Facial Synthesys of 3D Avatars for Therapeutic Applications

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Abstract. People with autism spectrum disorder (ASD) find it difficult to recognize and respond to emotions conveyed by the face. Most existing methodologies to teach people with ASD to recognize expressions use still images, and do not take into account that facial expressions have movement. We propose a new approach that uses state of the art technology to solve the problem and to improve interactivity. It is based on an avatar-user interaction model with real time response, which builds upon the patient-therapist relationship: it is designed to be used by the therapist and the patient. The core technology behind it is based on a technique we have developed for real time facial synthesis of 3D characters.

Keywords. facial animation, computer graphics, autism spectrum disorder, therapy, rigging, modeling, animation, HCI

Introduction

Many efforts have been done to teach people with ASD to recognize facial expressions with varying results \cite{1,4,5}, but none focused on using real time facial synthesis. Most methodologies use Paul Ekman's approach \cite{2} based on photographs of facial expressions. Besides having severely limited interactivity, they fail to reproduce the dynamics of a facial expression: far from being a still image, it is the voluntary and involuntary contraction of muscles that produce different facial movements.

Our methodology is designed to assist people with ASD to recognize facial expressions in a playful way. The system will run on PC and Xbox 360, so it can be used by specialized personal or directly by relatives of the patients.

1. Method / Tool

The core technology builds on a facial synthesis method \cite{3} we have developed, that eases the real time animation process. The main research challenges arise from the synchronization and realism problems, the support for the reusability of facial components, and the need for an avatar-user interaction model with real time response.

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Our methodology uses a videogame based approach, where the avatars can adopt different appearances, like human, cartoon or fantastic creature. It contains a set of exercises embedded in the gameplay that reinforce the learning process and generate a real time avatar response based on direct therapist input or on a set of predefined rules.

We also include a facial expression editor capable of displaying 3D characters in real-time. This allows the therapist to adjust or create new exercises on the fly, without the need of artistic or technical skills.

2. Results

To achieve high quality facial synthesis it is crucial to have an efficient rig that animates in real time (a rig is a set of controls that allow the animation of a character). We consulted several specialists to determine how the characters should look like, especially for non-human avatars. They suggested that the position and proportions of the eyes and mouth should follow the anatomy of the human face, so that the patients can easily map what they learn from the avatar to real life.

We have developed and extensively tested a sophisticated facial rig that deforms in real time, has anatomically correct deformations, and is easy to adapt. Thus, this rig becomes the foundation of the system pipeline. It will ensure that the characters animations follow a consistent artistic style, to ease the process of recognizing facial expressions and emotions. Figure 1 shows screen shots of some of our avatars, the rig that drives character animation and two facial expressions (happy, sad).

The user interface includes: a 3D avatar on the main window, the facial expression the user needs to match, the score and the level of difficulty of the game. On the main game area, the avatar displays a sequence of expressions and the user needs to match the expression display on the upper right part of the screen. These expressions are generated randomly at the beginning of each exercise. There are different types of exercises: match the facial expression on all of the face, match the facial expression on the upper part of the face or match the facial expression on the lower part of the face. Figure 2 shows a child playing the game and the videogame user interface.

![Figure 1](image1.png)

**Figure 1.** (a) rig, (b) expressions, (c) and (d) examples of our 3D models (copyright 2009 Face In Motion).
3. Conclusion

We argue that current technological advances in character animation can substantially improve the way we teach people with ASD to recognize facial expressions and emotions. Our approach introduces a novel and sophisticated interaction model that enables patients to learn by imitating the avatars’ movements. Future work includes a field test with therapists and patients for further validation of the methodology, and suggestions for new exercises to be integrated in the system.

References