A Robust Face Annotation Method by Mining Facial Images

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Abstract—This paper proposes a robust face annotation technique by mining weakly labeled facial images. One challenging problem for face annotation scheme is how to effectively perform annotation by exploiting the list of most similar facial images and their weak labels that are often noisy and incomplete. To tackle this problem, we propose an effective face annotation method for refining the labels of web facial images using machine learning techniques. On a training set of images with annotations, we compute feature vectors of image features which allow us to predict the probability of generating a word given the image regions. This may be used to automatically annotate and retrieve images given a word as a query. We formulate the learning problem as a convex optimization and develop effective optimization algorithms to solve the large scale learning task efficiently. To further speed up the proposed scheme, we also propose a clustering algorithm which can improve the scalability considerably.

***Index Terms*—Face annotation, Facial images, SVM classifier, Weak label**

I. INTRODUCTION

Due to the popularity of digital cameras and the rapid growth of social media tools for internet-based photo sharing [1], recent years have witnessed an explosion of the number of photos captured and stored by consumers. Photos shared by users on the Internet are human facial images. Some of these photos are tagged with names, but many of them are not tagged correctly. This has motivated the study of auto face annotation, an important technique that aims to annotate facial images automatically.

Auto face annotation can be useful to many real-world applications. For example, with auto face annotation techniques, online photo-sharing sites (e.g., Facebook) can automatically annotate users' uploaded photos to facilitate online photo search and management. Apart from this face annotation can also be applied in news video domain to detect important persons appeared in the videos to facilitate news video retrieval and summarization tasks [2], [3].

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Classical face annotation approaches are often treated as an extended face recognition problem, where different classification models are trained from a collection of well-labeled facial images by employing the supervised or semi-supervised machine learning techniques [2], [4], [5], [6], [7]. However, the "model-based face annotation" techniques are limited in several aspects. First, it is usually time-consuming and expensive to collect a large amount of human-labeled training facial images. Second, it is usually difficult to generalize the models when new training data or new persons are added, in which an intensive retraining process is usually required. Last but not least, the annotation/recognition performance often scales poorly when the number of persons/classes is very large.

One challenge faced by such SBFA paradigm is how to effectively exploit the short list of candidate facial images and their weak labels for the face name annotation task. To tackle this problem, we investigate and develop a search-based face annotation scheme. We also propose a clustering-based approximation (CBA) algorithm to improve the efficiency and scalability. As a summary, the main contributions of this paper include the following:

- We propose an effective face annotation method for refining the labels of web facial images using machine learning techniques.
- On a training set of images with annotations, we compute feature vectors of image features which allow us to predict the probability of generating a word given the image regions. This may be used to automatically annotate and retrieve images given a word as a query.
- We formulate the learning problem as a convex optimization and develop effective optimization algorithms to solve the large scale learning task efficiently.
- To further speed up the proposed scheme, we also propose a clustering algorithm which can improve the scalability considerably.

We conducted an extensive set of extensive set of experiments, in which encouraging results were obtained.

II. RELATED WORK

Our work is closely related to several groups of research work.

The first group of related work is on the topics of face recognition and verification, which are classical research problems in computer vision and pattern recognition and have been extensively studied for many years [8], [9].

The second group is about the studies of generic image annotation [10], [11], [12], [13].The classical image annotation approaches [14], [15], [16] usually apply some existing object recognition techniques to train classification models from human-labeled training images or attempt to infer the correlation/probabilities between images and annotated keywords.

The third group is about face annotation on personal/family/social photos. Several studies [17], [18], [19], [20] have mainly focused on the annotation task on personal photos, which often contain rich contextual clues, such as personal /family names, social context and so on.

The fourth group is about the studies of face annotation in mining weakly labeled facial images on the web. Some studies consider a human name as the input query, and mainly aim to refine the text-based search results by exploiting visual consistency of facial images. For example Le and Satoh [21] proposed a new local density score to represent the importance of each returned images.

III. PROPOSED SYSTEM

Face annotation is metadata (e.g. a comment, explanation, name of the person in an image and presentational markup) attached to image. In the proposed system we are developing an efficient technique for face annotation. Initially set of images are collected to train them by respective features like texture shape, face coordinates. The process of extracting knowledge from a data set is called mining. Later after assigning the metadata to the faces, clustering process takes place. In this project, grouping the images based on the similar facial feature vector is called clustering. A test image can be identified by matching the facial feature vectors of the trained images with this images' facial feature vectors.

A. WORKFLOW OF PROPOSED SYSTEM

In the proposed system, there are two stages namely training and testing.

Training: First step towards face annotation technique is to collect sample images for training. For every image collected, image preprocessing is done. Image preprocessing is a technique to improve the image quality by applying methods like noise removal, color conversion, mathematical operations like dilation, erosion, etc. Using AdaBoost algorithm faces are detected in preprocessed images.
AdaBoost (Adaptive boosting) is a well known meta machine learning algorithm.

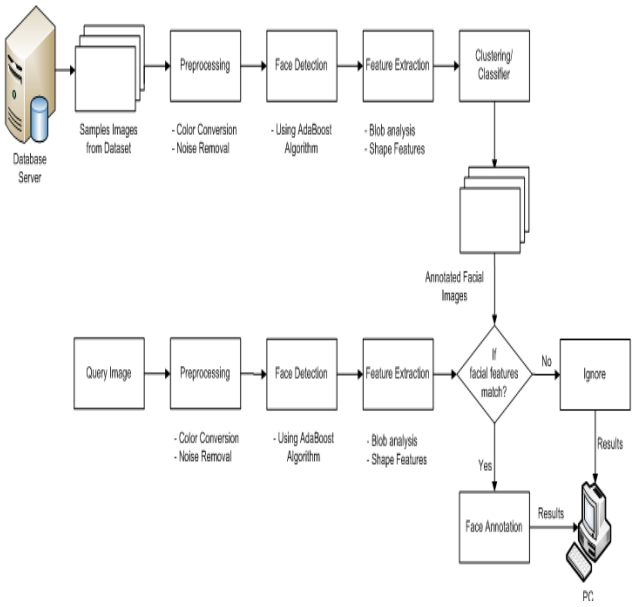

Figure 1: Architecture Design of Proposed System

Machine learning deals with the construction and study of algorithms that can learn from data. Such Algorithms operate by building a model based on inputs and using that to make predictions or decisions, rather than following only explicitly programmed instructions. Once faces are detected using AdaBoost algorithm, for every image – features are extracted. In image processing, a feature is a piece of information which is relevant for solving the computational task related to a certain application. Features such as points, edges, objects, blob analysis, shape features, texture features, etc are considered in feature extraction methods. After extracting the features, clustering/classification is done. In clustering/classification we group the images based on similarity of features and hence we name those group of images as one. This process is called face annotation.

Testing: An image labeled as query image, is used for checking the face annotation. Preprocessing, Face Detection, and Feature Extraction of query image are done using similar methods which are used in training phase. After completing the feature extraction procedure, we compare the features of trained images with test images. If any similar features match with the trained images, then that image is annotated or else those image(s) are ignored.

B. ALGORITHM

The algorithm used in this project is AdaBoost algorithm, which contains the five steps as shown in Figure 2. Which is used to detect faces.

1. **Input:** S={$(x_1,y_1),\ldots,(x_N,y_N)$}, Number of Iterations T
2. **Initialize:** $d_n^{(1)} = 1/N$ for all $n = 1,\ldots,N$

3. **Do for** *t=1,…,T,*

   a. Train classifier with respect to the weighted sample set $\{S,d^{(t)}\}$

   b. Calculate the weighted training error ε_t of h_t:

$$\varepsilon = \sum_{n=1}^{N} d_n^{(1)} I(y_n \neq h_t(x_n)),$$

   c. Set :

$$\alpha_t = \frac{1}{2} \log \frac{1-\varepsilon_t}{\varepsilon_t}$$

   d. Update Weights:

$$d_n^{(t+1)} = d_n^{(t)} \exp\{-\alpha_t\, y_n h_t(x_n)\}/z_t$$

   Where z_t is a normalization constant, such that $\sum_{n=1}^{N} d_n^{(t+1)} = 1$

4. **Break if** $\varepsilon_t = 0$ or

$$\varepsilon_t \geq \frac{1}{2}$$

   And Set T = t-1

5. **Output:** $f_T(x) = \sum_{t=1}^{T} \frac{\alpha_t}{\sum_{r=1}^{T} \alpha_r} h_t(x)$

Figure 2: AdaBoost Algorithm

IV. RESULTS AND DISCUSSION

After running the main program of this project we follow the following procedure,

- First we get the main menu as shown in Figure 3. In that first we select Create Database option.
- After selecting Create Database option we get the Face Region Image as shown in Figure 4 and 5 by extracting features of the images.
- After creating database we train the images which are in database by selecting Training option.
- After training we select a query image from the database by clicking on Select an Query option as shown in Figure 6 in that we have chosen Person 5 image.
- We also extract the features of the selected query image.
- And finally by using SVM classifier we classify the query image and annotate it as shown in Figure 7 in that we annotate the image as Person 5. And we can also see the result in Command Window as shown in Figure 8.
- We can also see the accuracy of the proposed system by clicking on Result Analysis option as shown in Figure 9 in that the accuracy of the proposed system is 85% where as existing system accuracy is 60%.

Figure 3: Menu

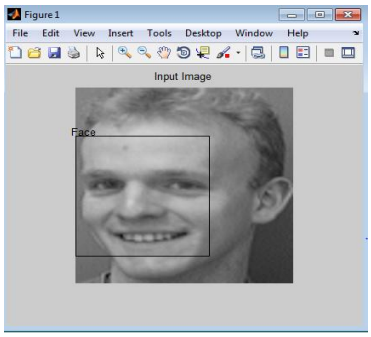

Figure 4: Input Image

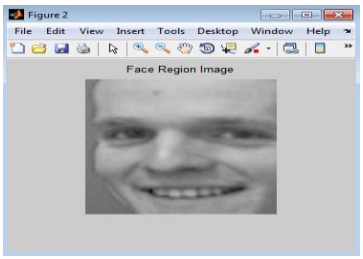

Figure 5: Face Region Image

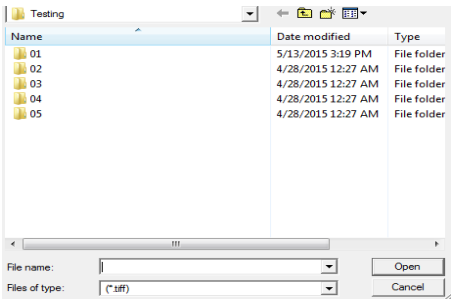

Figure 6: Selecting Query Image

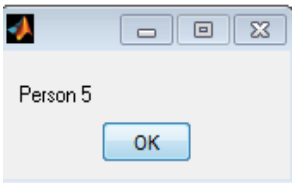

Figure 7: Final Result

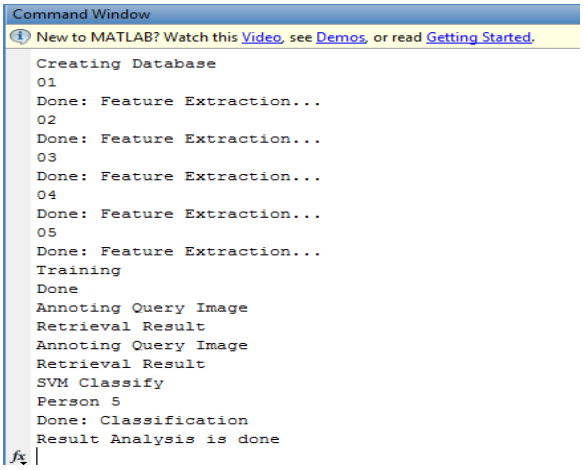

Figure 8: Result in Command Window

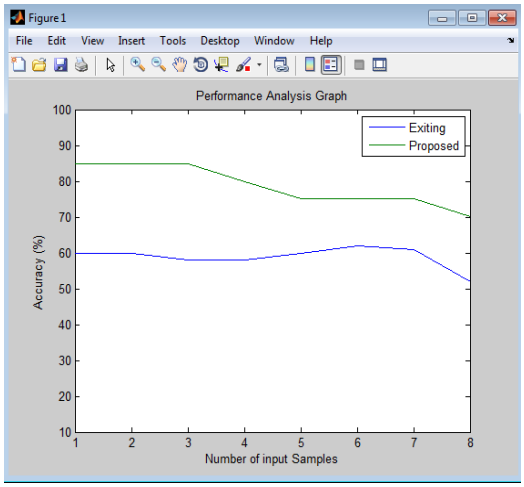

Figure 9:Performance Analysis Graph

V. APPLICATIONS

- Face annotation method is very useful in detecting faces in news videos, web videos.
- It is useful in searching for images in World Wide Web (WWW).

VI. CONCLUSION

The face annotation framework proposed in this paper is focused on all types of image qualities. To further improve the scalability, clustering algorithm is implemented, which successfully accelerated the optimization task without introducing any performance degradation. Finally the proposed system concludes that efficiency of the system will be shown better than other face annotation methods.

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