

Content Based Image Retrieval (CBIR) of Face Sketch Images Using WHT Transform Domain

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Abstract. Content based face sketch retrieval can be used to find images of criminals from their sketches "Crime Prevention". This paper investigates the problem of CBIR of face sketch images in transform domain. Face sketch images that are similar to the query image are retrieved from the face sketch database. Features of the face sketch image are extracted in the WHT spectrum domain. For the performance analyses of features selection methods the "Indian face database" is used. The City block distance measure is used to evaluate the performance of the retrieval process. The investigation concludes that, the retrieval rate is database dependent. But in general, the DWT is the best. On the other hand, the WHT is the best with respect to the speed of retrieving images.

Keywords: Face sketch image retrieval, Content Based Image Retrieval (CBIR), Image retrieval in WHT transform domain, Features selection for CBIR

1. Introduction

Face image retrieval is a process for finding a predefined number of images in a database that are similar to the query face image. Face image retrieval techniques can be used in applications such as *Crime prevention*, *Security Check*, etc. [1].

There are many ways of specifying what kind of images a user wishes to retrieve from the images database. *Category browsing*, *query by concept*, *query by sketch*, and *query by example* are commonly used query formations [1]. The first two types of queries (text based) are related to the semantic description of images. The other two types of queries (content based) are to provide an example image or draw a sketch from which images with similar visual features will be extracted from the database.

In query by example the system converts the example image provided by the user into an internal representation of features. And then images, with similar features, stored in the database are searched. Query by example can be further classified into query by external image example, if the query image is not in the database, and query by internal image example, if otherwise. In query by sketch the user draws a sketch of an image with a graphic editing tool, or free hand drawing, and then scanned. In most cases, a coarse sketch is sufficient, as the query can be refined based on retrieval results. Figure1 shows an example face image and face sketch that can be used as query images.



Face image



Face sketch image

Figure1: Query face images.

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Content Based Image Retrieval (CBIR) methods can be assigned to one of two major approaches, spatial or transform domain techniques. Spatial domain techniques are mostly based on color, shape, or texture features that are extracted directly from images [2]. Transform domain methods utilize global information from images to perform image retrieval. The global information of an image is fundamentally represented by a small number of features derived from the spectrum of the image after transforming it from the special domain to the transform domain, using transforms such as Discrete Cosine Transform (DCT) [3,4], Discrete Wavelet Transform (DWT) [5,6], Contourlet Transform (CT) [7], and Walsh Hadamard Transform (WHT) [8]. Different sizes of the feature vectors are analyzed, using City block distance measure.

This research is intended to develop an approach for face sketch image retrieval in WHT transform domain. The proposal idea comes from the problem of searching for digital face images in a large face database. The content based face image retrieval system is illustrated next.

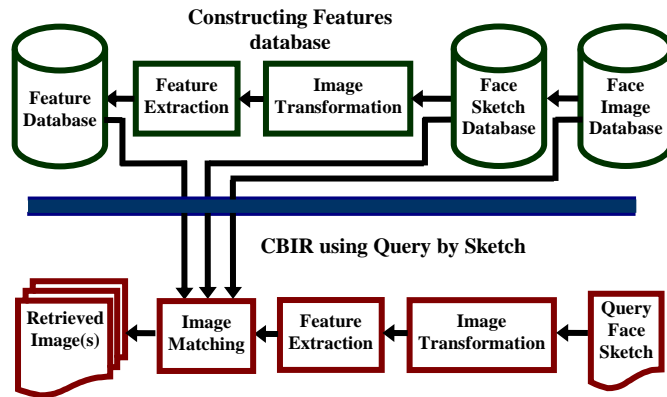


Figure 2. Illustration of CBIR using Query by Sketch

2. Content Based Image Retrieval

The two main steps of Content Based Image Retrieval are 1) Extracting image features to a distinguishable extent. 2) Matching these features to yield a result that is visually similar.

2.1. Constructing the Feature Vector using WHT

To investigate face image retrieval, different features selection methods are utilized using WHT. The system of Walsh functions is the basis for Walsh transform. Walsh functions are orthogonal and have only +1 and -1 values [9]. In general, the Walsh transform can be generated by the Hadamard matrix as follows:

$$H_{2^k} = \begin{cases} \begin{bmatrix} H_{2^{k-1}} & H_{2^{k-1}} \\ H_{2^{k-1}} & -H_{2^{k-1}} \end{bmatrix} & \text{for } k=1,2,3,\dots \\ H_1=1 & \text{for } k=0 \end{cases} \quad (1)$$

By repeatedly applying the definition given above the 8×8 natural order Hadamard matrix is shown next.

$$H_8 = \begin{matrix} & & & & & & & & \text{matrix} & & \text{row} \\ \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 & 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 & 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 & 1 & -1 & -1 & 1 \\ 1 & 1 & 1 & 1 & -1 & -1 & -1 & -1 \\ 1 & -1 & 1 & -1 & -1 & 1 & -1 & 1 \\ 1 & 1 & -1 & -1 & -1 & -1 & 1 & 1 \\ 1 & -1 & -1 & 1 & -1 & 1 & 1 & -1 \end{bmatrix} & & \end{matrix}$$

The WHT was also used for face and signature recognition [9], because the output array of WHT coefficients contains integer values only, as a result Hadamard transform is a very fast transform, it can be implemented in $O(N \log_2 N)$ additions and subtractions.

The sequency ordered Hadamard matrix is constructed by changing the row ordering of the above matrix, based on the number of sign changes in each row. The natural ordering is transformed into sequency order by

In this section the constructed face sketch database is used to demonstrate the performance of the CBIR system. Results of selecting the features vector (vector of coefficients) in WHT domain are recorded and then analyzed. Coefficients are taken from first row, column, and diagonal of WHT spectrum.

The percentage of retrieving the same number of face sketches from each class is calculated. Such as, every sketch in a class of N face sketches is considered as query and the algorithm retrieves N images that have the smallest distance between their features vectors and the features vector for the query sketch.

3.1. Images Database

For the performance analyses of the features selection methods the "Indian face Database" [10] is used. This Face Database contains 440 face images of 40 people. The original images of this database are color images of size 640x480 pixels. Images of this database are cropped to obtain face images and then converted to gray scale, as illustrated in Figure 4. The sketches for all face images of the selected database are constructed, and resized to 64 x 64 pixels. Samples from these face database, together with their sketches, are shown in Figure 5.



Figure4: An example of original, cropped, Gray scale image.



Figure5: Sample of face images and their sketches.

3.2. CBIR using Indian faces database

The results in Table1 and Figure6 show that the retrieval rate is 36.94 % when the features vector is constructed using the first 16 features from each of the first row, column, and the diagonal of the spectrum.

Table 3: Percentage of Correctly retrieved images

| No. of Features | | | Correctly retrieved images |
|-----------------|-----|-----|----------------------------|
| row | col | dia | |
| 8 | 8 | 8 | 36.61 % |
| 16 | 16 | 16 | 36.94 % |
| 24 | 24 | 24 | 34.92 % |
| 32 | 32 | 32 | 33.53 % |
| 48 | 48 | 48 | 32.14 % |
| 64 | 64 | 64 | 30.97 % |

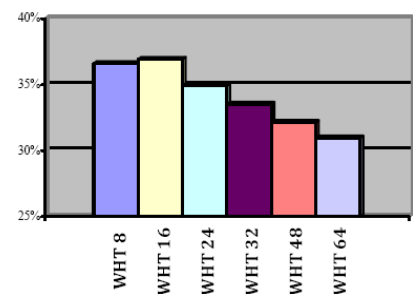


Figure6. Percentage of Correctly retrieved images

An example of the retrieved sketches and the corresponding images from the Indian database is given by Figure7, for the features vector constructed from first row = 16, first column = 16, diagonal = 16. The face sketch in the top is an exact copy of the query sketch. The query face sketch has 11 images in its class. The 11 face sketches with the smallest distance between their features vector and the features vector of the query face sketch are retrieved. The sketches and their corresponding face images that belong to the class of the query sketch are given in Figure8.



Figure7: Retrieved sketches using WHT features



Figure8: A class of sketches and their corresponding face images

4. Conclusion

The problem of features vector selection, for Content Based Face Image Retrieval in the WHT spectral domain, is investigated. The "*Indian*" face database is used to evaluate the performance of the CBIR system. Different sizes of the features vector are analyzed. These features are extracted from the WHT spectrums. The investigation concludes that the WHT can be used for CBIR, especially when considering the speed of retrieving images, because its coefficients contain integer values only, and it can be implemented using additions and subtractions operations only.

5. Acknowledgement

This research work was sponsored by Libyan Authority for Research, Science and Technology, Ministry of Higher Education and Scientific Research, Libya.

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