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Efficient Face Image Retrieval using Dynamic Selected Facial Attributes

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Abstract: Photos with faces of people are increased to a large extent in recent times due to tremendous growth in camera and mobile devices. People can easily take photos and upload them in social networks or other websites. It is quite a challenge to retrieve facial images of people due to large variation in pose, lighting and expressions, as well as occlusion and clutter. Automatic attribute detection may have false positive images. So, retrieved results may be unsatisfactory for the user who has access to only limited similar faces. In order to increase the retrieval results with a more similar image, two methods are proposed and combined, namely LOP feature extraction and dynamic attribute selection to generate attribute-enhanced sparse codewords and dynamic indexing for improved retrieval with more satisfactory results. Experimenting with PubFig data set, the proposed methods can achieve 45% improvement compared to existing methods.

Keywords: *Face Image Retrieval, Dynamic human attribute, content based image retrieval.*

1.Introduction

In the digital era of today, people can easily take photos and upload them onto the internet. Rapid growth of mobile phones and camera allows people to easily take photos and upload them in social networks like Facebook. This raises an issue in maintaining a separate database for each person as well as in the retrieval of their information. Face search in Google images may provide some similar images or unrelated images which may lead to user dissatisfaction. User satisfaction is the main issue to be resolved in face retrieval. To achieve this, variety of techniques are used such as feature extraction, face detection, face attribute consideration etc.

Face Image Retrieval System (FIRS) involves the activity of retrieving an image of a person's face from the face database. It also takes into account the measure of finding the similarity between the query image given and the face image in database. The database has a variety of images of the same person with different expressions, pose and illumination. So the retrieval results tend to be unsatisfactory. This can be eliminated by considering high-level human face attributes instead of using low-level features [9]. Low level features lack semantic meaning. Low-level features are extracted considering only the components of the face like eye, nose, mouth, etc. But the components of the same person's face may vary in different images with regard to pose, illumination, expression, etc. They should be easily identifiable by the system to recognize the person's face.

Face image retrieval system includes the process of

- Face identification
- Feature extraction
- Similarity comparison
- Indexing

- Fig.1 shows that the major steps in Face Retrieval, Initially person face image is given as input and Facial features are extracted from the query image. Same procedure is done for each face image in the dataset. Similarities computation is done between query image and image in the database. The face image relevant to query image is retrieved.

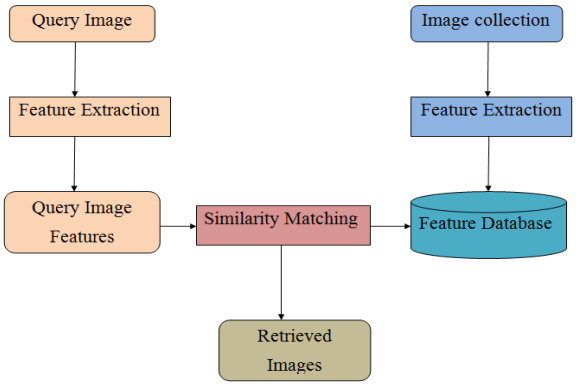

Figure 1. Major Steps in Face Retrieval

Combining low-level features with high-level human attributes[10],we can find feature representation to enhance retrieval results. Automatic face attribute detection has high-level semantic descriptions about a person's face. These can be useful in many applications such as face verification, face identification, keyword based face image retrieval and similar attribute search. So from the above discussion, we can conclude that human attributes may also be useful in identifying a person. In this work, we provide a new perspective on content based face image retrieval, by incorporating dynamic attribute selection combined with facial features to achieve better retrieval results. Dynamic attribute selection is the process of selecting the face attributes by the user in an online stage so that the images can be retrieved based on the user's wish. Feature extraction is done both in online and offline stages. Automatic attribute detection is performed in an offline stage. But attribute selection is performed in an online stage dynamically by the user.

In order to evaluate the performance of the proposed methods, we conduct experiments on public face datasets named Pubfig. These datasets have facial images taken from an unconstrained environment and are hence a real challenge for content-based face image retrieval. Some examples of Pubfig datasets can be found in figure4.

To sum it up, the contributions of this paper includes the following:

- We combine user selected high-level human face attributes and low-level features to retrieve a similar image from the database which matches with the query image.
- We conduct experiments and demonstrate the performances of the proposed methods on a public dataset and still ensure real time response.

We can identify faces from the database based on the attribute chosen by the user and facial image provided in the query. Similarity comparison of query image and images in the database are also done.

2. Related Works

Yu-Heng Lei*et al.* [4] utilizes face attributes and face similarity of the target person to retrieve the face image from the database by allowing the user to graphically specify the face positions.

Xiaohui Shen*et al.* [1] proposed an approach for face detection that integrates image retrieval and discriminative learning. This approach focuses on the issues of face detection such as variance in facial appearance, occlusion and clutter. This issue can be solved by proposing voting-based scheme. This scheme makes the classifiers cast a vote on the test image. Face detection, validation of face, Face landmark detection and face alignment are done in this proposed method of

retrieval based face detection system. This face detection task can also be used in attribute recognition as well as general object detection.

Stephen Milborrow*et al.* [3] proposed a framework to efficiently locate facial features using active shape model with simple extension. Face landmark detection is finding the location of the face components which is further used for face image retrieval. The proposed method can comparatively locate more landmarks than actually needed.

Timo Ahonen *et al.* [2] proposed a Local Binary Pattern for feature extraction from face to represent face image which is also used for face recognition. The face image after alignment is further divided into small regions by considering only the pixel. A region is a n*n matrix of pixels and feature extraction using LBP. After the feature extraction from each region, they are combined into a single histogram representing the face. Experimenting using FERET test proves the efficiency of LBP based method by solving the issue of facial expression, lighting and aging.

Bor-Chun Chen *et al.*[20] proposed a framework for the efficient face retrieval using automatic face attribute detection,LBP feature extraction,Attribute-Enhanced Sparse Coding and Indexing. The results can achieve up to 43.5% relative improvement in MAP compared to the existing methods.

Yan-Ying Chen *et al.*[23] proposed a framework for detecting attributes from faces. Initially, a face image with noisy labelled attribute is added and given as input. Visual relevance and context are combined to rank the diverse training images. The third step is the generic facial attribute detection for the trained images.

Yan-Ying Chen *et al.*[21] proposed a concept in analysing facial attribute for individual in group photos. In social media, people may take group photos with friends and family. In order to search individual face from group photos, facial attributes are learned and detected facial attributes(gender, race, age etc.,) are used. This can be used for recognition of individuals in social networking and personalized recommendation.

Kumar *et al.* [10] propose a concept to find describable visual attributes automatically. Using automatically detected human attributes,they achieve excellent performance on keyword-based face image retrieval and face verification.

Scheirer*et al.*[19]propose a Bayesian network concept that effectively utilize the humanattributes for face identification. Descriptive attributes are face attributes contained in an individual. Combining the descriptive attributes improve the accuracy of face identification through intelligent score weighting by up to 32.8%.

Behjat Siddiquie *et al.* [5] proposed a novel approach for ranking and retrieval of images in multi-attribute queries. Training separate classifier for each query word and combine their outputs for multiattribute queries may avoid the interdependies among query words. In order to solve this issue, the correlation between the attributes are modeled for multiattribute face image retrieval.

3.Proposed System

The proposed system explains the mainly the Feature Extraction using LOP, dynamic attribute selection and dynamic indexing. In Feature extraction, direction of pixels is calculated using horizontal, vertical and diagonal derivatives for second-order LOP. Attributes are dynamically decided based on the importance of attributes and the contextual relationship can be exploited between them. To do this A score function is first used to calculate the score of each attribute value and a score matrix is constructed, and then the score matrix is transformed into a normalized score matrix . An entropy-based procedure is proposed to derive attribute weights based on the normalized score matrix. Furthermore, the additive weighted averaging operator is utilized to fuse all the normalized scores into the overall scores of alternatives and the ranking of all the given alternatives is obtained. Fig. 2 shows that the overall steps in Face Retrieval. It includes two stages offline and online stage.

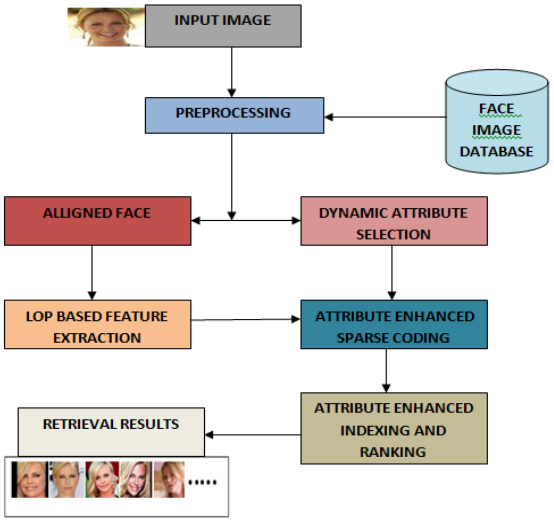

Figure 2. Overall Framework

Offlinestage:

Human face image are trained in this stage. In pre-processing, detection of face, face landmark detection, face alignment takes place to get the aligned face for the further processing. The components of face images such as eyes, nose and mouth is extracted and identity based vocabulary is added for each component. For each component LBP, LTrP and LOP are used to extract face features. The attribute scores are calculated from aligned face. The extracted feature and attribute score are combined to generate codewords using sparse coding for each face images.

Online stage:

In this stage, query image is given as input. For the given query image preprocessing, feature extraction are similar as offline stage. Then attribute are given by the user dynamically. Based on attribute given, dynamic sparse codewords are generated. Similarity computation is done with sparse codewords and attribute signature to get set of retrieval images in attribute embedded inverted indexing and all ranking result of similar images from database image are retrieved.

A. Pre-processing

The preprocessing steps which combines three steps face detection, face landmark detection and face alignment can be illustrated in Fig.3.Face detection from the query image can be done by using Viola-Jones detector.Face landmark detection can be done using Active Shape Model. The ASM starts the search for landmarks from the mean shape aligned to the position and size of the face determined by the global face detector.

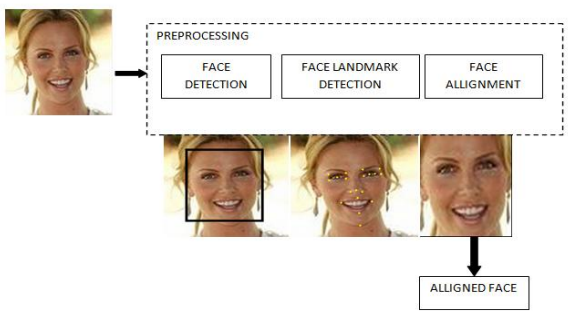

Figure 4. Preprocessing Steps

B. Feature Extraction

i. LOP Feature Extraction

The LOP algorithm[11] is initially fixing the pixel of matrix from face as centre pixel and horizontal, vertical and diagonal pixel are threshold with the centre pixel and interpreting the result as binary number. Further adjacent pixel of centre pixel is considered as centre pixel and threshold. This process continuous for all adjacent pixels. So the feature of face component is extracted efficiently by considering for each pixel as centre pixel.

C. Dynamic Attribute Selection

Face attributes are given dynamically by the user to give importance to the attribute based face retrieval. Attribute are converted to attribute scores which is combined with the extracted features to generate attribute enhanced sparse codewords. Low level features are lack of semantic meaning. By combining low-level features with high-level human attributes, we are able to find better feature representations and achieve better retrieval results. Some of the face attributes with accuracy is given in the TABLE I.

Attribute	Accuracy
Asian	94%
Gender	85.9%
Black hair	91.1%
Sunglasses	96.7%
Eyeglasses	92.5%
Wearing Earrings	77.8%
Smiling	96.1%
Mouth closed	91.1%
Wearing Lipstick	86.8%
Blurry image	93.5%
Side pose	80.1%
Round Face	75.6%
Straight hair	78.5%
Eye closed	80.1%
Mustache	92.9%

TABLE I. ACCURACY OF SINGLE ATTRIBUTE

4. Experimental Results

Fig.4 shows that the PubFig data set for the experiments. PubFig database [12] contains 58,797 face images of 200 people collected from the internet which is taken in different conditions. From the images, we have taken 30 images of 15 people for experiments. Fig.5 shows that significant improvement in retrieval results by solving the issues of illumination changes, side pose etc., Retrieval results can have increase in positive image compared to earlier results.

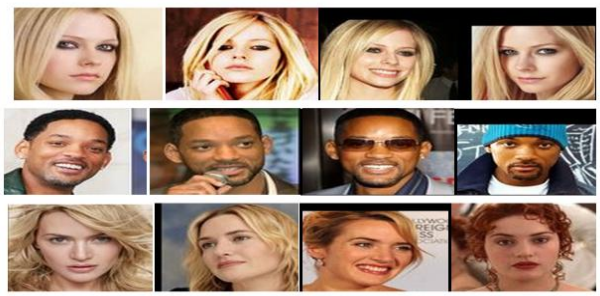

Fig.4: PubFig DataSet

Figure 5. Retrieval results for the query image. The red boxes indicate the false positives results and the attribute given by the user for the query (a)brown hair (b) smiling (c) eyeglasses. In (c) even the query have some occlusion and illumination changes face detection algorithm clearly get the face features combined with dynamic human attributes and get the user satisfaction results.

5.Conclusion

To retrieve image with accurate matching and improved results, dynamic attribute selection and LOP feature extraction are combined. Combining low-level features with high-level features can achieve better results. The code word generation in offline stage and indexing in online stage may also adds reason for efficient content based face image retrieval. Dynamic attribute may higher preference in online stage than detected attribute in offline stage. Single dynamic attribute selection may have lower the number of results. So multiple attribute selection will be the future enhancement.

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