Probabilistic Modeling for Detection and Gender Classification

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ABSTRACT

In this paper, the authors contribute to solve the simultaneous problems of detection and gender classification from any viewpoint. The authors use an invariant model for accurate face localization based on a combination of appearance and geometric. A probabilistic matching of visual traits allows to classify the gender of face even when pose changes. The authors deal with the local invariant features whose performances have already been proved. Each facial feature retained in the detection step will be weighted by a probability to be male or female. This feature contributes to determine the gender of the face. The authors evaluate our model by testing it in experiments on different databases. The experimental results show that the face model performs well to detect face and gives a good gender recognition rate in the presence of viewpoint changes and facial appearance variability.

Keywords: Face Detection, Gender Recognition, Learning Model, Local Invariant Features, Object Appearance Recognition, Probabilistic Matching

1. INTRODUCTION

The face image analysis is become the worldwide area of study. One of the most common visual trait classification task is to determine gender from face images. We try to treat face detection and gender classification simultaneously. Many models exist which perform the detection with high precision but not over all viewpoints of face. Local Haar wavelets can be computed very efficiently and is proved useful for frontal face detection using boosted classifiers (Viola, 2001). The integral image approach is less effective in coping with arbitrary viewpoints. It needs a series of classifiers or a set of detectors to model in-plane deformation parameters such as image scale and orientation and out-of-plane viewpoint changes (Toews, 2006).

Contrary to global features, the local feature approaches give robust invariance to illumination, viewpoint and orientation changes. Thus, they offer opportunity for further performance to detect faces and to classify their gender.
Local invariant features (Kadir, 2001; Lindeberg, 1998; Lowe, 2004; Mikolajczyk, 2002; Mikolajczyk, 2004; Yu, 2009) have a high capability to capture appearance information. They allow to select the sparse appearance patches of objects, as faces. Thus, it becomes possible to model faces and learn their appearance variability through a model that embeds features and that present invariant properties. We extend the face invariant model developed in (Taffar, 2011) to recognize the gender of faces. Using the co-occurrence statistics of features with the trait of interest, we train a classifier to recognize the gender of faces in terms of visual traits. The gender of a face can be inferred from a collection of image features which define the traits of gender. Thus, unlike object subcategories defined solely by image features (Ahuja, 2007) which use matching or similarity metric, classification based on visual traits implies a learning process based on external training information.

The approach taken in this paper learns simultaneously the appearance, spatial relations, and co-occurrence of the features. It uses a probabilistic matching to predict the presence of facial appearance and then to classify its gender with a best rate. The improved invariant model needs low degree of supervision and complex assumptions on face parameters to learn and detect the rich multimodal appearance (i.e., expression, wink) in the presence of viewpoint changes.

In the following we present a brief background of works in this research area related to object appearance modeling and gender classification from face images. The facial appearance modeling is discussed in section 3 followed by its probabilistic formulation that is simultaneously useful to localize and decide the gender of face. Then, in section 5 a description of sex classification process is given which computes the appearance probabilities of sex of traits that have contributed to detect faces. Section 6 report experimental results obtained on face localization and gender recognition. Finally, conclusion is given in the last section.

2. RELATED WORKS

In face image analysis, determining gender of face from facial trait classification is still a challenging task. The greater part of publications of gender classification highlights the state-of-the-art in general trait classification. Trait learning is done by using spatially global feature representations such as templates (Kim, 2006; Gutta, 1998), principal components (Moghaddam, 2002), independent components (Jain, 2005), or image intensities directly (Baluja, 2007). While most approaches utilize intensity data, 3D information may also improve sex classification (O’Toole, 1997). In this context, much works have explored the capacity of different machine learning such as neural networks (Gutta, 1998), SVMs, and boosted classifiers (Baluja, 2007). Recently, trait classification based on local features (Kadir, 2001; Lowe, 2004; Mikolajczyk, 2002; Mikolajczyk, 2004; Yu, 2009) has emerged, using local regions (Ben Abdelkader, 2005) or Haar wavelets (Shakhnarovich, 2002; Yang, 2006). Local features are principally computed from the regions of image as the values of Histograms of Oriented Gradients (HOG) (Lowe, 2004). They are image descriptors in variant to 2D rotation which have been used in many different problems in computer vision.

The majority of approaches to gender classification are based totally on single viewpoints, i.e., frontal faces (Jain, 2005; Baluja, 2007; Dance, 2004; Makinen, 2008; Moghadam, 2002; Gutta, 1998; Bekios-Califa, 2013). They assume that, prior to classification, some environment constraint such as background distraction must be respected, and faces or facial features precisely localized. They reported low error rates and used different images of the same person in both training and testing classifiers (Moghaddam, 2002; Yang, 2006). As facial features arising from different frontal images of the same person are highly correlated, one cannot know whether the low classification error reported reflects the ability of the classifier to generalize to new, unseen faces or simply classification by recognition (Toews, 2009).
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