Chapter 13

Face in Person Re-Identification

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ABSTRACT

The face represents one of the most diffused and established biometrics for both identity verification and recognition with a large corpus of research focused on advancing the accuracy, the robustness, and the response speed of face recognition systems by means of 2D, 3D, and hybrid approaches. One of the new research lines emerging in this field during the last years is face-based people re-identification, namely the task of recognizing new occurrences of an individual’s face once it has been detected and initialized at a given time on the same location or eventually at other locations covered by a network of non-overlapping cameras. In this chapter, the main issues and challenges specifically related to face-based people re-identification are described, and the most promising techniques and results proposed on this topic so far are presented and discussed.

INTRODUCTION

About twelve years after September 11th 2001, the diffusion of person identification and verification systems has reached a worldwide dimension, as anyone travelling overseas has probably experimented while waiting in a queue for immigration control procedures. Biometric systems exploiting face, fingerprint, iris, etc. have progressively become part of everyday life as predicted by pioneers of this technology, covering a growing number of applications in which the access to information, to services or even to physical locations is granted by the recognition of user’s biometric traits. With regard to face, precision of recognition and robustness to changes in pose and expressions have represented the major concerns for researchers and developers so far, performances have been steadily improved as witnessed by the various editions of face recognition contests organized in the last decade like the FRVT- Face Recognition Vendor Test (Phillips et al., 2007) and the FRGC - Face...
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Recognition Grand Challenge (Phillips et al., 2006); nevertheless new technical and applicative challenges are still open. Among these challenges, face-based person re-identification represents an active and interesting topic that has the potential to further extend the range of application of face as a biometric.

In general, person re-identification involves identifying new occurrences of a given subject previously detected at a different location and time across a network of sensors covering a large area by non-overlapping fields of view, but there are other declinations of this topic like recognizing an individual each time he/she is visible by the same camera over time, or even counting the number of occurrences of a given person in a video file/stream in an off-line approach. Re-identification is particularly useful in all the situations in which a large crowd gather, a kind of event more and more common in everyday life due to architectural (tall buildings, huge commercial centers, airports and stations which usually contain several thousands persons) and social reasons (e.g. big entertainment events) among the others. Consequently, it is easy to understand the interest of authorities and government agencies (which often monitor remotely these scenarios) in detecting and re-identifying subjects of interests during their movements across sensitive locations or in using automated surveillance systems able to recognize reported persons. Main obstacles in performing the above mentioned goals include multiple viewpoints and different object poses, wide lighting variations among cameras or over time, unpredictable trajectories, lack of camera coverage and also changes in clothing. Most of the approaches proposed so far to address the aforementioned issues rely on human appearance-based models (Yu et al., 2007; Gray & Tao, 2008; Farenzena et al., 2010; Doretto et al., 2011) to perform various kinds of pattern analysis to find recurrent relationships among clusters of pixels eventually classified as person’s head, body or clothes. Nevertheless, biometric descriptors have also been proposed and, under the right conditions, they could represent a viable approach to the person re-identification problem. To this aim, face is particularly interesting since it can operate at a distance as it is inherently a contactless biometric. In the following pages, the main aspects of using face biometric for re-identification purposes will be presented and analyzed, together with a detailed description of the contributions published so far on this.

FROM FACE RECOGNITION TO FACE RE-IDENTIFICATION: ISSUES AND CHALLENGES

As already recalled before, the research on face recognition conducted in the last two decades produced a great number of algorithms and methodologies (Belhumeur et al., 1997; Etemad & Chellappa, 1997; Wiskott et al., 1997; Moghadam, 2000; Bartlett et al., 2002, Wright et al., 2009). The first objective was mainly in raising the upper limit of recognition accuracy in controlled conditions (one of the explicit goals of FRGC) also because most of the first publicly available reference datasets for face recognition like the FERET (Phillips et al., 1998) and the YaleB (Georghiades et al., 2001) were acquired in studio with controlled settings and cooperative subjects.

However, after the first wave of approaches resulted in higher and higher recognition precision, the efforts were focused on improving performances in the presence of Pose, Illumination and Expression (PIE) variations, three issues extremely common in real world applications which could degrade significantly the accuracy of the results. That said, the re-identification problem poses even more compelling challenges (Chellappa et al., 2012) that can be resumed as:
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