necessary. The variation in a data set can be seen as representing the information that we would like to keep. Figure 2 shows the testing results of flag recognition system.

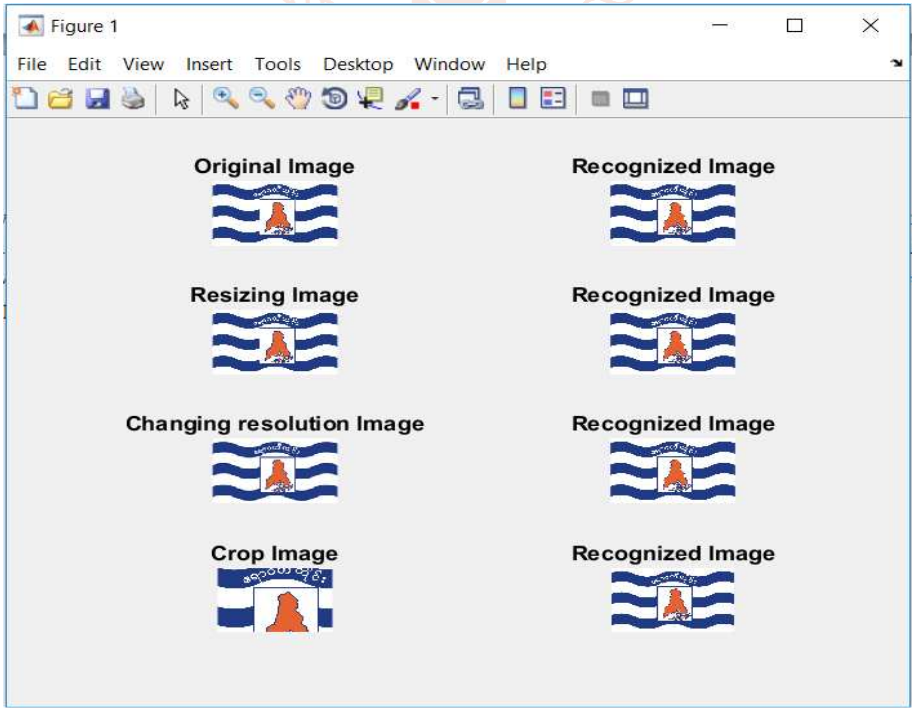

Figure2. Testing results of flag recognition system

Principal Component Analysis (PCA) is a well-established mathematical technique for reducing the dimensionality of data, while keeping as much variation as possible. PCA achieves dimension reduction by creating new, artificial variables called principal components. Each principal component is a linear combination of the observed variables. According to the results, features extraction based flag recognition system can recognize the correct flag image for testing data. In this experiment, receiver operating characteristic (ROC) curve has been used to verify the effectiveness of the proposed method. Figure 3 gives the ROC curves as the flag recognition results. It can be seen that the variation of the performance function for training and testing.

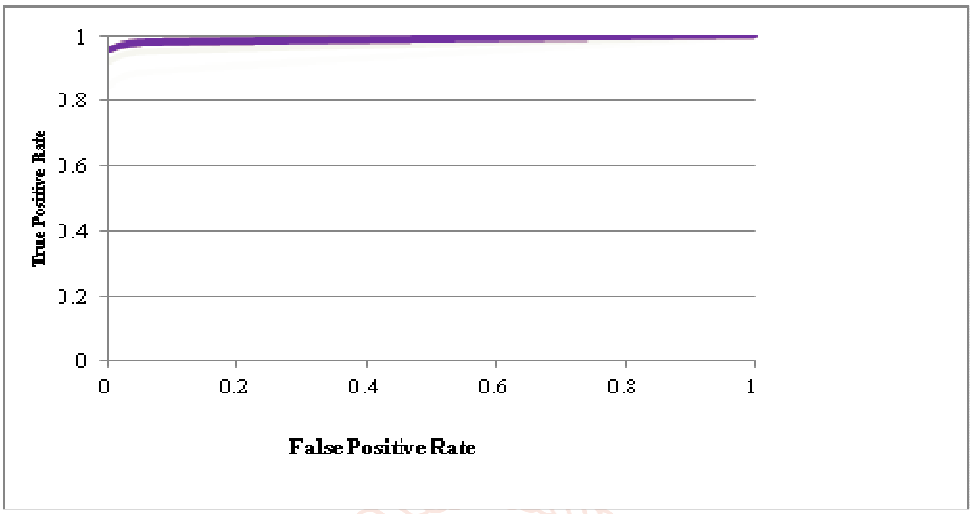

Figure3. ROC curve under different type of flag image

5. Conclusion

National flag recognition system is implemented by using texture features and principal component analysis. The computer system can automatically recognized all national flags of Myanmar via loaded from camera, web cameras or natural scenes. Applying texture based features extraction techniques are combined to use with PCA, which reported better accuracy for flags recognition results. The eigenvector for PCA approach thus provided a practical solution that is well fitted to the problem of flag recognition system. PCA achieves dimension reduction by creating new, artificial variables called principal components. Each principal component is a linear combination of the observed variables. Recognition accuracy of the proposed system from 90 % to 95 % depending on weather the flag is among 14 state and region.

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