

Expressing Emotions on Robotic Companions with Limited Facial Expression Capabilities

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Abstract. Facing the challenge of accurately expressing emotions with robots and characters with limited expressive capabilities, we developed an abstraction model for generating emotional expressions based on the atomic features that enable human beings to recognize emotions in other humans' faces. The model is also augmented by animation theory from movies and puppetry. A small evaluation of the expressions showed that some expressions were well recognized, in particular *Anger* and *Sadness*.

Keywords: Non-Verbal Communication, Expressive Behavior, Animation, Robotic Companion, Facial Expression

1 Motivation

Non-verbal expression of emotions serves very important functions in human social relationships, for example, to convey information about ourselves, to regulate social interactions (e.g. turn-taking and proximity) and express intimacy and emotional closeness [1], and thus is also a very important mechanism in human-agent interaction[3]. In this paper, we present an approach to the problem of expressing emotions in robotic companions with limited facial expression capabilities, in a way that they are correctly perceived by users. Our approach is based on both FACS [2] theory and cartoon animation principles. The work of Ekman and Friesen [2] describes, in terms of action units of the face, how humans universally express the six basic emotions: surprise, disgust, fear, anger, happiness and sadness, along with psychological and physical descriptions of their reflection in the human being. In robotic embodiments the expression of emotions is limited because, in most platforms, there is a lack of features that are present in the human face. Thus, we took inspiration from some of the twelve principles of animation [4]: *exaggeration*, *slow in/out*, *arcs* and *timing*, in order to better transmit emotions. We also made use of the *Tex Avery expression* [5], in which eyes pop out of a character's face, for use in a robot that supports it.

2 Expressing Emotions in Robotic Companions through Facial Animation

We developed a model of expressions based on a simplification of FACS coding system[2]. Abstract definitions of expressions were created from FACS, by analysing which are the necessary features in facial expression that humans use to understand emotions. We then map each expressive feature of the robot (e.g., eyebrows) to a feature from our model, thus mapping the abstract definitions into concrete expressions for each specific robot. Cartoon practices are finally introduced to refine the model with regard to each robot’s expressive capabilities.

3 Evaluation and Discussion

We implemented our model on the EMYS robot and performed a preliminary evaluation with six children, using soft and strong intensities for each of the six emotions, illustrated in Figure 1. Our results showed that Anger and Sadness were easily recognized, with Disgust being confused with Anger, and the other three confused all between them. These results were used to refine the expressions for a large-scale online evaluation. We also plan on implementing and evaluating the same model on the iCat¹ robot, in order to validate our abstraction.



Fig. 1. The six basic emotions expressed on EMYS, using our model.

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¹ <http://www.hitech-projects.com/icat/>