Detection of Facial Feature Points Using Anthropometric Face Model

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Summary. This chapter describes an automated technique for detecting the eighteen most important facial feature points using a statistically developed anthropometric face model. Most of the important facial feature points are located just about the area of mouth, nose, eyes and eyebrows. After carefully observing the structural symmetry of human face and performing necessary anthropometric measurements, we have been able to construct a model that can be used in isolating the above mentioned facial feature regions. In the proposed model, distance between the two eye centers serves as the principal parameter of measurement for locating the centers of other facial feature regions. Hence, our method works by detecting the two eye centers in every possible situation of eyes and isolating each of the facial feature regions using the proposed anthropometric face model. Combinations of different image processing techniques are then applied within the localized regions for detecting the eighteen most important facial feature points. Experimental result shows that the developed system can detect the eighteen feature points successfully in 90.44% cases when applied over the test databases.

17.1 Introduction

Identification of facial feature points plays an important role in many facial image applications including human computer interaction, video surveillance, face detection, face recognition, facial expression classification, face modeling and face animation. A large number of approaches have already been attempted towards addressing this problem, but complexities added by circumstances like inter-personal variation (i.e. gender, race), intra-personal changes (i.e. pose, expression) and inconsistency of acquisition conditions (i.e. lighting, image resolution) have made the task quite difficult and challenging. All the works that have addressed the problem of facial feature point detection so far can be grouped into several categories on the basis of their inherent techniques. Geometrical shape of facial features has been adopted in several works for facial feature point localization and detection [1][2]. Each feature is demonstrated as a geometrical shape; for example, the shape of the eyeball is circle
and the shape of the eyelid is ellipse. This method can detect facial features very well in neutral faces, but fails to show better performance in handling the large variation in face images occurred due to pose and expression [3]. To overcome this limitation, a variation of shape-based approaches that looks for specific shape in the image adopting deformable and non deformable template matching [4],[5], graph matching [6], snakes [7] or the Hough Transformation [8] has also been deployed. Due to the inherent difficulties of detecting facial feature points using only a single image, spatio-temporal information captured from subsequent frames of video sequence has been used in some other work for detection and tracking facial feature points [9][10]. Combination of color information from each of the facial features has been extracted and used to detect the feature points in some other works [11][12]. One of the main drawbacks of the color based algorithms is that they are applicable only to the color images and can’t be used with the gray scale images. Approaches of facial feature points detection using the machine learning techniques like Principle Component Analysis [13], Neural Network [3], Genetic Algorithm [14] and Haar wavelet feature based Adaboost classifiers [15] require a large number of face images and computational time for initial training. There are also some works that have used image intensity as the most important parameter for detection and localization of facial features [16][17].

Although anthropometric measurement of face provides useful information about the location of facial features, it has rarely been used in their detection and localization. In this chapter, we have explored the approach of using a statistically developed, reusable anthropometric face model for localization of the facial feature regions as well as for detection of the eighteen most important facial feature points from these isolated regions using a hybrid image processing technique. The subsequent discussion of this chapter has been organized into the following sections: Section 2 explains the proposed anthropometric face model, Section 3 focuses on the isolation of facial feature regions using the anthropometric face model, Section 4 explains the techniques of detecting the eighteen feature points from the identified face regions, experimental results are represented in Section 5 and finally Section 6 concludes the paper.

### 17.2 Anthropometric Model for Facial Feature Region Localization

Anthropometry is a biological science that deals with the measurement of the human body and its different parts. Data obtained from anthropometric measurement informs a range of enterprises that depend on knowledge of the distribution of measurements across human populations. After carefully performing anthropometric measurement on 300 frontal face images taken from more than 150 subjects originated in different geographical territories, we have been able to build an anthropometric model of human face that can be used in localizing facial feature regions from face images [18]. Rather than