A Facial Repertoire for Animation

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Abstract

Character design and facial animation of characters is among the most tedious parts of creation of animations. In contrast to body animations, performer data have not been successfully used for faces. The CharToon system provides a facility to create a powerful repertoire of reusable components at several levels for the construction of faces and face animations. The knowledge embedded in the system allows for reuse of facial architectures, motion methods and animation definitions for newly constructed or adapted faces. These methods cover among other things, expressions, speech animations and changing view points.

This paper describes the organization of the repertoire, how it can be built and extended, and gives examples of its usage. The repertoire offers a perspective of how a higher level system of animation behaviors can be created on top. The presentation will show many animated examples of the contents and working of the repertoire.

1. Introduction

The use of humanoids in user interfaces is hampered by the lack of effective methods of creating and presenting expressive faces, with appropriate emotional and cognitive behavior. The creation methods are too slow and too tedious to use. The presentation and delivery systems are also slow, demanding high bandwidth, and are in general not easily controllable from scripts. The latter is a must for the realization of good responses during interactive dialogues, where the (re) action is driven by the real time assessment of the dialogue status.

A good example of the need for improvement is the avatars present in virtual environments, which exhibit the poorest of facial expressiveness.

The FASE project at CWI has developed a $2^1/_2$½ D facial animation system, called CharToon [3], containing the key functionality needed (in our view) to provide for interactive humanoid faces that can be driven by dialogue- or behavioral scripts. In the sequel we describe the most relevant features of the system with respect to the requirements for easy and flexible assembly and use of humanoid faces. The major characteristics of CharToon are given in the next paragraph. A complete technical description of the CharToon system can be found in [2].

2. About CharToon

CharToon is a system developed to design $2^1/_2$D faces (and other objects) which can be animated, compose animations for such faces, and play animations. The corresponding components of the system are Face Editor, Animation Editor and Face Player. These programs exchange data with each other and possibly with other applications via ascii files (see Figure 1).

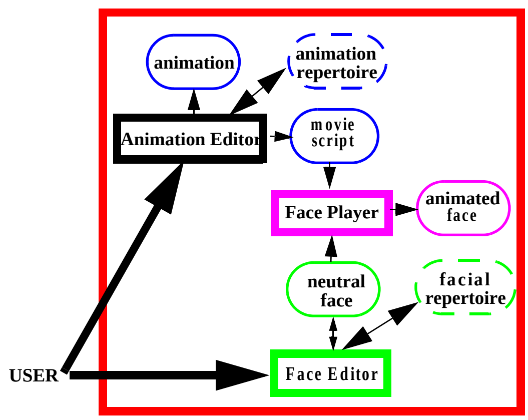

Figure 1: *The components of CharToon*

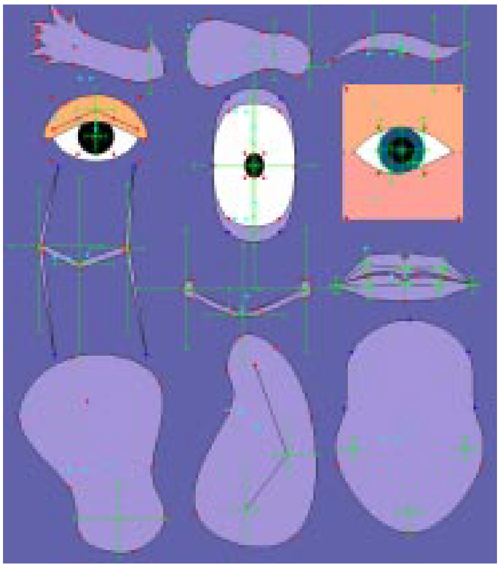

Figure 2: *Facial feature components*

A face is expressed in terms of vector graphics, and an animation is given as ascii data defining the so-called control points of the face. All the components are written in Java, which makes Web-based applications possible. (See [1] for an applet demo.)

3. The CharToon Repertoire

In this paper we will concentrate on the repertoire building and using facilities of CharToon , how we perform usability tests and how we will proceed further. The basic idea is to provide user interface developers with a *repertoire of animation building blocks* to create the animated interface from, not unlike the way widgets are used. The resulting animations are vector graphics based movies. Each movie frame can be generated at frame rate from a parameterized drawing. The frame descriptor merely contains the parameter values, and is thus conveniently small. Hence, apart from creating a complete movie with CharToon, it is also possible to produce a collection of movie sequences which can be played under the control of a dialogue script.

This report describes in more detail the possibilities to create a repertoire of facial animation building blocks [4]. It is very well possible to build another repertoire for other objects such as hands, bodies and backgrounds. However since faces are the paramount elements in internet animations, we concentrate on these here.

The major functions that are embedded in the building blocks are:

- The *facial architecture components* such as mouth, eye, hair and facial outline. An assembly of a face from such components typically is the starting point for shaping a particular face. Note that a basic property

Figure 3: *A face composed of some of the feature components*

of the repertoire is that each element of it is editable. This means that the creator of a character can alter and/or replace any component selected. This allows him/her to use the elaborate structures the system provides combined with full freedom concerning the shape and looks of his/ her puppets.

- The controls for animation as i*dentifiable control points*. Each component can be animated independently, or be coupled as a slave to a higher- level animation control, together with other components.
- The component hierarchy and the master slave relations among the control points in the components.
- The visual aspects of the components when seen from different angles, e.g. frontal, half- and full profile.
- The expression repertoire that a component can support, in the form of partial animation segments which can contribute to the formation of a particular expression. As a rule the six basic emotional expressions (joy, surprize, fear, sadness, anger and disgust) are available for each component.
- A *viseme repertoire* for the production of animated speech, lip synch with the sound.
- A *stationary repertoire* which can keep the faces alive (lively), when a face has to remain in the same state (e.g. looking friendly).
- Four *levels of quality*, High , Medium, Low and Primitive in terms of how fine detail of control is provided. Higher level control functions are more computationally demanding and require more designers effort to deal with all the details.

The repertoire is aiming at maximal orthogonality, i.e. components can be freely combined, and the resulting complex inherits all the components' properties. For instance, a face can use the animations from visemes as well as the animations from expressions, also simultaneously, through some form of animation blending.

For particular application areas the repertoire in principle is extendable with new functional categories. One of those already planned for is to add global head movements for underlining expressions and making the connection to the body movements.

Figure 2 is showing examples of facial building components, and some of the built-in motion controls. Figure 3 is showing a face build from the repertoire component assembly, and some of the motions inherited from these components.

This assembly and the exploration of the motion repertoire typically take place in the FaceEditor of CharToon. The result can be used by animators to animate the characters from scratch, to select key frames, or to select an animation sequence that can be generated from the repertoire.

Figure 4 shows examples of shapes that a facial component can take for the sake of making expressions. A face showing a neutral, a moderate and a strong expression is also given, showing the application of the components.

Figure 5 shows a mouth and a number of visemes for speech animation. The viseme controls can be reused for other mouth shapes as well, usually causing little need for adjustment of the new mouth.

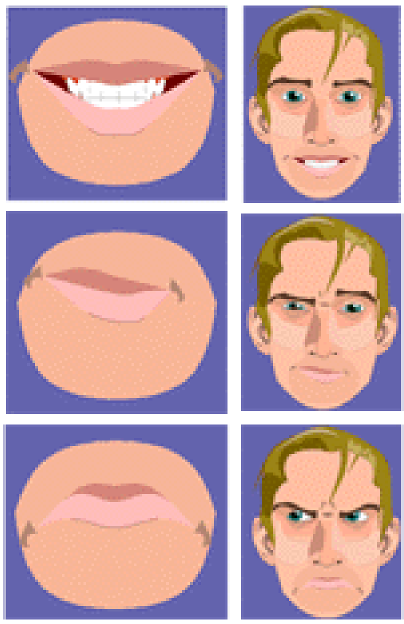

Figure 4: *Expressions of stand-alone components and used to make expressive faces.*

4. Exploring the Repertoire

A generic repertoire like the one described here can produce an enormous variety of faces and the corresponding behavior e.g. how it talks, how it smiles, etc. Basically the variety is exponential in the number of elements per repertoire category. With the modest basic components we now have the number of different faces is in the millions, and will eventually become billions.... We therefore introduce utility functions to explore and select from the repertoire. The utility approach is open-ended, because animators may decide to look for new combinations of features all the time. The basic utility of course is just to see what is there in the repertoire. To support this function we have a navigational aid that can at any element of the repertoire illustrate it either as icon or as an element in a sample face. In this paper we present two examples of exploration:

- The emotion disc, capable of showing the six basic emotional expressions contrasted against the neutral face as well as all in between expressions in a continuum.
- The profile and half profile faces derived from a frontal face. The utility gives for each frontal face expression the equivalent in profile and half profile.

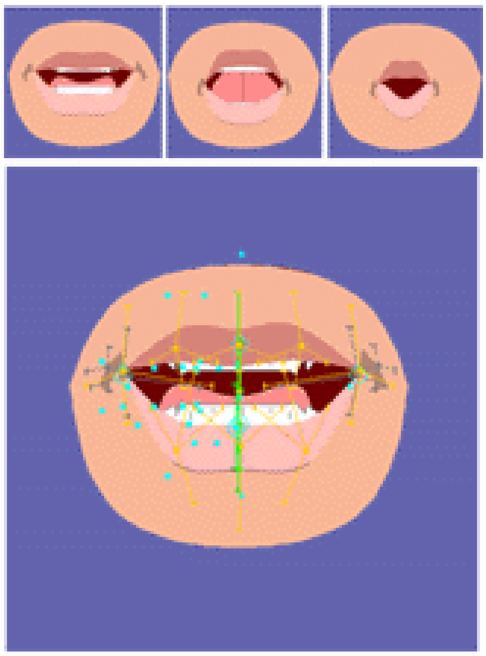

Figure 5: *Visemes for a mouth. Below the controlpoints are shown.*

The Emotion Disc

CharToon and its repertoire are structured in such a way that the classical sequence consisting of character design, followed by motion design followed by animating the story can be followed also for user interfaces.

The emotion disc can be used in all stages of the animators' work, to judge the expressiveness of the character and to support motion planning or key frame selection.

The emotion disc is based on the following properties of the repertoire:

- Each facial component has, in addition to its basic neutral, shape, information defining the shape variations corresponding to the six basic emotional expressions for joy, surprise, fear, sadness, anger and disgust.
- According to Schlosberg [5], the six basic emotional expressions for joy, surprise, fear, sadness, anger and disgust are visually related in such away that they can be arranged in a two dimensional space as a visual continuum, see figure 6. The space is arranged as a round disc showing a neutral face in the center and a maximal expression on the perimeter. Each position in the so-called emotion disc corresponds to an expression obtained by interpolation between the known expressions positioned on the disc.
- The repertoire contains a script to generate the emotion disc for an assembled face, and provide the inspection interface.

Figure 6: *The Emotion Disc with the 6 basic expressions. The expression at location X is computed as bi-linear interpolation of the expression components given at points 1,2,3 and 4.*

The emotion disc has been evaluated by an experiment with uninitiated users who had to classify and compare real life expressions with the range given by the emotion disc. The results are reported in [7]. In general one may conclude that the expressions so created are well understood, and mostly correctly perceived. This is true both for the type of expressions as for the strength of the expressions.

The emotion disc can be refined with further expressions. For instance, the sector for joy can be extended with further key expressions for special cases of joy.

Ultimately we aim at support for the user to create an emotion space for each character. Extension of the emotion space to a full expression space, also containing non-emotional expressions, such as attentiveness, are being investigated.

Faces in Profile

The repertoire contains examples of how facial motions as seen from different view points (i.e. frontal- , half- and full-profile) are related. For this knowledge from 3D facial models is used. The correspondence is represented in a hierarchy of master-slave relations among control points. These relations can be edited as part of the normal face editing routine. In figure 7 an example is given of such master-slave control as well as two corresponding profile faces.

Especially in the case of generating a viseme set for a new face this function is extremely helpful.

During animation sequences it is possible to switch to a new profile even under external script based control.

The Facial Animation Repertoire

The most important use of the repertoire is during animation, i.e. a session with CharToons' Animation Editor. The repertoire together with the animations so far produced becomes a source for selecting key frames, canned animations, generic animations (e.g. produced from a text to speech converter) and animation copied from other faces with a corresponding control profile.

At this stage the orthogonality of the repertoire is paying off:

- The repertoire is structured in such a way that after having created components on a higher level, the lower level elements can still be adjusted, without having to rebuild the layers on top.
- The repertoire is stratified in such a way that expressions and controls of faces can be derived from faces of the same type (i.e. control structure scheme), provided that the new face is not more complex. The system can simplify but cannot invent behavior of added parameters.

Figure 7: *Half and full profile of a face can be driven by animation made for the frontal view*

- The system will be capable of blending animations, either in time (coupling sequences), or across expressions (e.g. visemes with emotions).

5. Conclusions

The experience so far has indicated that character designers and animators greatly appreciate the facilities provided by the repertoire subsystem. To make it more useful to novice users, a user-friendly interface should be provided. This is under construction.

The repertoire turns out to be very useful even if a designer decides to create all of his characters form scratch. This has to do with the fact that in these cases the structures can be reused. This avoids some tedious work.

The system also provides support for optimizing the controls for more efficiency, without loosing expressiveness. This is due to the possibility to simplify the controls by reducing the parameter set, while keeping the animations valid. Simplifying in this way appears to be easier done than trying to find a simple but sufficient motion repertoire at the initial stage. A typical example is to derive a simpler viseme set from the initial one.

The possibilities to extend the repertoire with further features are dazzling. It will be difficult to select a direction, given the resources. It may be more appropriate to create a reservoir of extensions supplied by the user community of CharToon. This is currently being considered.

6. Further Work

The emotion disc as described here is a first example of a real time parameter driven animation, where the parameter values are user controlled. The built-in knowledge concerning facial emotional expressions creates a high level of control, i.e. the user selects emotions directly rather than manipulates, say, facial geometry via transformations. The system hides the underlying manipulations. The selection is based on direct visual feedback.

The built-in knowledge is intended to be general, e.g. the same position in the disc creates corresponding expressions for each face so constructed.

The repertoire also lends itself for experiments with higher level scenarios that can be realized on the basis of a behavioral repertoire. Such a scenario facility is being studied in the context of user interfaces using talking characters.

A further research question to be addressed is to upgrade the system to a 3D facial animation system, rather than the current $2^1/_2$D system. As a first approach we are building a link to an avatar environment based on VRML.

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