Documents Image Classification and Retrieval Based on Logo Recognition

Dr.Mohanad Sameer Jabber

Abstract

Logo plays an important role in document images classification and retrieval. This fact motivates us to propose a novel approach for logo classification depending on color and texture features, Naïve Bayesian (NB) is used for the logo classification purpose. Because of lack of color logo image dataset on the internet, therefore, dataset proposed used for training and testing phases. Besides, this method obtainedexcellent classification accuracy reach to 90.243%.

Keywords: ***Logo image classification, document image, texture feature, color feature, Naïve Bayesian Classifier.***

تصنيف واسترجاع الوثائق الصورية بالاعتماد على تميز الشعار

المستخلص

يعتبر الشعار له دورا هاما في تصنيف الوثائق واسترجاعها. من هذا الواقع يدفعنا إلى اقتراح طريقة جديدة لتصنيف شعار اعتمادا على ميزات اللون والملمس ، ويستخدم السذاجة النظرية الافتراضية مصنف للتصنيف. بسبب عدم وجود قاعده بيانات تحتوي على صور شعار ملونه على شبكة الإنترنت، لذلك، تم اقترح قاعده بيانات لاستخدامها في التدريب واختبار الطريقة المقترحة. وقد حققت هذه الطريقة أفضل دقة تصنيف 90.243٪.

الكلمات المفتاحية: تصنيف صورة الشعار، تصنيف الوثائق واسترجاعها، الوثائق الصورية

1.Introduction

The most important and common graphical elements present in document image collections are logos, which spread on a number of document image categories including memos, letters, and official documents. The logo is a graphic emblem or mark represent of any institution or industry, which represents the functionality of their respective work. Once a logo is designed for any a company or organization [1].

The logos can be classified into three classes: graphical logo consists of some symbols or graphics, text logo contain only text information and mixed comprises graphical and text logos as shown in figure 1.The document image retrieval based on logo image has generated a great interest among the work community of document image processing [2].

Any Companies or organizations deal with large amount of documents in workflows. Incoming mail is received and this mail contains document images. The document images need of manually processing (opening, data typing, sorting, archiving), this processing images represents an important quantity of the cost and money if we consider the everyday amount of incoming images received by large organizations or companies.

As an example, if a company receives a paper image holding and this image contains the logo of a computer supplier, usually that paper image should be addressed to the IT branch, whereas if the logo of a bank, it is quite possible that paper image should be forwarded to the accounting branch [3].With this motivation, in

this paper present a logo image classification method which classifies the logos to the class that it belongs to.

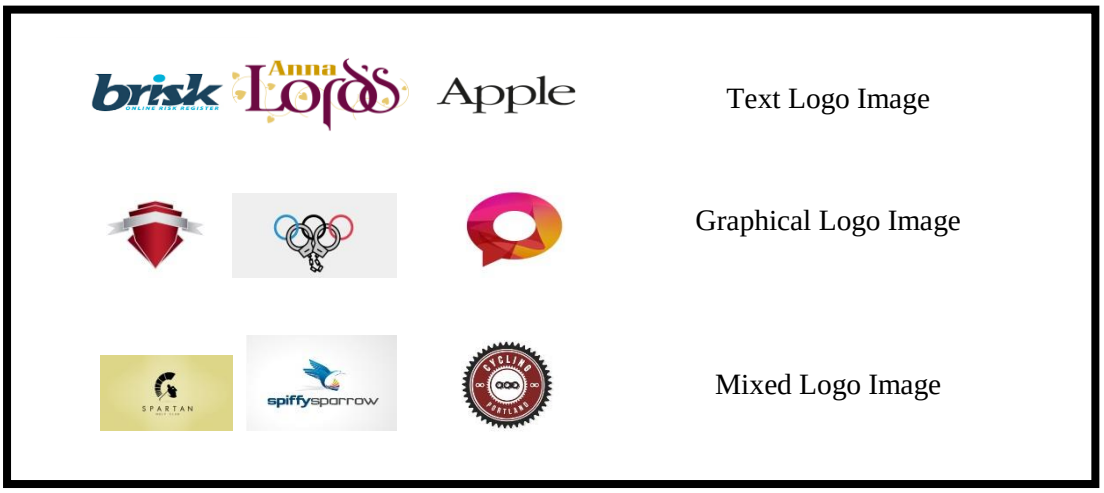

Figure (1), Samples logo images

2. Related Works

Previous research on logo analysis in document images can be categorized into two main classes: logo detection aims to extract feature vectors from the segment parts which are then used to divide the parts depended on whether or not they are likely to hold a logo and logo classification deal with segment parts which have been identified as logos are classified into logo classes that have been previously learned or conclude that it does not belong to any class [4].

Guru, D. S. et al.[1] presents a method for classification of logos images depending on color, texture, and shape features. For classification purpose, the K−means clustering algorithm is used. Eight partition method for color extraction, Steerable Gaussian filter decomposition with four orientations $(0°, -45°, +45°, 90°)$ is used to extract texture features and Zernike

moments shape with two orientations $(0°$ and $90°)$ for shape features. The recognition accuracy was 71.73 %.

Asefnezhad A. et al. [5] proposed a system for extraction and classification logo. This system consists three parts, first part: the detection position of the logo through the pyramidal tree structure, horizontal and vertical analysis, second part, the logo image is extracted by using the boundary extension of feature rectangles and third part the KNN classification was used for the classification of the logo. The experimental results have shown Accuracy rate 85%.

David Doermann et al. [6]present a research for logo retrieval in document images based on the SURF feature for logo retrieval. A novel indexing algorithm for efficient retrieval and the orientation of local features and geometric constraints are used to filter results. Experimental results showed that the logo retrieval can be performed with high accuracy and efficiently with a large datasets.

3.Preprocessing

The preprocessing operations are used to perform initial processing to improve the accuracy of feature extraction algorithm and classification. In this paper, two methods ofpreprocessing tasks are used: image resizing aims to resize all the logo images to keep the uniformity in the dimensions of the logo images and grey scale conversion aims convert the color logo images (RGB) into grey scale images [7].

4.Lab Color Model [8]

The Lab color model can control intensity and color information more simply and independently than RGB color model. The Lab color model is especially best efficient in the measurement of small color changes as it allows direct color comparison based on geometric separation within the color model.

The color image (RGB) is converted into Lab color model to extract color features, to do this, the RGB color model should be converted into the tri stimulus XYZ color model form the primaries in this color model. This tri stimulus can be obtained by a linear transformation from the corresponding RGB coordinates. The transformation matrix can be given as:

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} 0.607 & 0.174 & 0.200 \\ 0.200 & 0.587 & 0.114 \\ 0.000 & 0.066 & 1.116 \end{pmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix} (1)$$

The Lab color model has three channels where L is the Lightness channel a, and b are two color channels. Once the X, Y, Z tri stimulus coordinates are known, conversion to the Lab color model can be achieved using the following nonlinear transformation:

$$L = 116 \sqrt[3]{\frac{Y}{Y_0}} - 16 \quad (2)$$

$$a = 500 \left[\sqrt[3]{\frac{X}{X_0}} - \sqrt[3]{\frac{Y}{Y_0}} \right] \quad (3)$$

$$b = 500\left[\sqrt[3]{\frac{Y}{Y_0}} - \sqrt[3]{\frac{Z}{Z_0}}\right] \quad (4)$$

5.Texture Feature Extraction Using GLRLM[9]

Texture is one of the most important features of an image and can be used to characterize the local spatial variations in image. Texture analysis method can be divided into four groups: Statistical method is based on the concept of characterize the image using numerical analysis of pixel intensity values, model method based on a mathematical model to predicting pixel values, transform method is based on the concept of some kind of modification to the image and then analyse to extract texture features and structural method aims seek to understand the hierarchal structure of the image.

Gary–Level Run–Length Method (GLRLM) is one of statistical method. GLRLM is described texture depending on relationships between the grey scale of the image with particular direction from the reference pixels [12].The GRLM is a matrix of the number of adjacent pixels that have the same grey intensity in a particular direction and from matrix can be extracted the texture features for texture analysis. The GRLM has 4 directions of run (0°, 45°, 90°, 135°). Table 1 shows example how computed GRLM matrix from the sub image with 4 grey scale. Table 2 shows that the run length matrix in the direction of0°.Seven features (LGLRE, HGLRE, GLN, RP, SRE, RLN and LRE) can be extracted from the GLRLM matrix [12].In addition to 0° direction can be calculated in all four directions. The features are extracted from matrix used grey scale of pixel in sequence.

Table (1), Matrix of Image

1	2	3	4
1	3	4	4
3	2	2	2
4	1	4	1

Table (2), GLRLM of Image

Gray Levels	Run Length(j)			
	1	2	3	4
1	4	0	0	0
2	1	0	1	0
3	3	0	0	0
4	3	1	0	0

6.Naïve Bayesian Classifier [10]

Naïve Bayesian (NB) is used in identification process. Naïve Bayesian (NB) is a classification technique built on Bayes' Theorem with independence assumption among predictors. The NB classifiers is easy to build and particularly useful for very large datasets. In simple terms, the NB can be very fast compared to more sophisticated methods because based on the decoupling of the class conditional feature means that each feature vector can be separately estimated as a one dimensional distribution. This in turn helps to relieve problems stemming from the curse of dimensionality. The NB classifier represents a statistical method for classification as well as a supervised learning

method.By Bayes theorem, $P\ (C_i|X)$can be computed using the following formula:

$$p(C_i|x) = \frac{p(x|ci)p(ci)}{p(x)} (5)$$

Where,

- $P(c|x)\ is$ |x) the posterior probability of target (class).
- $P(c)\ is$ (c) the prior probability of class.
- $P(x|c)\ is$ |c) the likelihood which is the probability of predictor given class.
- $P(x)\ is$ (x) the prior probability of predictor.

7.The Proposed Method of Logo Classification

The proposed method is based on training classifier and then classifying a color logo image into class that it belongs to. Therefore, the proposed method consists of two phases: training and testing phases. The three stages of these phases are preprocessing, feature extraction and classification will be explained in the following subsections.

A. Preprocessing of Proposed Method

Preprocessing stage is an essential stage in the logo image classification because the effectiveness of this process on the classification rate. Several steps have been taken place in this stage that makes the proposed method achieve a best accuracy. The input to proposed method is a color logo image. First step is image resized, after testing several sizes (64x64, 128x128 and 256x256) the 128x128 size gave best classification rate. Hence, all the dataset logo images normalize into size 128x128 and then

converted to gray scale image and this conversion used to extract the texture features. This stage is used in training and testing phased.

B.Features Extraction

The most important stage in proposed method is the feature extraction. The high accuracy classification depends on effective feature extractions methods. A color and texture features has been proposed for classification purpose.

For color features extraction, color logo image (RGB) is converted into Lab color model. The Lab has three channels, a and b channels are divided into four parts each part extracted statistical measures (mean and standard deviation).While L channel ignore since the L channel gives lightness information may be change for same image.

For texture features extraction, after convert the color image into gray scale, two dimensional GLRLM for each gray scale logo image were calculated in directions($0°$, $45°$) and their seven features, namely, LGLRE, HGLRE,GLN, RP, SRE, RLN and LRE features obtained. Also, this stage is used in training and testing phases.

C. Logo Classification using Naïve Bayesian Classifier

In this paper, the Naïve Bayesian Classifier is used for the classification purpose. In training phase, a feature vectors (color, texture) is passed to train Naïve Bayesian Classifier, one sample is taken for each logo image.

While in testing phase, the feature vectors of a test image is passed Naïve Bayesian Classifier to determine the class label that is belongs to. Thus a test image is classified as a label number

of class belongs to. The same step is followed in classifying all the residual images

8. The Proposed Logo Classification Design and Implementation

In this section, the proposed method for logo classification approach is represented as two main sub-sections; the first sub-section presents the block diagram of the proposed system design, while the second one describes the implementation of the proposed approach as a formal steps algorithm.

8.1. The Proposed Logo Classification System Design

The block diagram in figure (2), describes the proposed system design which includes several steps as follow:

1. Input color logo image to the proposed system.
2. Pre-processing, in this step there are two sub-steps including: image resizing to $128*128$ and converting the logo image to gray scale.
3. Feature Extraction, a proposed feature extraction method is used as color and texture vector that is extracted through converting the color logo image (RGB) into Lab color model, while the texture feature is manipulating after converting the logo image to gray scale.
4. Classification, by using naive Bayesian classifier to classify the logo image in both training and testing phases.

Figure (2), describes the proposed system design that represents the training phase and testing phase.

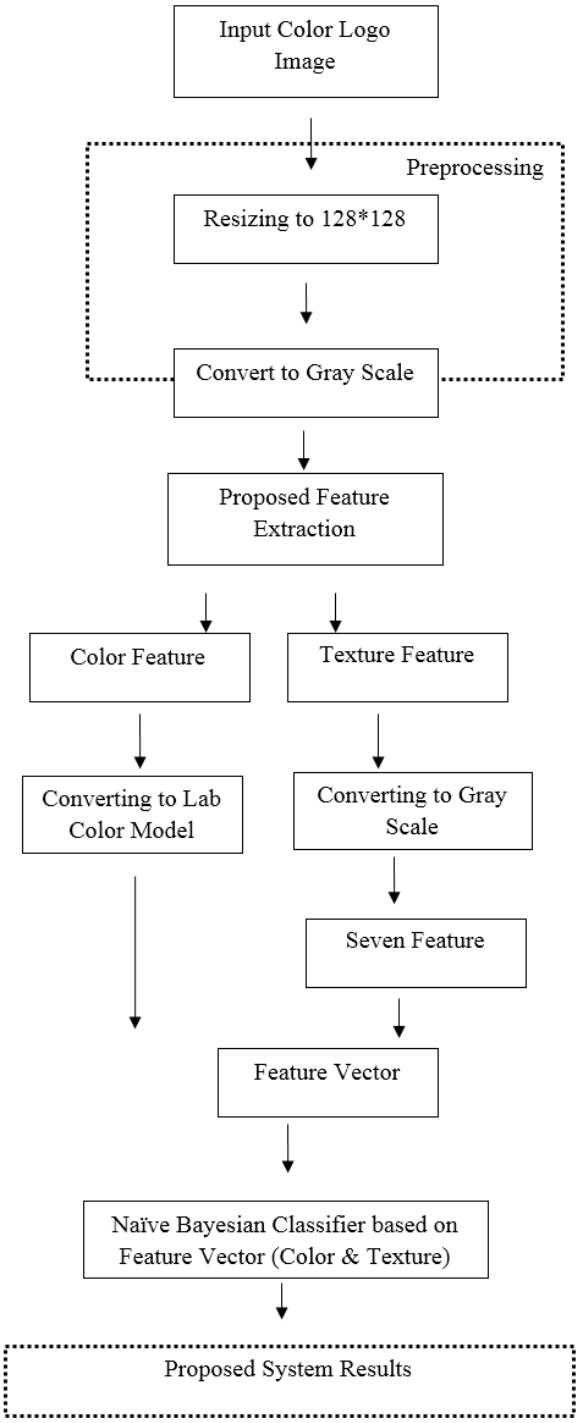

Figure (2), the proposed Logo classification System Block Diagram

8.2. The Proposed Logo Classification System Implementation

In this sub-section, the implementation of the proposed system of logo classification is representing as formal steps algorithm which describes the system flow to decide the aim of the proposed system as a logo classifier to check each input logo image for each class that it belongs to.

Algorithm: Proposed Method for Logo Classification.

Input: the color logo image N*M.
Output: the class number of the logo image that it belongs to.
Begin
Step 1: Read the color logo image N*M.
Step 2: Resize of the color logo image into 128*128.
Step 3:Construct the feature vector as a set of the color and texture Features.
Step 3.1. For the Color feature
A- the logo image (RGB) is converted into XYZ color model by applied equation 1.
B- the logo image (XYZ) is converted into Lab color model by applied equation 2, 3 and 4.
C- a and b channels are divided into four parts and each part Extracted statistical measures.
Step 3.2. For the Texture feature
A- The logo image (RGB) is converted into grey scale image.
B- Grey-Level Run-Length Method (GLRLM)is computedof the number of adjacent pixels that have the same grey intensity in the direction(0°,45°).
C- Extract seven features from GLRLM matrix and their seven Features are LGLRE, HGLRE, GLN, RP, SRE, RLN and LRE features.
Step 4:Classify feature vector of the logo image using learned Naïve Bayesian Classifier.
End

9. Experimentation Results and Discussions

In this paper, the dataset is proposed consists of 173 color logo images. One sample to each color logo image is used to train classifier, in this paper, 50 color logo images are passed to train Naïve Bayesian Classifier. Other color logo images are used to test the proposed system.Besides, these other image has many images with noise and different light condition.

9.1. Proposed Method Results

Various work for logo classification are depicted that has been mentioned in related work In order to compare it with the proposed methods. In literatures are almost depending on detection and recognition logo in binary document image. The number of work for color logo image classification is quite limited for comparing. But, Guru, D. S. et al. proposed method for classification color logo image.

In Table3 it noted the proposed system is obtained the highest accuracy this is due to the use of efficient color and texture features and also Naïve Bayesian Classifier. The proposed method obtains best accuracy compared with [1, 5, 6] systems.

Table (3), Comparison results

Methods	Accuracy
Guru, D. S. et al.[1]	71.73 %
Asefnezhad A. et al. [5]	85%
David Doermann et al. [6]	high accuracy
The Proposed method	90.243%

10. Conclusions

In this a work, a proposed method is a best accurate for retrieval document image based on logo classification. This method use 50 color logo images of the dataset for training and 123 color logo images for testing. The proposed method is gave best accuracy with Naïve Bayesian Classifier. The best accuracy achieved by several factors starting from the efficient preprocessing stage with the use of Lab color model and efficient GLRLM features and finally with more accurate Naïve Bayesian classification. Experiments, the proposed method obtained high classification accuracy than the existing systems.

In addition, we are planning to apply proposed method in future for classification or retrieval documents based on logo image and it need efficient segmentation method that can segment logo part without losing of any pixel of logo image. Support Vector Machine (SVM) classifier can be used for the segmentation and classification which may improve our results.

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