A Comprehensive Survey to Face Hallucination

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Abstract This paper comprehensively surveys the development of face hallucination (FH), including both face super-resolution and face sketch-photo synthesis techniques. Indeed, these two techniques share the same objective of inferring a target face image (e.g. high-resolution face image, face sketch and face photo) from a corresponding source input (e.g. low-resolution face image, face photo and face sketch). Considering the critical role of image interpretation in modern intelligent systems for authentication, surveillance, law enforcement, security control, and entertainment, FH has attracted growing attention in recent years. Existing FH methods can be grouped into four categories: Bayesian inference approaches, subspace learning approaches, a combination of Bayesian inference and subspace learning approaches, and sparse representation-based approaches. In spite of achieving a certain level of development, FH is limited in its success by complex application conditions such as variant illuminations, poses, or views. This paper provides a holistic understanding and deep insight into FH, and presents a comparative analysis of representative methods and promising future directions.

1 Introduction

Face images, compared to other kinds of biometrics such as fingerprint, iris, and retina, can be acquired in a more convenient, natural, and direct way because they are collected in a non-intrusive manner (Jain et al. 2000). Consequently, a growing number of face image-based applications have been developed and investigated. These include face detection (Zhang and Zhang 2010), alignment (Liu 2009), tracking (Ong and Bowden 2011), modeling (Tao et al. 2008), and recognition (Chellappa et al. 1995; Zhao et al. 2003) for security control, surveillance monitoring, authentication, biometrics, digital entertainment and rendered services for a legitimate user only, and age synthesis and estimation (Fu et al. 2010) for explosively emerging real-world applications such as forensic art, electronic customer relationship management, and cosmetology.

The intrinsic fluidity of face imaging and uncontrollable extrinsic imaging conditions (such as an intended target deliberately concealing his/her identity) means that suitable face images for processing and identifying a person cannot always be obtained. In cases where low-resolution face images are acquired by live surveillance cameras at a distance or face sketches are drawn by an artist, however, face

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