

On the Expressive Potential of the Computer-Controlled Human Face.

Arthur Elsenaar and Remko Scha

Institute of Artificial Art
Amsterdam

Summary

We propose to present a performance by a computer program which displays sequences of patterns on an interactive live human face, using a custom-built face-interface system which allows fast and precisely synchronized simultaneous computer control of 16 different facial muscles. The performance will be introduced by our collaborator Huge Harry, who will briefly discuss the dramatic potential of computer-controlled human facial expressions, and its theoretical and artistic implications.

Theoretical Background

The performance proposed here takes place in the context of a larger research project carried out at the Institute of Artificial Art in Amsterdam, which is concerned with the automatic generation of artificial works of art in a wide range of different genres. Our efforts in this direction have already produced successful results in visual art and in music. This is not surprising; to the extent that visual or auditory art works are based on formal structures or physical processes, they can be easily produced by computer programs or by mechanical devices. Our current algorithms and machines make work that is comparable to the output of first-rate human artists (but at much greater speed). Soon they will surpass human painters, composers and musicians, and make traditional art and music obsolete.

In the areas of dance and theatre, however, we face a very different challenge. When a human person watches a dance- or theatre-performance, the strongest impressions on their minds are evoked by empathic reactions to the facial expressions and bodily movements of their performing fellow-humans. This explains why fully automatic theatrical performances, which do not involve human persons, tend to make a rather limited impact on human audiences.

To make really powerful automatic dance- or theatre-pieces, we must therefore put human muscles under computer control. This has been one of the central issues in our

research over the last few years. In our presentation at Ars Electronica 1997, we will review this research and demonstrate some of our latest results.

Techniques for computer control of human movements exploit the electrical nature of the motor-control processes in the human body. The contraction of a muscle group can be externally triggered by electrically stimulating the nerve that normally carries the signals from the brain to the muscle. This nerve can be relatively easily accessed at the "motor point", i.e., the location where the nerve is attached to the muscle. Devices applying these insights to control live human muscles were first developed for medical applications in the nineteenth century. The present-day art world has become familiar with this technology through numerous demonstrations by the Australian performance artist Stelarc.

At the Institute of Artificial Art we have developed a substantially refined version of this technique, and implemented devices based on these developments. Our current muscle-interface-hardware employs a sophisticated multiplexed microprocessor system which allows fast, precisely synchronized and finely tuned simultaneous control of 16 different muscle groups. The device can be controlled by a host computer through MIDI.

Using such custom-built devices, we have carried out many experiments concerning the external control of various muscles. Initially, these experiments were concerned with the movements of arms, hands and shoulders. During the last few years, however, our research has largely focused on a different part of the human body which has turned out to be very interesting: we have started to investigate the muscle system of the human face. In doing this, we have been able to build on important insights that were formulated already in the nineteenth-century by the French neurophysiologist Guillaume B. Duchenne de Boulogne (*Mécanisme de la Physionomie Humaine ou Analyse Électro-Physiologique de l'Expression des Passions*, Paris, 1862).

Our first important finding in this research was that various configurations of muscle contractions are consistently used by human persons to signal particular states of their operating systems, and that these configurations are rather reliably recognized by other human persons. Our collaborator Huge Harry has discussed this result in considerable detail at several scientific gatherings (e.g. at the Annual Meeting of the American Anthropological Society, and in the Research Colloquium of the M.I.T. Media Lab).

More recently, we have developed an algorithm which successively realizes *all* possible muscle contraction configurations on a human face. This experiment gave rise to our second major research finding: it turns out that the vast majority of possible muscle contraction configurations is *never* spontaneously used by human persons, and that

I 185

umans are in fact *incapable* of producing these contraction configurations without external electrical stimulation.

We expect that the face-interface-technology that we developed, and the research findings that it gave rise to, will have very important artistic applications. The external algorithmic control of the human facial muscles will be the basis of a new kind of "chamber theatre": facial choreography. New muscle contraction configurations (i.e.: new emotions!) can be realized in arbitrary patterns, with great precision, exactly synchronized with algorithmically generated music. (Since our latest face-interface-hardware is MIDI-based, integration with computer-controlled music will be easy.)

Demo/Lecture

At Ars Electronica 1997 we propose to present a performance by a digital computer controlling the muscle system of a live interactive human face. A fully automatic algorithm will demonstrate the repertoire of possible muscle contraction configurations of the human face. Also, various patterns of movements between different contraction configurations will be shown. Completely conventional human emotions will be demonstrated, as well as configurations that no-one has seen before. There will be some musical accompaniment by MIDI-controlled instruments, but that aspect will be kept fairly simple.

The performance will be introduced by our collaborator Huge Harry. He will explain the behaviour of our unique face-interface-system, and discuss the prospects for artistic applications of our surprising findings regarding the patterns that can be produced on the human face.

Video Tape Documentation

The video-tape submitted with this entry is *not* a tape of the performance/lecture that Huge Harry will give at Ars Electronica 1997; it would not be possible to submit such a tape, since Huge Harry never gives the same lecture twice, and since the details of a talk or demonstration are always established relatively briefly before the actual occasion, in order to connect with the local situation, and in order to take our most recent research results into account. The tape that is submitted therefore contains some different elements that together give an impression of the kind of demo/lecture that we have in mind for Ars Electronica 1997.

I 185

01'01" - 03'02": *The Varieties of Human Facial Expression. (12 bit version)*

This is a 2 minute fragment from 32 minute video-tape which enumerates all facial expressions that can be realized by combinations of on/off settings of twelve different facial muscles. The complete tape is ordinarily shown as a loop in a visual art exhibition context. It must be shown on a monitor turned 90 degrees in the clockwise direction.

The live demo proposed for Ars Electronica will show dynamic patterns of "facial choreography". These patterns will employ facial expressions from a larger repertoire: we will employ 16 different facial muscles, and a virtually continuous scale of contraction strengths (128 levels).

03'09" - 04'45": *Robot Rights Rally.*

This is a short piece of a promotion tape which records some sounds and images from a political manifestation (about equal rights for machines) organized in Groningen by Huge Harry. It gives an impression of our research agenda concerning large-scale theatre: algorithmic patterns on computer-controlled human muscles, algorithmic music on computer-controlled instruments, computer voice, algorithmic video-mixing, etc.

The live demo proposed for Ars Electronica will contain some algorithmic musical elements, but will have a much more modest scale than this public outdoors manifestation.

04'51" - 25'52": *Towards a Digital Computer with a Human Face*

This amateur registration conveys an impression of a Huge Harry lecture. The tape is much longer than what you requested; you don't need to look at all of it. The lecture starts with a fairly long introduction (04'51" till 11'40"); the second part (from 11'40" till 25'52") contains some demonstrations of human facial muscle contractions.

This tape shows how we use a video camera with a video projector to give a large audience a good view of subtle details of muscle movements on a live human face. We intend to use the same technique in the Ars Electronica presentation.

That presentation will be more demo-oriented than this lecture, but it will also include several theoretical statements by Huge Harry.