Abstract

What man primarily sees in his continual social interactions are the faces of other persons. Starting from this vision is how he tries to infer what is happening in the bodies and minds of those individuals and then conclude if the person in question is happy, angry or in any other state of mind and thus, based on this information, modify his behavior. Using our vision system is how we analyze changes in the principal facial expressions to indirectly determine the emotion associated with these changes. Identification and recognition of emotions are therefore important abilities that facilitate the social and emotional development of people as well as being a fundamental factor of non-verbal communication. It is worth mentioning that the emotions can be expressed by diverse means, namely, bodily behaviors, vocalizations and facial expressions, being the last one mentioned, the most important.

A computer system automatically capable of determining an expression related to a face, taking into account that this expression is a reflection of the persons inner state, would be of enormous utility in fields as diverse as medicine, psychology, human behavior, security, human-computer interfaces and education.

Facial expression recognition is a very active research field and there are various solution proposals put forth by academic and commercial teams. Designing these systems requires knowledge in various scientific and computational fields such as: image processing, vision, artificial and computational intelligence, stochastic processes as well as psychological and physiological essentials.

The work reported in this thesis takes into consideration several aspects of a computational model for the automatic detection and quantification of facial emotions based primarily on the analysis and measurement of the changes in facial expressions, which are related to a

ruled-based fuzzy system which identifies and measures the intensity of the displayed emotion.

Among the enormous challenges raised by the detection of facial emotions, the solution to two of these, predominantly constitute the contribution of this research. The first of these contributions is in the psychological and physiological fields where we developed an Emotion Knowledge Data Base which allow creating models, based on facial movement, and using the Facial Action Coding System (FACs) developed by Paul Ekman, the Facial Animation Parameters (FAPs) and the Facial Definition Parameters (FDPs) of the MPEG-4 standard which serve as a basis for identifying and measuring the intensity of the so called basic and no basic emotions. Despite the fact that the model only handles the six basic emotions, the advantage of the methodology is that it can be used systematically to model any non-prototypical emotion. It is very important to mention that our Emotion Knowledge Data Base allows defining diverse geometrical facial movements or mathematical transformations of facial features as features vectors.

Despite that the emotion section of the MPEG-4 standard was defined in principle for facial animation, we used it in conjunction with the so called Action Units (AUs) of the Facial Action Coding System (FACs) developed by Paul Ekman. This was due mainly because the MPEG-4 is a standard unto itself and that it also puts forth the movement of specific facial points (FDPs) which can be determined and followed with current Computational Vision techniques. Our research does not propose any methodology for the extraction of facial expressions.

The second contribution of this thesis is to have improved the fuzzification process of an AI rules-based diffuse system in order to not only detect the emotion but be able of measure its intensity. Additionally we have developed a structured method for creating systems of this kind. These systems can be easily adapted for identifying and scoring any other emotion.

The results obtained in this research are promising enough, they show, in first instance, that our system when compared with other similar systems or neural networks has similar global recognizing rates with the advantage that our system is also able of measure the emotions intensities. Also and very important, our methodology is far from the mathematical complexity of those methodologies as neural networks, it is more

intuitive, easy to apply and modify allowing to not expert people to develop his own applications.

Regarding the knowledge data base, it demonstrated its usefulness and importance in the development of this work, allowing a structured framework in order to define the required rules to detect each particular emotion.

In conclusion, our knowledge database constructs the required knowledge which allows, in a structured way, the rules definition for detecting either prototypical or not prototypical facial expressions. And our ruled-based fuzzy system has a recognizing rate similar to other important techniques with the advantage of being able to measure also, in a continuous way, the intensities of action units and emotions, thus enabling our system to recognize more complex emotions.