Evolving Expression of Emotions in Virtual Humans using Lights and Pixels

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An intelligent virtual human should not be limited to gesture, face and voice for the expression of emotion. The arts have shown us that complex affective states can be expressed resorting to lights, shadows, sounds, music, shapes, colors, motion, among many others [1]. Thus, we previously proposed that lighting and the pixels in the screen could be used to express emotions in virtual humans [2]. Lighting expression inspires in the principles of lighting, which are regularly explored in theatre or film production [3]. Screen expression acknowledges that, at the meta level, virtual humans are no more than pixels in the screen which can be manipulated to convey emotions, in a way akin to the visual arts [4]. In particular, we explore the *filtering* technique where the scene is rendered to a temporary texture, modified using shaders and, then, presented to the user. Now, having defined the expression channels, how should we express emotions through them? We are presently exploring an evolutionary approach which relies on genetic algorithms (GAs) to learn mappings between emotions and lighting and screen expression. The GAs' clear separation between generation and evaluation of alternatives is convenient for this problem. Alternatives can be generated using biologically inspired operators – selection, mutation, crossover, etc. Evaluation, in turn, can rely on artificial critics, which define fitness functions from art theory, or on human critics. Humans can be used to fill in the gaps in the literature as well as accommodate the individual, social and cultural values with respect to the expression of emotion in art [1].

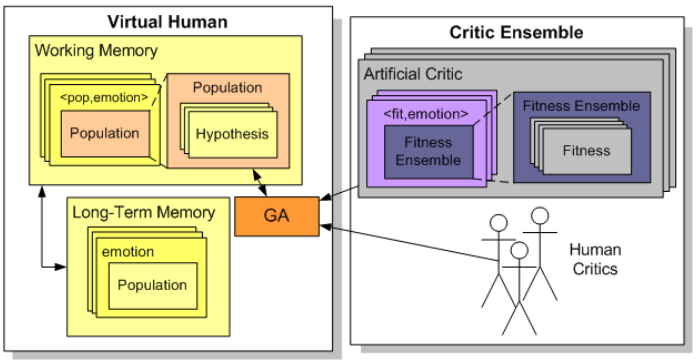

Fig.1. The evolutionary model.

Building on the expression model, the evolutionary model learns mappings between emotions and lighting and screen expression, see Fig.1. The model revolves around two key entities: the *virtual human* and the *critic ensemble*. The virtual human tries to evolve the best way to express some emotion. For every possible emotion, it begins by generating a random set of *hypotheses*, which constitute a *population*. A hypothesis reflects some configuration of lighting and screen expression. The population evolves resorting to a *genetic algorithm* under the influence of feedback from the critic ensemble. The ensemble is composed of *artificial critics*, which classify hypotheses according to guidelines from art theory, and *human critics*, which classify hypotheses according to subjective criteria. The set of populations (one per emotion) is kept in the *working memory* while being evolved but, can be saved persistently in the *long-term memory*.

A study was conducted where subjects were asked to evolve mappings of joy and sadness into lighting and screen expression. No artificial critics were used in this study. Subjects were asked to evolve five generations for each emotion. No gesture, facial or vocal expression was used throughout the whole experiment. The results were promising and showed that subjects classified each succeeding generation with increasing fitness and that they were comfortable interpreting emotions in virtual humans even though expression was exclusively based on lights and pixels. Interestingly, however, the notion of joy and sadness seemed to vary among subjects, see Fig.2. We are presently in the process of analyzing the collected data and what we seek to understand is what are the subjective fitness functions humans are using and how general these are. It would also be interesting to expand the mappings to the six basic emotions – anger, disgust, fear, joy, sadness and surprise – and, furthermore, explore more expression modalities such as the camera and sound of which much knowledge already exists in the arts [1].

Fig.2. Five top hypotheses for joy from different subjects in the study. What are the subjective fitness functions? What is common among them?

References

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