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A Study of 2.5D Face Recognition for Forensic Analysis

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Abstract: In this paper, we have introduced a specific study on 2.5D face recognition methodology to deals with the forensic analysis. The study suggested to use AAM technique in feature extraction stage while the OPSO-SVM in the classification stage. We expect that the proposed methodology will work professionally in digital forensic domain. As a future work, we will apply the proposed methodology on 2.5D images from different datasets.

I. INTRODUCTION

Face recognition has recently received a significant attention, especially during the past few years. Face recognition is considered as a natural, non-intimidating, and widely accepted biometric identification method (Ortega-Garcia et al., 2004). The growing interest in face recognition is fueled by its wide applications such as access control, forensic applications, surveillance, human machine interface, image/video indexing and biometric passport/ID (Kusoma & Chua 2011).

Generally, the face recognition scenario can be classified as face verification and face identification. Face verification is concerned with a one-to-one matching (1:1) that compares

image of a face with a template face images whose identity is being claimed. On the other hand, face identification is a one-to-many matching (1: N) that compares image of a face with all image templates in a face database in order to identify the identity of the query face (Abate et al., 2007).

II. LITERATURE REVIEW

Face recognition studies have recently been applied in various fields including computer vision and pattern recognition. Generally, as a result of rising number of real world applications, a great number of face recognition techniques have been developed. One of the most key developments in this regard is the 2D face recognition. In fact, much research efforts on 2D have shown that the texture information in 2D image provides detailed information for interpreting facial image. However, 2D face recognition is sensitive to illumination, pose variations and facial expressions (A. B. Moreno et al 2009), (F. Abate et al 2007). On the other hand, a 3D data represents a 3D shape explicitly and compensates for the lack of depth information in a 2D image. As a result, s 3D face recognition has the potential to achieve higher accuracy comparing with 2D face recognition. However, it is negatively affected by changes in facial Expressions (Kusoma & Chua 2011).

Based on the literature of 3D face recognition methods, it can be inferred that the practical applications of 3D methods is hindered by the cost and complexity of 3D method equipment (Chang, 2003). Due to the aforementioned drawbacks existed in both 2D and 3D face recognition approaches, this research suggests compensating for the problems of 2D and 3D by substituting them with 2.5D range images due to its robustness to the illumination variation as well as it contains extra dimension information, which is the shape information that is independent to any illumination conditions (Hajati et al., 2011), (Conde et al., 2006), (Zafeiriou & Petrou 2011). In addition, the 2.5D is used to overcome the limitations of the highly cost 3D equipment and its high computational complexity.

III. RESEARCH PROBLEM

Forensic science plays a crucial role in the justice system by providing scientific and foundational information for investigations and the courts (Ashcroft et al., 2009).

Digital forensics (sometimes known as digital forensic science) is a branch of forensic science encompassing the recovery and investigation of material found in digital devices, often in relation to computer crime (Reith et al., 2002, Carrier 2001). In the last few years, the digital forensic technique got more attention by the researchers due to its importance in wide area of applications such as firearm calculation (Ghani et al., 2010), license plate recognition (Abdullah et al., 2010) and suspicious behavior recognition (Chan, 2010). Despite their obvious importance, determining criminals and suspect evidences using digital imaging has proven to take a very long time and requires detailed process explanation.

For example, forensic examiners perform this manually which is the prime reason behind the lengthy time required to complete and verify the evidence. Hence, the first reason for the necessity of this study is to use the automated system which aims specifically at facial recognition in order to enhance the efficiency forensic work performed by various law enforcement agencies and to standardize the comparison process. Another argument for carrying out this research is that to date there is no working face recognition system that is accepted within the judicial system (T. Ali, R, 2010). In fact, the face recognition methods mostly use the AAM for face features extraction and recognition. But, this AAM based face recognition method lacks in the optimization process (H. Lee and D.Kim 2009).

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Last but not least, the used classification techniques in this area have a significant effect by rising up the system performance. However, the common and existing classification techniques have not converged to optimal decision, for example, the-states-of-the-art methods denote by PSO-SVM and BPNN (Jin Wei et.al 2011).

IV. RESEARCH OBJECTIVES

- To develop a 2.5D face recognition method able to work with the video in uncontrolled environment in order to identify suspects in forensic identification.
- To introduce reliable feature extraction method in forensic identification.
- To develop and enhance a hybrid classification method for improving the forensic analysis performance.
- To evaluate the performance of the proposed methods by comparing it with the states-of-the-art model.

V. RESEARCH METHODOLOGY

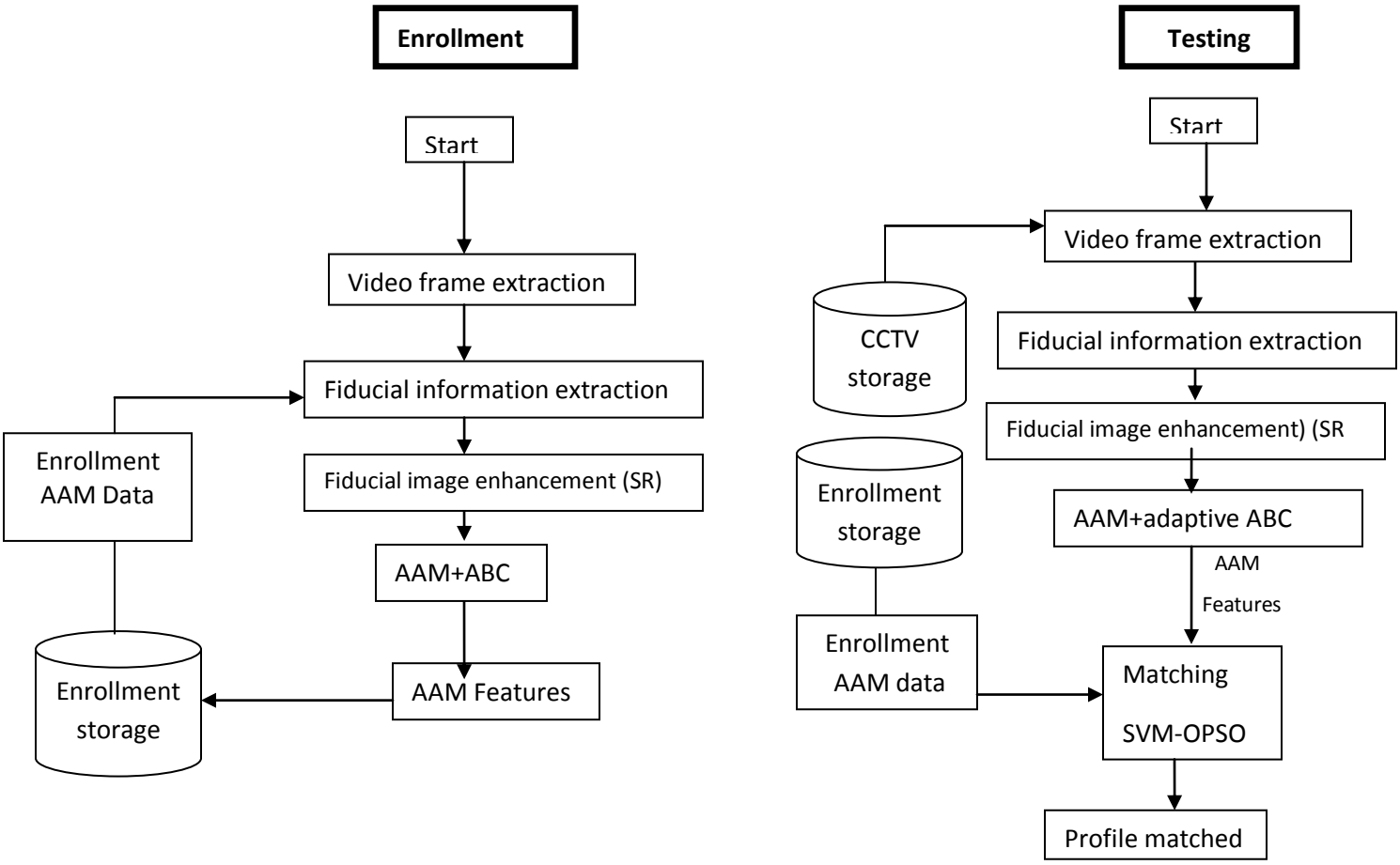

Figure 1. The proposed 2.5D Face Recognition Technique

As shown in the figure above, the proposed methodology framework is divided into two main stages. The first stage is the enrollment stage, while the second stage concerns with the testing video from CCTV dataset.

However, the enrollment stage is divided into four main steps, starting with video frame extraction. In this step, the video frames will be extracted and select the best frame. After that, the Fiducial information will be extracted from the best frame that extracted in the previous step because the fiducial information is the most important information in the video frames while the extra parts will ignore. Later, Appling enhancement process on the image that has fiducial information to get more enhanced image .After this step, the proposed Active Appearance Model (AAM) will be to extract the face features .In the proposed AAM, the fitting problem of AAM is solved by introducing a new adaptive ABC algorithm. The adaptiveness improves the fitting efficiency when compared to the conventional ABC algorithm. The extracted features will be saving in the enrollment storage part. In the second stage of the proposed framework, testing stage will start with video frame extraction from the CCTV videos that are stored in CCTV storage. Fiducial information will be extracted from the frame that will be selected. After that, the enhancement will be applied on the fiducial information that extracted in the previous step. Then, the features will be extracted from the selected fiducail information using the proposed Active Appearance Model. Then, the matching among the features that have been extracted in the enrollment stage and the features that will be extracted in the testing stage will be applied to make the decision. The matching will be using PSO- SVM method. In this step, the PSO will be used to get the best parameter for SVM.

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