Chapter 8
Communication and Automatic Interpretation of Affect from Facial Expressions

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ABSTRACT
The objective of this chapter is to introduce the reader to the recent advances in computer processing of facial expressions and communicated affect. Human facial expressions have evolved in tandem with human face recognition abilities, and show remarkable consistency across cultures. Consequently, it is rewarding to review the main traits of face recognition in humans, as well as consolidated research on the categorization of facial expressions. The bulk of the chapter focuses on the main trends in computer analysis of facial expressions, sketching out the main algorithms and exposing computational considerations for different settings. The authors then look at some recent applications and promising new projects to give the reader a realistic view of what to expect from this technology now and in near future.

INTRODUCTION
In June 2009, Microsoft released a trailer of its latest project for Xbox 360 gaming console, called Project Natal. The video, an instant Facebook epidemic and a YouTube favourite, featured Peter Molyneux, the creative director of Microsoft Game Studios Europe, demonstrating a virtual agent called Milo. Using the sensing and processing capabilities of its hardware, the virtual agent communicated with the user as if the boundary of the screen is just a window, recognizing identity
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and speech, but also emotions, which enabled it to respond to the user with an impressive range of realistic behaviours. The innovation of the project was in its ambitious scope: creating a virtual agent that truly communicates with the user. The key to life-like communication was recognizing emotions of the user, and in return, generating states that carry affect information for the agent in human-readable form, i.e. in the body posture, vocal intonation, and most importantly, facial expression.

The recently flourishing field of social signal processing (Vinciarelli et al., 2009) targets a greater contextual awareness for computer systems and human–machine interaction, and drawing on cognitive psychology, places great emphasis on automatically understanding facial expressions. The human face is a window that allows peeking into diverse patterns of emotions that manifest themselves voluntarily and involuntarily, communicating affect or projected displays of personality. Even dissociated from gesture and voice (as in still face pictures), facial expressions convey complex, layered, and vital information. Consequently, it is a great challenge to create computer systems that can automatically analyse images to reveal the sometimes obvious and sometimes subtle messages engraved in faces. In this chapter we aim to provide the reader with a broad overview of how computer scientists have risen to this challenge, starting from relevant taxonomies and guidelines, briefly touching upon the cognitive aspects of affect and face recognition, summarizing recent advances in algorithmic aspects of the problem, giving pointers and tools for the initiate, and finally, discussing applications and the future of facial expression recognition.

CATEGORIZATION OF FACIAL EXPRESSIONS

The human face is a complicated visual object; it contains a lot of information with regards to identity, communicative intent and affect, and humans can “read” these cues, even under difficult visibility conditions. We can for instance understand the emotions of a person we see for the first time. In this section we look at taxonomies of facial expressions, and point out to several important factors that need to be taken into account in evaluating facial expressions.

A facial expression can be the result of an emotional response (spontaneous), or a construct with communicative intent (volitional) (Russell & Fernandez-Dols, 1997). It can occur naturally, or it can be posed. In both cases, it can have different intensities, and it can be a mixture of pure expressions. These factors make the task of sorting out a facial expression difficult. Additionally, the categorization of expressions can be achieved in ever-finer levels. It is one thing to label the category of an expression as “happy”, quite another to distinguish between a real smile (also called a Duchenne smile), a miserable smile, an angry smile, an embarrassed smile, and a dimpler. Finally, cultural differences in facial expressions also need to be taken into account.

Categorization of emotions predate computers by hundreds of years, but the roles of particular emotions in society are different for each culture; in India, for instance, it was believed that the basic emotions are sexual passion, anger, disgust, perseverance, amusement, sorrow, wonder, fear, and serenity. Facial expressions of these emotions are culture-dependent, but also the semantic counterparts of these emotions do not completely overlap with the current understanding of these words, adding to the difficulty of systematically categorizing emotions. Furthermore, the experimental settings under which any study is conducted and the ensuing databases on which we measure the success of a given method are not independent of cultural influences. For instance it is known that in some cultures the expression of emotion is more restricted for social reasons. Finally, as facial morphology also changes according to the anthropological group of a subject, it is natural
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