Identity and Message recognition by biometric signals

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Abstract

The project addresses visual information representation, and extraction. The problem is investigated within applications that are normally embedded into multidisciplinary applications, e.g. robotics, forensic science,, human machine communication. Multimodal biometric identification and communication has been at the focus.

Keywords

Image processing, biometric identification, feature extraction, information encoding, information decoding.

Background and Motivation

Facial detection and recognition resilient to physical image deformations is a challenging problem that hinders not only face based identity recognition but also iris based identity recognition goes en-masse. We have been studying both in conjunction with periocular image analysis, Fig. 1.

Illumination, Scale, and orientation invariant information encoding and decoding is central to many pattern recognition problems. We have been studying this in the context of lip-motion analysis for identity and spoken message recognition.

Quality and orientation descriptors for forensic images is important to reliable and efficient use of Automatic Identification of Fingerprint Systems. In this project we have been studying image analysis techniques to help using the visual capabilities of human forensic experts more efficiently when they communicate with recognition engines.

Facial detection and recognition

Biometric identity recognition using periocular images based on retinotopic sampling grids and Gabor analysis of the local power spectrum has been studied. Periocular images include iris based recognition, a weak link of which is the segmentation of iris region containing useful identity cues. A new method, using the Generalized Structure Tensor, has been studied. Segmentation performance under different degrees of image defocus and motion blur has also been evaluated.

Speech & speaker recognition by lips

Methods for detecting high-level lip-motion events have been studied. The mouth events of opening and closing has been at the focus of attention, Fig. 2. The approach is based on a recently developed optical flow algorithm that handles the motion of linear structure in a stable and consistent way.

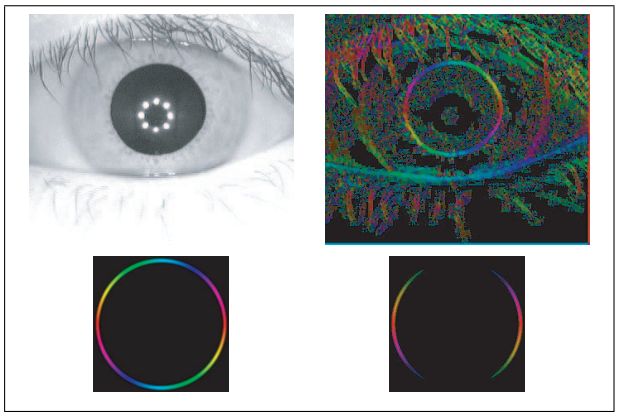

Figure 1: Iris segmentation depicting orientation map representing directions with hue, the models of pupil and scelera in orientation space. mouth-opening (area)

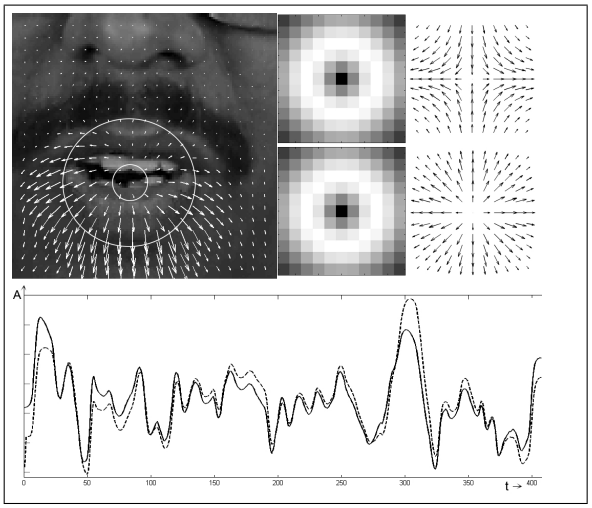

Figure 2: Lip-movements estimation, and the estimated mouth-opening (area)

Measurements for Forensic identification

Forensic images are of extreme low-quality. We have been studying feature extraction for increased identification power of fingerprints by dense orientation maps with frequency adaptation. Annotated databases is important. However, such databases are scarce and those that exist contain few image samples. We have been investigating ways to obtain most from existing databases to facilitate method developments.

Results

We also show that top verification rates can be obtained without rotation compensation, thus allowing to remove this step for computationalefficiency. Also, the performance is not detected substantially if we use a grid of fixed dimensions, or it is even better in certain situations, avoiding the need of accurate detection of the iris region.

Reported results shows the effectiveness of the proposed algorithm, with similar performance than the others in pupil detection, and clearly better performance for sclera detection for all levels of degradation.

We have developed a novel method for mouth opening and closing events. We have shown that it is translation and rotation invariant, works at very fast speeds, and does not require segmented lips. A semi-automatic tool for generating groundtruth segmentation of video data, based on the optical flow algorithm used for tracking keypoints at faster than 200 frames/second has been developed. This resulted in groundtruth for 50 sessions of visual speech of the XM2VTS database consisting of hours of lip-movements.

We have established ground truth of minutia level correspondences for the publicly available NIST SD27 data set, whose minutia have been verified by forensic fingerprint experts by using semi-automatic extraction methods, Fig. 3. We have been developing novel orientation-based features which are rotation invariant and

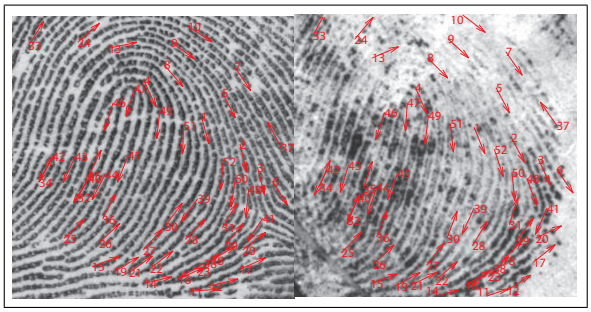

Figure 3: Forensic fingerprints minutia correspondence example, NIST-sd27

use large neighborhoods, so that each minutia can be described with more than the minutia-ridge orientation–the current practice.

Partners and Duration

The project has been implemented mainly with support of 3 sub-projects, the details of which are listed below. The CAISR project acting as a frame and catalyst is an appreciated supplement during 2012. Main partners of collaboration have been University of Twente (NL), Autonomous university of Madrid (ES), Radboud University (NL), Dutch forensic institute (NL), Swedish Forensic Laboratorium (SE), University of York.

Swedish VR project(2010): Bio-distance, Biometrics at a distance
EU-Marie Curie project (2011-2012): BIOMETRICS AT A DISTANCE
Swedish VR project (2013-2014): Facial detection and recognition resilient to physical image deformations

Swedish VR project (2010-2011): Lip-motion, face and speech analysis in synergy, for human-machine interfaces
Swedish VR project (2012-2013): Scale, orientation and illumination invariant information encoding and decodingA study on invariant visual codes

EU-Marie Curie project (2011-2013: BBfor2Bayesian Biometrics For Forensics.

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