Fingerprint Image Retrieval Based on SURF and MSER Feature

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Abstract. Fingerprint is one of the most well-known identical for human identification in the real world. Many biometric systems use image processing methods to be the automatic system for real world applications. In this paper, we proposed model based SURF feature for representing and describing the textural information presented in fingerprint images in a compact way. For that purpose, the feature vector used to characterize the fingerprints is obtained by modeling the SURF (Speed-Up Robust Feature) of the image. This feature vectors is used both to retrieve the similar fingerprints, given a query image, and their indexation is used to reduce the search spaces of candidate images. From our experiments we can conclude that the best retrieval accuracy was achieved by modeling the SURF and MSER feature.

Keywords: CBIR, Feature extraction, SURF, MSER.

1 Introduction

Nowadays, the content based image retrieval (CBIR) is common technique used for image retrieval. In any feature based image retrieval method, the extracted features and feature vectors are the essential keys for image retrieval. SIFT and SURF has extremely improved the quality of content-based image retrieval (CBIR) application. The popularity of fingerprint image retrieval have led to the creation of large-scale databases. While the large size of these collections compromise the retrieval speed, the noise and the misrepresentation that can be found in fingerprint images may reduce the overall retrieval accuracy. Therefore, both retrieval accuracy and speed play an important role in the fingerprint retrieval process.

In this paper, we used SURF, MSER for key-points extraction and description which aims to identify the key-points that are important for the image retrieval system. The proposed solution should be very effective in the content based image retrieval.

2. Content Based Image Retrieval

In CBIR, images are indexed by their visual content of texture. There are three fundamental bases for content based image retrieval, i.e. visual feature extraction, multidimensional indexing, and retrieval system design. The CBIR mainly consists of two steps. One is the feature extraction and another one is the similarity matching. The difference between the user's information need and the image representation is using SURF and MSER features extraction methods. The proposed system has the following structure.

1) Collection of Database: A database must contain number of images with any one of the formats .bmp, .jpg, .tiff are required.

2) Query: The user inputs a sample image as the query for the system.

3) Feature Extraction: the SURF feature is extracted from fingerprint image. The extracted SURF feature is modeled by kth moment methods. the MSER feature is extracted form fingerprint image. The extracted MSER feature is modeled by kth moment methods. The calculated kth moments of both features are horizontally concatenated to form proposed feature.

4) Discriminant analysis: It is a classification method. It assumes that different classes generate data based on different Gaussian distributions. Linear discriminant analysis is also known as the Fisher discriminant, named after its inventor.

- To create a classifier, the fitting function estimates the parameters of a Gaussian distribution for each class.
- To predict the classes of new data, the trained classifier finds the class with the smallest misclassification cost.

5) Image Retrieval: The System retrieves and presents a sequence of images ranked in decreasing order of similarity or with the minimum distances is returned to the user.

To evaluate the effectiveness of the proposed system precision and recall rates are to be calculated [2][4][5].

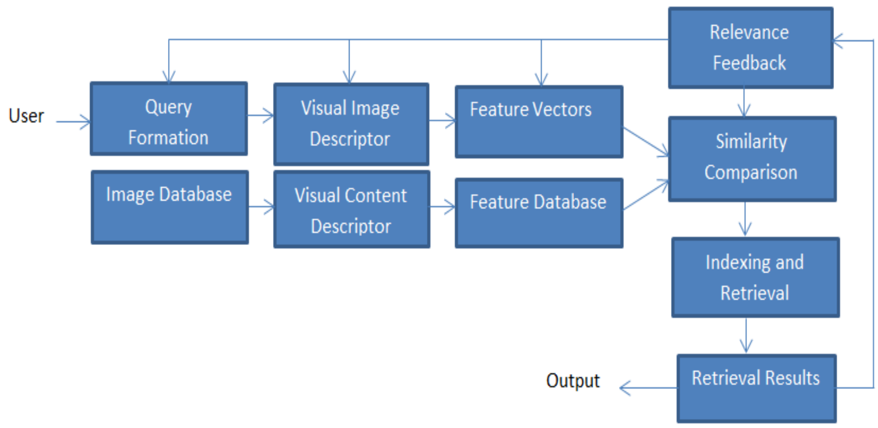

Fig.1. Diagram for Content Based Image Retrieval System

2.1 Proposed Feature Extraction

Feature Extraction is the basis of content based Image retrieval (CBIR). Feature may include both text based feature and visual based features. It is related to dimensionality reduction. The abstracted features are used to retrieve the image from query image. When the user enters the input image to the system, the extraction method makes measurements and transform into reduced set of features. The selected features are expected to contain the relevant information from the input images, so that the user preference work can performs by using feature extraction methods. The former includes color, texture, and shape feature while the latter is application dependent and may include for example human faces, finger prints etc. It is an important step in Image Retrieval or Image Processing [6],[7].

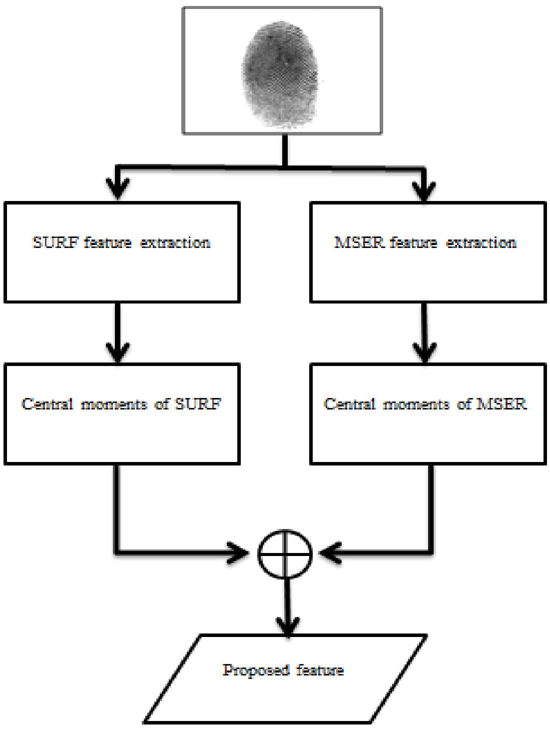

Fig.2. Proposed Feature Extraction for Fingerprint Image Retrieval System

2.2 SURF (Speeded-Up Robust Feature) Feature Extraction

SURF is fast and robust interest points detector/descriptor which is used in many computer image applications, such as object recognition, image registration, classification or 3D reconstruction. It is partly inspired by SIFT method. It is a scale and rotation invariant interest point detector and descriptor which computationally is very fast. To identify interest points, SURF uses an integer approximation of the contributing factor of Hessian blob detector, which can be computed with 3 integer operations using a precompiled integral image. Its feature descriptor is based on the sum of the Haar_wavelet response around the point of interest. SURF algorithm is implemented in three divisions as Interest point detection, local neighbourhood description and matching. These can also be computed with the aid of the integral image. A SURF feature based image retrieval system was built and found to be workable, though with a low success rate using annotations as a truth based feature. SURF used in this approach to extract relevant features and descriptors from fingerprint images [1],[10].

2.3 MSER Feature Extraction

Maximally stable extremal regions (MSER) are used as a method of blob detection in images. The detector selects the salient regions among the extremal regions of an image I, defined by the extremal property of the image intensity function f on the region outer boundary. Among these region's, minimal (resp. maximal) extremal regions are such connected regions R of the image that all the elements on the outer boundary have strictly greater (resp. smaller) intensity than all the adjacent region elements. It is based on a different computational ordering of the pixels, which is suggested by another immersion analogy than the one corresponding to the standard connected-component algorithm.
With the new computational ordering, the pixels considered or visited at any point during computation consist of a single connected component of pixels in the image, resembling a flood-fill that adapts to the grey-level landscape [3].
For example, a binarized region Q(t) (where t indicates its threshold level) is considered MSER if the growth rate function q(t) defined by the derivative of the region area over the threshold values:

$$q(t) = \frac{\frac{d}{dt}||Q(t)||}{||Q(t)||} \tag{1}$$

reaches a local minimum (||.||_ indicates the region area).
In practice, Eq. 1 is substituted by one of its discrete approximations:

$$\bar{q}(tj) = \frac{||Q(tj) - Q(tj-1)||}{||Q(tj)||} \ (or) q(tj) = \frac{||Q(tj+1) - Q(tj-1)||}{||Q(tj)||} \quad (2)$$

where the difference tj −tj−1 defines the threshold increment Δt. The above formulas apply to both dark and brigth MSERs (for the latter, images should be inverted). A number of other parameters is used to control stability of MSER detection and to reduce the nesting effects (e.g. caused by blurs)[8].

3. Performance Evaluation

To evaluate the performance of our proposed image retrieval system, we determined the relevant images retrieved in response to a query image. Precision and recall are used to determine the performance of the proposed system. Precision is used to determine the number of relevant images returned to the query image and it shows the specificity of the image retrieval system [9].

$$Precision = \frac{Number\ of\ relevant\ images\ retrieval}{Total\ number\ of\ images\ retrieved} \quad (3)$$

Recall is used to measure the sensitivity of the image retrieval system. Recall is calculated by the ratio of correct images retrieved to the total number of images of that class in the dataset.

$$Recall = \frac{Number\ of\ relevant\ images\ retrieved}{Total\ number\ of\ relevant\ images} \quad (4)$$

1. System Design And Implementation

In this system, the user can enter the fingerprint image from the image to the system. When the query image is entered SURF and MSER extract features, classify and detect white space among the extremely regions of an image. After that, it retrieves the relevant images from the database that the user wants. At that time, the system can evaluate the performance of proposed image retrieval system. The system has evaluated 97% of accuracy for fingerprint image retrieval.

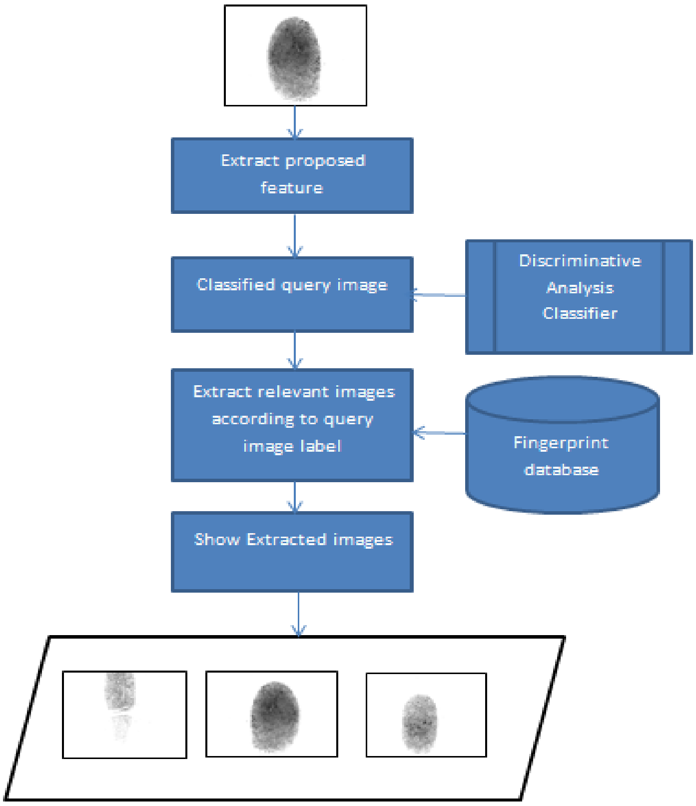

Fig.7. System Design for Fingerprint Image Retrieval System

2. Experimental Results

In this section, the experimental results of the proposed method are presented. This system is used to simulate and evaluate over MATLAB, which is a high-level language and interactive environment for image processing, visualization, and programming. By using MATLAB, we can extract features, analyze data, develop algorithms, and create models and applications.

Our experiments were conducted independently on database, the Bologna FVC-2004 databases, as DB1. DB1 contains 8 fingerprint samples of 10 different fingers. Thus, this data set has 80 fingerprints. By considering that this data set was collected through different fingerprint technologies, in order to cover the advances in fingerprint sensing techniques, the size of the fingerprint images, as well as the resolution, varies among them. This database was not acquired in real environments and, according to a formal protocol, the data are characterized by the presence of distortions (rotations, translations, low quality images) within fingerprints of the same individual's

finger. All these aspects make this dataset very useful for testing our system in extreme conditions.
A simulated query is one of the 80 images in the data set. Thus, a total number of 80 different fingerprint queries were performed. The label of each query is defined by Discriminative analysis. The relevant retrieved images for each query are defined as the remaining fingerprints from the same individual, and the distances between the images are stored in increasing order of same class labels. The 10 class labels in DB1 are 101,102,103,104,…,110.

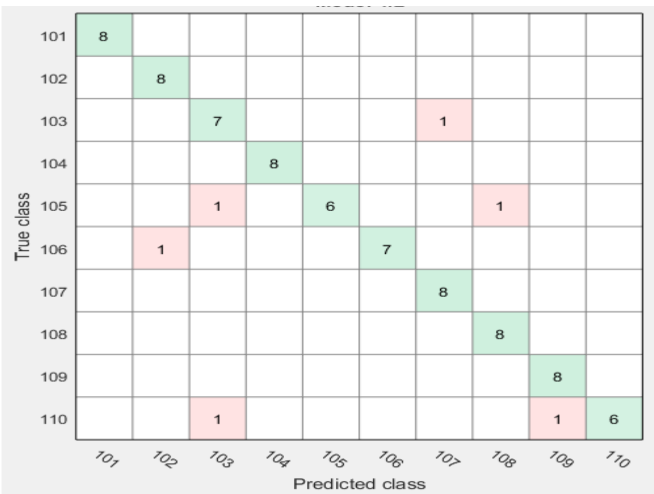

Fig.3. Confusion Matrix for each query of 80 images

Fig.4. Confusion matrix for each query with True positive rate and false negative rate

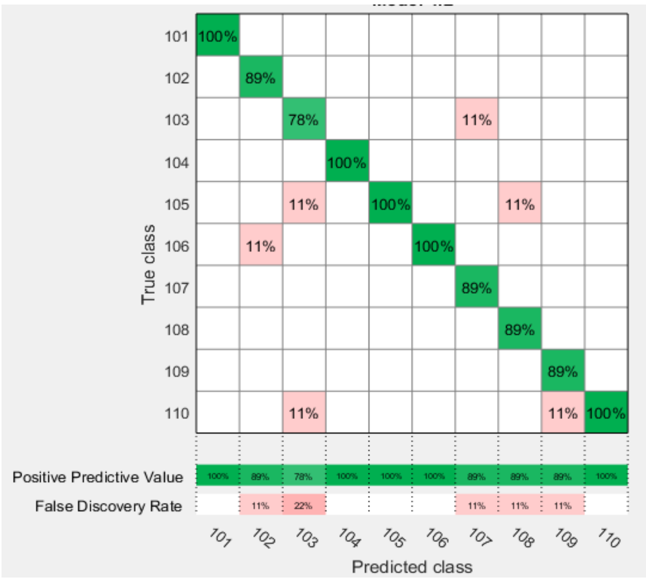

Fig.5. Confusion matrix for each query with positive predictive value and false discovery rate

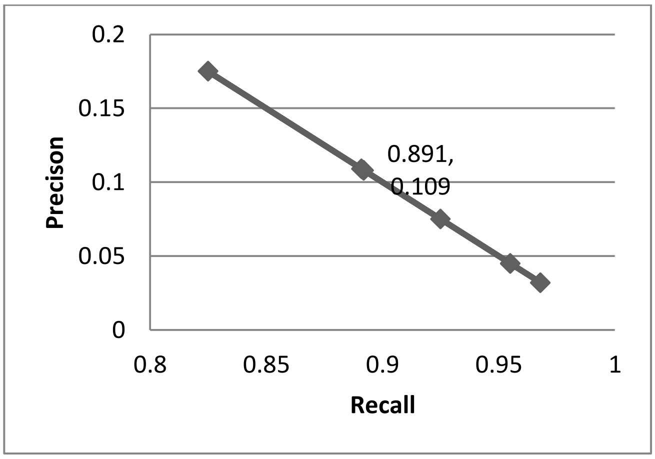

Fig.6. Precision and recall for 80 query images

3. Conclusion

We presented fingerprint image retrieval system by using SURF and MSER features. This method is used to extract the most similar images with different view point and different transformations. It is fast in performance scale and rotation in variant interest point detector and descriptor. By using the integral images, the speed is high. A query image can be retrieved efficiently from a large database. CBIR technology has been used in several applications such as fingerprint identification, biodiversity information systems, digital libraries, crime prevention, medicine, historical research. It has been verified that other important characteristics, namely the average numbers of features in images and repeatability of features, are practically the same for MSERs. Our experiment shows that the proposed feature overcomes the complicity of image retrieval system.

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