

3D Face Recognition: Where we are.

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Invited Paper

1. Short overview of 3D Face Recognition

Although face recognition (FA) has drawn increasing interest for decades and that significant advances have been achieved, intra-class variations due to various factors in real-world scenarios such as illumination, pose, expression, occlusion and age remain a challenge in practical face recognition (FR) systems.

In the Face Recognition Vendor Test (FRVT) 2002 systems based on 2D intensity or color images were shown to deliver recognition rates of over 90% under controlled conditions [1]. However, with the introduction of aforementioned variations, in particular differences in expression, performance deteriorates significantly. These results led to acceleration in studies of alternative modalities, especially involving three-dimensional (3D) face images, since it is an a priori natural approach to mitigate difficulties related to pose and illumination. Consequently, through the use of 3D, FRR levels of 0.01 and FAR levels of 0.001 were reported at FRVT 2006.

Today, a number of early commercial systems based on diverse approaches have appeared on the market. For instance, the Geometrix Face Vision 3D Sensor outputs tightly calibrated stereo image pairs that are processed into a precise 3D shape while the Konica Minolta Vivid series exploits laser-beam light sectioning technology. More recently, with the arrival of Microsoft's affordable Kinect has given rise to a depth camera revolution in vision-related research and enables a wide range of applications such as robotics and HCI.

Even with the a priori inherent advantages of 3D FR, challenges to make this technology directly usable and reliable in real applications are still numerous with regards to fingerprint technologies for example.

Obviously, 3D FR has greater potential than its 2D counterpart but, in practice, it is not straightforward to obtain accurate 3D image input data. Systems that extract shape information from 2D images, e.g. passive stereo approaches, rely on the knowledge of extrinsic parameters of the scene and intrinsic parameters of the camera to obtain a certain degree of

accuracy. With other acquisition technologies such as active sensors, i.e. laser scanners, a scan can take several seconds, and additionally requires the subject to remain still during the acquisition process. The reconstruction of depth is furthermore possible only at short distances. Additionally, while a 3D facial shape is intrinsically independent of illumination variations, the accuracy of current 3D acquisition systems is still sensitive to differences in lighting conditions. Finally, while pose and illumination variations can be managed by utilizing 3D data, expressions which alter the facial surface characteristics remain an open issue.

2. Eurecom's contributions to 3D FR

Currently, Eurecom participates in two 3D face recognition related research projects: a national French project entitled Face Analysis and Recognition in 3D (FAR 3D) [7], and a European project entitled Trusted Biometrics under Spoofing Attacks (TABULA RASA) [8].

FAR 3D: This project harnesses the effort of four teams (Eurecom, USTL, ECL and THALES) to explore 3D face recognition techniques. Eurecom's contributions mainly focus on the concept of asymmetrical protocols in 3D face recognition where enrollment performed in both 2D and 3D (i.e. shape and texture of faces) whereas test face images are captured only in 2D or from video. The problem of expressions in 2D probe images is addressed by simulating facial expressions using the 3D neutral model of each subject during enrolment. In order to obtain realistic simulations of facial expression, an automatic procedure is proposed to generate MPEG-4 compliant animatable face models from the 2.5D facial scans (range images) of the enrolled subjects based on a set of automatically detected feature points (see Fig. 1).

TABULA RASA: This European project, addresses some of the issues of direct (spoofing) attacks against trusted biometric systems, Eurecom is leading efforts to develop countermeasures against 3D FR spoofing attacks. Since the recent introduction and development of 3D FR systems, the main issues which have been addressed are related to expression variations or

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occlusions, i.e. more generally speaking, robustness against intra- versus inter- class variability. However, spoofing attacks against 3D FR systems, where a malicious user might pretend to be someone else at the sensor or acquisition point of the system, still remain under investigated. Eurecom's efforts within this project aim to fill this gap.

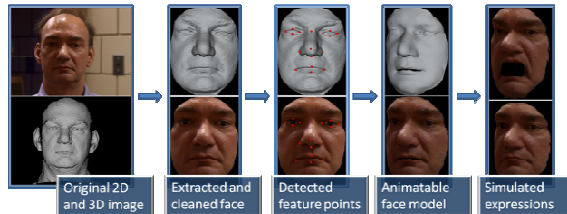


Fig 1. Simulation of a facial expression is illustrated.

3. Current 3D Face Products

Security is a very important topic, and new technologies may help in providing better solutions. There exists an important and increasing demand for more effective and less intrusive security systems. Therefore, in addition to numerous 2D FR technologies, several well-established or also new companies started to produce 3D FR products to meet this demand. Below, we briefly present some early products thus far developed.

- **3D FR Technology of L-1 Identity Solutions (now part of Safran MORPHO):**

The *3D FastPass Face Reader* produced by L1 Identity Solutions provides high-speed access to offices and restricted areas. It authenticates users in less than a second. The *3D FastPass* system increases security while maintaining high throughput for access to buildings while making the process effortless for employees.

- **SureMatch 3D Suite of Technest:** *SureMatch 3D* is a suite of facial recognition tools that provides more robust detection capabilities through 3D enhancement [3]. The suite consists of 3D Face Map, 3D Enroll, 3D FaceCam, 3D Sketch Artist, 3D Face Match and integrated systems.

- **3D FR System of Godrej Group:**

The *Face Reader* produced by Godrej group can be connected to a LAN and remotely managed through the Administration software. With an access controller it can be effectively used with other biometrics and card based systems [4]. The reader also authenticates users in less than a second and is optimized for high traffic areas.

- **Vision Access 3D FR of A4 Vision (Applications for Vision), Inc.:**

A4Vision develops advanced identification systems for tracking and targeting camera systems using 3D FR technology [5]. The *Vision Access 3D face reader* is commonly used to control physical access to buildings. An integrated LCD and audio feedback assist the user to adopt a suitable position in order for the reader to quickly capture an optimal image [6].

References

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