

Facial and Character Animation Research at UH CGIM

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1. Introduction

The Computer Graphics and Interactive Media Lab (CGIM) (<http://graphics.cs.uh.edu>) at the University of Houston (UH) was founded by Dr. Zhigang Deng in October 2006. Its focused research directions include 3D Computer Graphics, computer animation, virtual human modeling and animation, human computer interaction, and medical/scientific visualization. The UH CGIM Lab is equipped with a state-of-the-art motion capture system.

2. Facial Animation Research

In this research direction, we focus on the synthesis of highly believable, expressive talking faces, efficient editing techniques for massive facial motion data, intuitive 3D facial sketching interfaces, and automated transferring of facial motions between various facial forms.

2.1. Data-Driven Expressive Speech Animation Synthesis

We present a novel data-driven expressive speech animation synthesis system with phoneme-level controls [DN06, DN08]. Given new phoneme-aligned expressive speech and its emotion modifiers as inputs, a constrained dynamic programming algorithm is used to search for best-matched captured motion clips from the processed facial motion database by minimizing a cost function. We also introduce phoneme-Isomap interface for visualizing and interacting phoneme clusters that are typically composed of thousands of facial motion capture frames. On top of this novel visualization interface, users can conveniently remove contaminated motion subsequences from a large facial motion dataset. Figure 1 shows a screenshot of our speech animation synthesis system.

2.2. Perceptually Guided Expressive Facial Animation

Most of current facial animation approaches largely focus on the accuracy or efficiency of their algorithms, or how to optimally utilize pre-collected facial motion data. However,

human perception, the ultimate measuring stick of the visual fidelity of synthetic facial animations, was not effectively exploited in these approaches. Therefore, we propose a novel perceptually guided computational framework for expressive facial animation, by bridging objective facial motion patterns with subjective perceptual outcomes [DM08]. First, we construct a facial perceptual metric model (*FacePEM*) using a hybrid of region-based facial motion analysis and statistical learning techniques. The constructed *FacePEM* model can automatically measure the emotional expressiveness of a facial motion sequence. Figure 2 shows the comparison results with and without *FacePEM*.

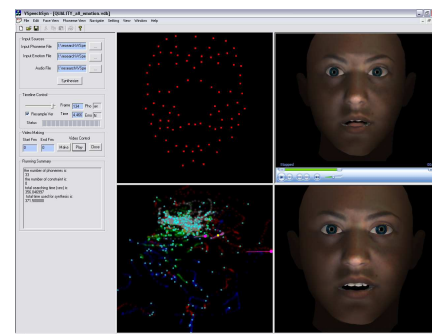


Figure 1: A screenshot of the expressive speech animation synthesis system [DN06, DN08].



Figure 2: Comparisons of expressive speech animations synthesized with/without *FacePEM* [DM08].

2.3. 3D Facial Expression Posing through 2D Portrait

Sculpting various 3D facial expressions from a static 3D face model is a process with intensive manual tuning efforts. We present an interactive 3D facial expression posing system through 2D portrait manipulation, where a manipulated 2D portrait serves a metaphor for automatically inferring its corresponding 3D facial expression with fine details [SMND08]. Users either rapidly assemble a face portrait through a pre-designed portrait component library or intuitively modify an initial portrait. Figure 3 show some edited results.

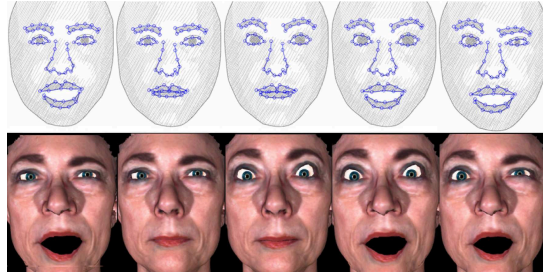


Figure 3: The top row shows 2D portraits edited by users. The bottom row shows generated 3D facial expressions [SMND08].

2.4. Facial Motion Capture Data Editing

We built a novel data-driven 3D facial motion capture data editing system [LD08] by automated construction of an orthogonal blendshape face model and constrained weight propagation, aiming to bridge the popularized facial motion capture technique and blendshape approach. Given a collected facial motion capture dataset, we construct a truncated PCA space spanned by retained largest eigen-vectors and a corresponding blendshape face model for each anatomical region of the human face. As such, modifying blendshape weights (PCA coefficients) is equivalent to editing their corresponding motion capture sequence. In addition, a constrained weight propagation technique allows animators to balance automation and flexible controls.

3. Character Animation Research

In character animation direction, we focus on how to effectively animate virtual humans and crowds, and the development of efficient algorithms to process, analyze and retrieve human motion data.

3.1. Compression of Human Motion Capture Data

A novel scheme is proposed to compress human motion capture data based on hierarchical structure construction and motion pattern indexing [GPD08]. Based on the observation that repeated motion patterns exist in human motion sequences, we design an adaptive algorithm to detect and extract motion patterns for each meaningful body part. Thereafter, a sequence of motion capture data can be efficiently



Figure 4: Compression ratio comparison with different algorithms [GPD08].

represented as a series of motion pattern indices. Figure 4 shows the comparison results with different algorithms.

3.2. Motion Marker Labeling for Interacting Targets

We present an online motion capture marker labeling approach for multiple interacting articulated targets [YLD07]. Given hundreds of unlabeled motion capture markers from multiple articulated targets that are interacting each other, our approach automatically labels these markers frame by frame, by fitting rigid bodies and exploiting trained structure and motion models. Figure 5 shows the labeling result of one frame.

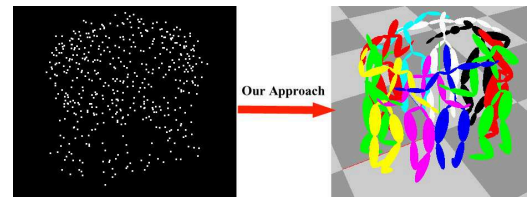


Figure 5: The left panel shows the snapshot of an input frame. The right panel shows its results after the markers are automatically labeled by our approach [YLD07].

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