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Scalable Face Restitution Via Attribute-Enhanced Sparse Code words

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ABSTRACT: *To develop a scalable face image restitution system we apply Attribute-Enhanced Sparse Code words on local features extracted from face images combining with inverted indexing to construct an efficient and scalable face retrieval system. Nowadays Photos with people are the major interest of users. Among all those photos, a big percentage of them are photos with human faces. The importance and the sheer amount of human face photos make manipulations (e.g., search and mining) of large-scale human face images a really important research problem and enable many real world applications. Thus, with the exponentially growing photos, large-scale content-based face image retrieval is an enabling technology for many emerging applications. To utilize automatically detected human attributes that contain semantic cues of the face photos to improve content based face retrieval by constructing semantic code words for efficient large-scale face retrieval. By leveraging human attributes in a scalable and systematic framework, we propose two orthogonal methods named attribute-enhanced sparse coding and attribute embedded inverted indexing to improve the face retrieval in the offline database. We investigate the effectiveness of different attributes and vital factors essential for face retrieval.*

Keywords – *Quantization, Content-based image retrieval (CBIR), Attribute Enhanced Sparse Coding, Face Attributes*

I. INTRODUCTION

Due to the popularity of digital devices and the rise of social network or photo sharing services, there are largely growing consumer photos available in our life. Among all those photos, a big percentage of them are photos with human faces. The importance and the sheer amount of human face photos make manipulations of large-scale human face images a really important research problem and enable many real world applications. It is an enabling technology for many applications including automatic face annotation [1], crime investigation [2], etc. Traditional methods for face image retrieval usually use low-level features to represent faces [3], [4], but low-level features are lack of semantic meanings and face images usually have high intra-class variance, so the retrieval results are unsatisfactory.

To tackle this problem, we propose to use identity based quantization and identity-constrained sparse coding, but these methods might require clean training data and massive human annotations. In this work, we provide a new perspective on content-based face image retrieval by incorporating high-level human attributes into face image representation and index structure. We combine automatically detected high-level human attributes and low-level features to construct semantic codewords. To the best of our knowledge, this is the first proposal of such combination for content-based face image retrieval.

To balance global representations in image collections and locally embedded facial characteristics, we propose two orthogonal methods to utilize automatically detected human attributes to improve content-based face image retrieval under a scalable framework. We conduct extensive experiments and demonstrate the performances of the proposed methods on two separate public datasets and still ensure real time response. We further identify informative and generic human attributes for face image retrieval across different datasets. The selected descriptors are promising for other applications as well.

1.1. CONTENT-BASED IMAGE RETRIEVAL (CBIR)

Content-based image retrieval (CBIR), also known as query by image content and content-based visual information retrieval is the application of computer vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases.

"Content-based" means that the search analyzes the contents of the image rather than the metadata such as keywords, tags, or descriptions associated with the image. The term "content" in this context might refer to colors, shapes, textures, or any other information that can be derived from the image itself.

1.2. FACE ATTRIBUTES

Face attributes determine the visual appearance of a face like various dimensions such as color, texture, shape, and others.

II. PROBLEM FORMULATION

The scope of this proposed work is to address one of the important and challenging problems in large-scale content-based face image retrieval. First we given a query face image, content-based face image retrieval tries to find similar face images from a large image database. It is an enabling technology for many applications including automatic face annotation, crime investigation, etc. The image ranking according to this similarity score can be efficiently found using inverted index structure.

2.1 EXISTING SYSTEM

The traditional methods for face image retrieval usually use low-level features to represent faces. Low-level features are lack of semantic meanings and face images usually have high intra-class variance (e.g., expression, posing), so the retrieval results are unsatisfactory. And also ignore strong, face-specific geometric constraints among different visual words in a face image. These features are typically high-dimensional and global, thus not suitable for quantization and inverted indexing. In other words, using such global features in a retrieval system requires essentially a linear scan of the whole database in order to process a query, which is prohibitive for a web- scale image database.

III. PROPOSED SYSTEM

To balance global representations in image collections and locally embedded facial characteristics, we propose two orthogonal methods to utilize automatically detected human attributes to improve content-based face image retrieval under a scalable framework. Two orthogonal methods are attribute-enhanced sparse coding and attribute-embedded inverted indexing [5] which can effectively retrieve index with more than one million face photos can be done in less than one second, reduce memory usage by many compression techniques in information retrieval, reduce the quantization error and achieve salient gains in face retrieval, improve content based face retrieval by constructing semantic codewords for efficient large-scale face retrieval. It is an enabling technology for many applications including automatic face annotation, crime investigation, etc.

In proposed work, a user will upload a Query image to face retrieval module and image database will verify it to allow for pre processing (Fig1). In pre processing, attribute enhanced sparse coding is applied to identifies the face attributes and alignment, face detection and ranking calculation to output ranked images.

3.1 ATTRIBUTE-ENHANCED SPARSE CODING

Attribute-enhanced sparse coding exploits the global structure of feature space and uses several important human attributes combined with low-level features to construct semantic code words in the offline stage.

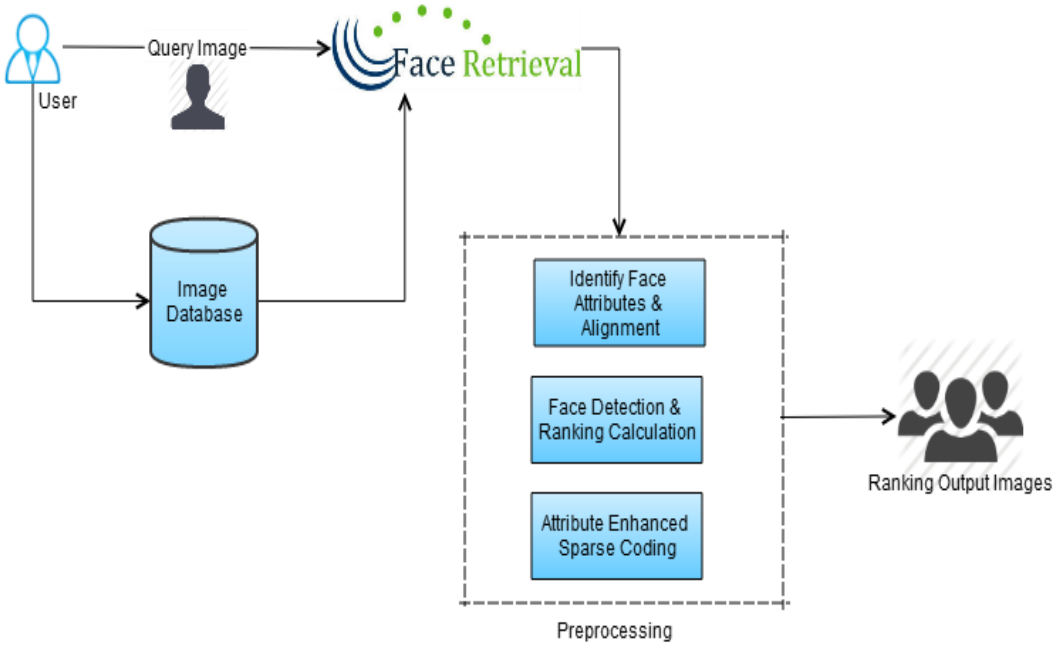

Fig 1: Architecture diagram

3.2 ATTRIBUTE-EMBEDDED INVERTED INDEXING

Attribute-embedded inverted indexing locally considers human attributes of the designated query image in a binary signature and provides efficient retrieval in the online stage. Automatically detected high-level human attributes and low-level features are combined in the proposed work to construct semantic codewords.

To the best of our knowledge, this is the first application proposal of such combination for content-based face image retrieval. In this application Viola-Jones face detector method is applied to find the locations of faces in the image present in the every database.

For a single query, face detection and alignment take about 0.7 seconds, computing sparse representation takes about 0.35 seconds, and retrieving index with more than one million takes about 0.02 seconds.

3.3 SCALABLE FACE RESTORATION

To complete the procedure of scalable face restoration process is enumerated below:

3.3.1 Detecting Face Attributes
3.3.2 Estimating Face Similarities
3.3.3 Content Based Image Search
3.3.4 Attribute Embedded Inverted Indexing Based Image Search
3.3.5 Scalable Face Image Retrieval
3.3.6 Ranking in Attribute Enhanced Sparse Coding

3.3.1. DETECTING FACE ATTRIBUTES

The explosive growth of camera devices, people can freely take photos to capture moments of life, especially the ones accompanied with friends and family. Therefore, a better solution to organize the increasing number of personal or group photos is highly required. In this module, we propose an Attribute Enhanced Sparse Codewords to search for face images according facial attributes and face similarity of the target persons.

Image retrieval systems achieve scalability by using bag-of-words representation and textual retrieval methods, but their performance degrades quickly in the face image domain, mainly because they produce visual words with low discriminative power for face images, and they ignore the special properties of the faces. The leading features for face recognition can achieve good retrieval performance, but these features are not suitable for inverted indexing as they are high-dimensional and global, thus not scalable in either computational or storage cost. In this aplication we build a scalable face image retrieval system. For this purpose, we develop a new scalable face representation using both local and global features.

Our goal of this application is to address one of the important and challenging problems large scale content-based face image retrieval. Given a query face image, content-based face image retrieval tries to find similar face images from a large image database. It is an enabling technology for many applications including automatic face annotation, crime investigation, etc.

3.3.2. ESTIMATING FACE SIMILARITIES

Face image retrieval usually use low-level features to represent faces in the traditional methods, but low-level features are lack of semantic meanings and face images usually have high intra-class variance, so the retrieval results are unsatisfactory. To tackle this problem, we propose to use identity based quantization and also propose to use identity constrained sparse coding, but these methods might require clean training data and massive human annotations. In this work, we provide a new perspective on contentbased face image retrieval by incorporating high-level human attributes into face image representation and index structure. Face images of different people might be very close in the low-level feature space. By combining low-level features with high-level human attributes, we are able to find better feature representations and achieve better retrieval results.

To enable search through face appearance, we adapt the face retrieval framework. The advantage of this framework includes: Efficiency, which is achieved by using sparse representation of face image with inverted indexing, and leveraging identity information, which is done by incorporating the identity information into the optimization process for codebook construction. Both of the above two points are suitable for our system.

In details, detected faces are first aligned into canonical position, and then component based local binary patterns are extracted from the image database. Sparse representations are further computed from these feature vectors based on a learned dictionary combined with extra identity information. By incorporating such framework into our system, the user can not only specify positions and attributes of the face but also use a face image itself with position as the query. The real valued similarity scores are normalized to the interval (0, 1) before they are used.

3.3.3. CONTENT BASED IMAGE SEARCH

Content-based image retrieval (CBIR), also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR) is the application of computer vision techniques to the image

retrieval problem, that is, the problem of searching for digital images in large databases. Human attributes have been shown useful on applications related to face images; it is non-trivial to apply it in content-based face image retrieval task due to several reasons. First, human attributes only contain limited dimensions.

When there are too many people in the dataset, it loses discriminability because certain people might have similar attributes. Second, human attributes are represented as a vector of floating points. It does not work well with developing large scale indexing methods, and therefore it suffers from slow response and scalability issue when the data size is huge. To leverage promising human attributes automatically detected by attribute detectors for improving content-based face image retrieval, we propose two orthogonal methods named attribute-enhanced sparse coding and attribute-embedded inverted indexing. In this module, we aim to utilize automatically detected human attributes that contain semantic cues of the face photos to improve content based face retrieval by constructing semantic codewords for efficient large-scale face retrieval.

3.3.4. ATTRIBUTE EMBEDDED INVERTED INDEXING BASED IMAGE SEARCH

Attribute detection has adequate quality on many different human attributes. Using these human attributes, many researchers have achieved promising results in different applications such as face verification [6], face identification [7], keyword-based face image retrieval [8], and similar attribute search [9]. Attribute-enhanced sparse coding [10] exploits the global structure of feature space and uses several important human attributes combined with low-level features to construct semantic codewords in the offline stage. On the other hand, attribute-embedded inverted indexing locally considers human attributes of the designated query image in a binary signature and provides efficient retrieval in the online stage.

By incorporating these two methods, we build a large-scale content-based face image retrieval system by taking advantages of both low level features and high-level semantics. To embed attribute information into index structure, for each image, in addition to sparse codewords computed from the facial appearance, we use a dimension binary signature to represent its human attribute. Attribute-embedded inverted index is built using the original codewords and the binary attribute signatures associated with all database images. Attribute-embedded inverted indexing further considers the local attribute signature of the query image and still ensures efficient retrieval in the online stage.

3.3.5. SCALABLE FACE IMAGE RETRIEVAL

The proposed work is a facial image retrieval model for problem of similar facial images searching and retrieval in the search space of the facial images by integrating content-based image retrieval (CBIR) techniques and face recognition techniques, with the semantic description of the facial image. The aim is to reduce the semantic gap between high level query requirement and low level facial features of the human face image such that the system can be ready to meet human nature way and needs in description and retrieval of facial image. Traditional CBIR techniques use image content like color, texture and gradient to represent images. To deal with large scale data, mainly two kinds of indexing systems are used. Many studies have leveraged inverted indexing or hash based indexing combined with bag-of-word model (BoW) and local features like SIFT, to achieve efficient similarity search.

We can automatically detect facial attributes and measure face similarity in the offline process to provide rapid on-line photo search. Integrated with aesthetics assessment, we can further save time for browsing photos with poor quality. Using human attributes like hair colors we can gather information from not only face regions, therefore we can still achieve good performance under the occlusion. If the quality of the query image is poor, we cannot correctly predict the human attributes and sparse codewords.

3.3.6. RANKING IN ATTRIBUTE ENHANCED SPARSE CODING

In this proposed application both the query and database images will go through the some procedures including face detection, facial landmark detection, face alignment, attribute detection, and feature extraction. Attribute-Enhanced sparse coding is used to find sparse codewords of database images globally. Codewords of the query image are combined locally with binary attribute signature to traverse the attribute-embedded inverted index and derive real-time ranking results over database images. The experimental results show that using the codewords generated by the proposed coding scheme, we can reduce the quantization error and achieve salient gains in face retrieval on two public datasets; the proposed indexing scheme can be easily integrated into inverted index, thus maintaining a scalable framework.

The image ranking according to Equation can still be efficiently computed using inverted index by simply doing a XOR operation to check the hamming distance before updating the similarity scores. XOR operation is faster than updating scores, by skipping images with high hamming distance in attribute hamming space, the overall retrieval time significantly decreases. We would like to highlight what improvements we can bring in as exploiting face attributes for semantic-rich sparse codeword representations. Certain attributes (smiling, frowning, harsh lighting, etc.) will decrease the performance in both datasets. It is probably because these

attributes are not correlated with the identity of the person. Informative human attributes across both datasets are also similar.

IV. CONCLUSION

Two orthogonal methods to utilize automatically detected human attributes to significantly improve content-based face image retrieval are used in this paper. Attribute-enhanced sparse coding exploits the global structure and uses several human attributes to construct semantic-aware code words in the offline stage. Attribute-embedded inverted indexing further considers the local attribute signature of the query image and still ensures efficient retrieval in the online stage. The experimental results show that using the code words generated by the proposed coding scheme, we can reduce the quantization error and achieve salient gains in face retrieval on two public datasets; the proposed indexing scheme can be easily integrated into inverted index, thus maintaining a scalable framework. During the experiments, we also discover certain informative attributes for face retrieval across different datasets and these attributes are also promising for other applications. Current methods treat all attributes as equal. We will investigate methods to dynamically decide the importance of the attributes and further exploit the contextual relationships between them.

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