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The role of facial asymmetry in recognizing age-separated face images ☆

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ABSTRACT

Recognition of age-separated face images is a challenging and open research problem. In this paper we propose a facial asymmetry based matching-score space (MSS) approach for recognition of age-separated face images. Motivated by its discriminatory information, we evaluate facial asymmetry across small and large temporal variations and use asymmetric facial features to recognize age-separated face images. We extract three different facial features including holistic feature descriptors using Principal Component Analysis (PCA), local feature descriptors using Local Binary Patterns (LBP), and Densely Sampled Asymmetric Features (DSAF) to represent face images. Then we develop MSS to discriminate genuine and imposter classes using support vector machine (SVM) as a classifier. Experimental results on three widely used face aging databases, the FERET, MORPH and FG-NET, show that proposed approach has superior performance compared to some existing state-of-the-art approaches.

1. Introduction

Human face contains a number of recognition-specific clues including age, gender, race and expressions. Over the past five decades, several face recognition algorithms have been proposed in the literature. Currently, face recognition of age-separated face images is receiving continuous attention of research community. The major challenge in recognition of age-separated face images is to extract such discriminatory information, which can reduce matching-scores gap between gallery and corresponding probe images. Facial temporal variations are highly complex in nature due to number of factors including facial asymmetry. Although facial asymmetry has been used in previous face recognition studies [1–6], yet these studies lack facial asymmetry evaluation across temporal variations and its discriminatory role in recognizing age-separated face images. Motivated by this fact, we aim at: (1) evaluating facial asymmetry with small and large temporal variations; and (2) combining asymmetric facial features along with holistic (PCA) [7] and local feature descriptors (LBP) [8] to exploit the discriminatory information for recognition of age-separated face images.

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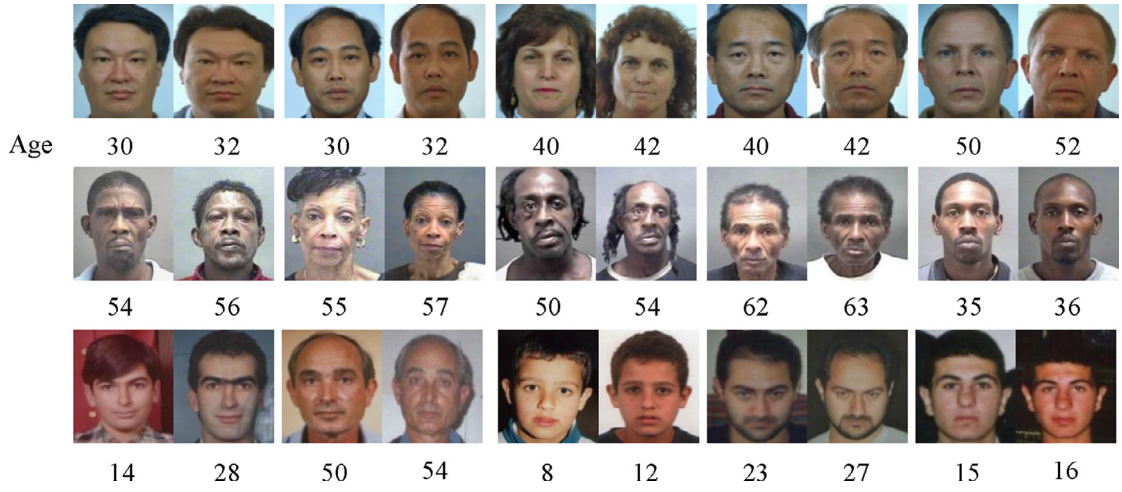

Fig. 1. Example age-separated face image pairs showing intra-subject temporal variations: top row FERET database, middle row MORPH database, and bottom row FG-NET database.

1.1. Related work

Recently a number of face recognition methods have been proposed for recognition of age-separated face images [9-13]. Existing methods to recognize age-separated face images can be broadly classified into two categories: (1) generative methods; and (2) discriminative methods. The generative methods rely on modeling of facial aging process. Though such methods are successful in discriminating age-separated face images, yet involve complex age simulation process. On the other hand, discriminative methods, such as [10,11,13], use multiple feature representations to improve face recognition performance. In [10], a multi-feature discriminant analysis is presented to recognize age-separated face images. In [11], Bacteria foraging fusion (BFF) scheme is used to optimize the weights assigned to different facial regions to maximize the recognition performance. A multi-view discriminative learning (MDL) approach based on three different local feature descriptors is presented in [13]. In a most recent approach [12] reported in the literature, human perception based fusion strategy has been proposed to recognize age-separated face images.

As described earlier, facial asymmetry has long been studied as a critical factor in face recognition. In [1], partial asymmetric left or right faces have been used for recognition. Bilateral facial symmetry has been used in [2] to calculate gender and degree of facial symmetry scores. In [3], facial symmetry has been used to correct pose variations for 3D face images for face recognition. In [4], facial symmetry based left half faces have been used for face recognition. In [5], mirrored face images, based on facial symmetry are used to construct highly accurate 3D face models. In [6], an optical flow based facial asymmetry measurement is presented to facilitate face reconstruction and recognition. Despite recent progress in recognizing age-separated face images, yet there are two main limitations including: (1) lack of facial features evaluation with temporal variations; (2) most of the existing methods rely on a single feature representation, such as local features and hence lack the discriminatory information. Furthermore, such features can be manipulated by certain age groups using artificial facial variations, for example, by facial make up, as suggested in [14]. In this study we address these limitations by: (1) evaluating asymmetric facial features with temporal variations; and (2) combining existing feature descriptors with asymmetric facial features to improve recognition performance of age-separated face images. Keeping in view the presented methods and to the best of our knowledge, the current research is the first to explore the role of facial asymmetry towards recognition of age-separated face images on three public domain facial aging databases, the FERET [15], MORPH Album II [16] (termed as MORPH in the rest of text) and FG-NET [17].

1.2. Facial aging databases

FERET is one of the largest publically available databases with 3540 face images of 1196 subjects in the age range of 10–70 years. It contains a gallery termed as fa set, fb set with alternative facial espressions and two aging sets termed as dup I and dup II, representing small and large temporal variations, respectively. MORPH is another large facial aging database, which contains 55134 age-separated face images of more than 13000 subjects in the age range of 16–77 years. FG-NET aging database contains 1002 age-separated face images of 82 subjects in the age range of 0–69 years. Some age-separated face images from these databases are shown in Fig. 1.

1.3. Etiology of facial asymmetry

Facial asymmetry, which refers to non-correspondence in shape, size, and arrangement of facial landmarks on both sides of the face, is common in humans, even in young healthy subjects [18]. Facial asymmetry may be classified as intrinsic and

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