# Online Face Detection and User Authentication

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## ABSTRACT
The ability to verify automatically and with great accuracy the identity of a person has become crucial in everyday life. Biometrics is an emerging topic in the field of signal processing. Our research on biometrics aims at developing a complete framework useful to control access. This technical demo shows the latest image processing techniques for face detection developed at France Telecom and for face recognition developed at Eurécom. Using only one computer and one standard webcam, our biometric system detects the user face and the recognition algorithm uses this image to enable the access to a resource, a service or a location.

## Categories and Subject Descriptors
I.4.6 [**Image Processing and computer vision**]: Segmentation – *Edge and feature detection;* I.4.8 [**Image Processing and computer vision**]: Scene Analysis –*Object recognition, Tracking.*

## General Terms
Algorithms, Security.

## Keywords
Face Detection, Biometrics, Face Recognition, Neural Networks.

## 1. INTRODUCTION
Biometrics [1] refers to the automatic recognition of a person based on his/her physiological or behavioral characteristics (face, hand, geometry, fingerprints, iris, voice, signature, etc). A biometric system is composed of at least two mandatory modules: the enrollment and recognition modules. During enrollment, the system extracts some features. Based on these features, a model is built and stored in a database. At the recognition level, features are extracted as done during the enrollment phase and are then compared with the model stored in the database. Generally, a biometric system can work under two different operational modes: identification or verification. During identification, the system should guess the identity of person among a set of N possible identities. During verification, the user claims an identity and the system should compare this identity with his/her stored model. Face recognition [2] is a challenging pattern classification problem as face images of the same person are subject to variations in facial expressions, pose and illumination.

In our work dedicated to biometrics, we have developed two algorithms in such a way that no human supervision is required. The first algorithm is able to detect and segment a face in the video input. At the next step, the recognition algorithm is applied on detected faces. Our algorithms enable the user to easily test the method thanks to the following specifications:

- There is no strong constraint for the user in terms of pose, illumination;
- No online training stage has to be performed after enrolling a new user;
- One face example per user is sufficient for recognition.

This demonstration will simulate an application like access control. Users will test the biometric system. Their face will be captured by a webcam and then, the users will be identified.


*MM'05*, November 6–11, 2005, Singapore.
ACM 1-59593-044-2/05/0011.

## 2. FACE DETECTION
In this open environment, faces have to be robustly detected and segmented before being recognized. We use the "Convolutional Face Finder (CFF)" [3] that has been designed to precisely locate faces of minimum size 20x20 pixels and variable appearance, rotated up to $\pm 20$ degrees in image plane and turned up to $\pm 60$ degrees, in complex real world images. Based on a specific architecture of convolutional neural layers, this system has been built by automatically synthesizing simple problem specific feature extractors and classifiers from a training set of faces, without making any assumptions or using any hand-made design concerning the features to extract or the areas of the face pattern to analyze. Once trained, the face detection procedure acts like a pipeline of simple convolution and subsampling modules that treat the raw input face image as a whole, in near-real time, without requiring any local preprocessing in the input image.

The CFF system proved to be very robust to variations in head poses, facial expressions as well as lighting variations and noise. Experiments have shown high detection rates with a particularly low number of false positives, on difficult test sets, without requiring the use of multiple networks for handling difficult cases. For instance, a good detection rate of 90.3% with 8 false alarms has been reported on the CMU test set, which are the best results published so far on this test set.

## 3. FACE RECOGNITION

This demonstration introduces a novel deformable model for content based image retrieval, which is applied to face identification, and whose stochastic model focuses on the relation between observations of the same class rather than the generation process. An important assumption made here is that the intra-class variability is the same for all classes.

While most face recognition techniques directly model the face, our goal is to model the transformation between two face images of the same person. As a global face transformation may be too complex to be modeled in its entirety, it is approximated by a set of local transformations with the constraint that neighboring transformations must be consistent with each other. Local transformations and neighboring constraints are embedded within the probabilistic framework of a two-dimensional Hidden Markov Model (2-D HMM) [4].

Our system could model with great accuracy facial expressions with local geometric transformations but it is clear that geometric transformations cannot grab certain types of variability such as illumination variations which are known to greatly affect the performance of a face recognition system. In our system, small variations illuminations are compensated by a log operator.

## 4. R&D DEMO SETTINGS & DESCRIPTION

This technical demonstration is easy to use and does not assume any expertise from users. Users will be able to test our application online to see how their face is detected and then identified by the recognition algorithm. The system makes use of a PC and a webcam. No physical constraint is required. Users will sit in front of the webcam, situated on top of or next to a monitor (see Figure1).

**Figure 1. Settings for the demo: just one computer and one standard webcam are needed**

During the demo, users will see two feedbacks windows (see Figure 2). On one of them, they will see the database, on the other one, they will see the online video input and for example, their detected face in real-time. First, to be recognized, users must be enrolled by the system. The interface allows users to localize faces by hand, i.e. clicking some feature points, in order to compare results with those obtained using Automatic Detection. Users will choose between identification or verification mode. When working in verification mode, users must claim their identity by selecting their face from the database or their name from a list of enrolled persons.

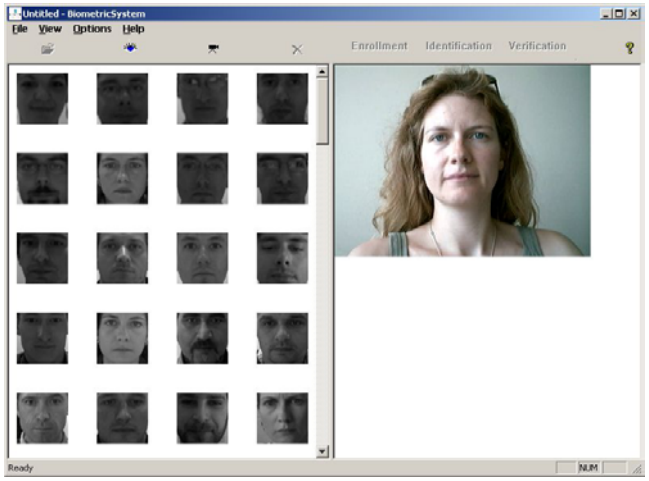


**Figure 2. Feedback screens**

## 5. REFERENCES


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