# 3D model fitting for facial expression analysis under uncontrolled imaging conditions

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## Abstract

*This paper addresses the recovering of 3D pose and animation of the human face in a monocular single image under uncontrolled imaging conditions. Our goal is to fit a 3D animated model in a face image with possibly large variations of head pose and facial expressions. Our data were acquired from filmed epileptic seizures of patients undergoing investigation in the videotelemetry unit, La Timone hospital, Marseille, France* [1].

## 1. Introduction

Facial expression analysis has been an active research topic for behavioral scientists and psychologists since the work of C.Darwin in 1872 [4, 7]. In 1978, Suwa et al. [11] presented a preliminary investigation on automatic facial expression analysis by tracking the motion of several identified spots on an image sequence. Since then considerable progress has been made in building computer systems that attempt to automatically analyze and recognize facial motions [8, 10].

Two principal classes of approaches have been developed: Image-based [2, 9] and Model-based approaches [5, 6]. Image-based methods extract features from images without relying on elaborate knowledge about the object of interest. Their principal quality is their quickness and their simplicity. However, if the data images are very diverse (e.g.: variation of illumination, of view, of head pose) image-based approaches can become erratic and unsatisfactory. On the other hand model-based methods use models which maintain the essential characteristics of the face (position of the eyes relative to the nose for example), but which can deform to fit a range of possible facial shapes and expressions.

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In this work, we are interested in analyzing the facial expression of several patients during epileptic seizures. In fact, detailed study of such facial expressions produced during epileptic seizures could help in understanding the cerebral organization of the seizures. Because of the unsupervised nature of the data acquisition (a fixed camera in a hospital room), we chose to use a model-based approach. A large class of methods developed in the last decade was based on the Active Appearance Models [12] and more recently on 3D Morphable Model [3]. These methods construct a model from a learning set of several images of different persons showing different expressions. In our case, the expressions of the epileptic patients during their crises could be individual and complex and consequently a model built from a learning set of common expressions (typically such as anger, sadness or happiness) would not have been sufficient. This is why we chose to use the Candide [1] model in our work.

We first introduce the 3D face model we used in this paper. Then we present our method to fit this model on a facial image. The next section deals with the analysis of a facial expression. The final section shows some of the results on the real data.

## 2. The 3D face Model

### 2.1. Candide face model

In this work we use a modified version of the Candide 3D face model [1], but our method can easily be applied to any other model. Candide is a parameterized face mask specifically developed for model-based coding of human faces. The original Candide Model contains 113 vertices and 184 triangles. Fig.1 shows the mesh of the model.

To control the model, 14 shape units and 71 animation units are provided (see Fig.2 for some examples of