Painting on Canvas: A Facial Sketching Control System

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Abstract

Facial Animation in films and videogames has traditionally relied on creating all the facial poses and animation controls in the early stages of a production. This process, whether for key framed controls or motion captured animation, takes a lot of time and effort. We present a novel sketching control system inspired in the way artists draw, where a stroke defines the shape of an object and reflects the user's intention. We introduce the canvas, a 2D drawing region where the users can make their strokes. We present a Sketch-Based Free-Form Deformation technique that is used to create a real-time simple control system where facial deformation is sketched on, significantly speeding up the creation of poses. We show that the combination of strokes and canvases provides a new way to manipulate the shape of an implicit volume in space. As a result, we allow rapid prototyping of facial expressions on the fly in a very intuitive and interactive way. Our informal study showed that first time users typically master the system within seconds, creating appealing 3D facial poses and animations in just a few minutes.

Categories and Subject Descriptors (according to ACM CCS): I.3.6 [Computer Graphics]: Methodology and Techniques—Interaction Techniques;

1. Background

Our sketching system is inspired by previous sketch-based methods [ZHH96, EHEB97, IMT99] that interpret the user's free form strokes and interactively create 3D models. These systems free the user from explicit control of the underlying parameters. Generating 3D facial expressions through sketching has also been explored by a number of researchers. In contrast to sketching techniques used in 3D objects, facial sketching needs methods that can cope with subtle skin deformation. The uniqueness of each face makes facial synthesis so challenging. The smallest anomaly in the face shape, proportion, skin texture or movement is immediately detected and classified as incorrect. [CJ06] allow changing the shape of face by editing two curves: reference and target. The reference curve allows the user to select the facial features on the mesh and the target curve determines the new shape of the mesh. [LCXS09] build upon the previous concept and allow the animator to use pre-recorded data to eliminate the unnatural expressions that might be generated by ambiguous user input. [SMND08] allow creating facial expressions on a 3D model by manipulating the control points of a set of predefined curves on a 2D portrait. Our system generates facial deformations on the fly: when the user draws a stroke, the 3D model is deformed in real-time. Our system doesn't need additional curves or use pre-recorded data.

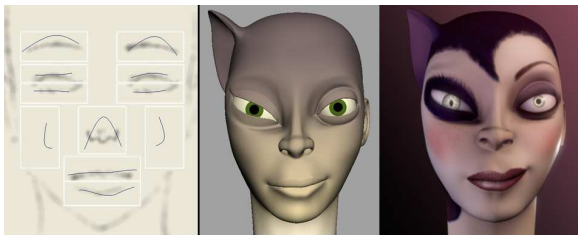

Figure 1: *drawing window (left): the boxes represent the canvases where users can draw the strokes; the background image is a generic face; scene window (middle): shows a facial pose of the 3D character and its rig; result (right): image generated with offline render.*

Also, it is not limited to a set of predefined curves with control points, but allows the user to generate facial deformation with any stroke and change the stroke at any point.

2. Control Sketching Concept

We start with a *drawing window* that can contains multiple *canvases*, which are drawing regions. A *stroke* is a free-form curve drawn on a canvas whose shape deforms the surface of an associated object. This object is a 3D model displayed on a separate window, which we call *scene window*. Each canvas supports multiple strokes. *The combination of strokes and canvases becomes the effective controller of the associated object*. We define a 2D domain as tuple $<\mathcal{C},\mathcal{D}>$, where $\mathcal{C}$ is a free-form parametric NURBS curve (the stroke), and $\mathcal{D}$ is the canvas. We define a 3D domain as a tuple $<\mathcal{M},\mathcal{W}>$, where $\mathcal{M}$ is a 3D model, and $\mathcal{W}$ is the scene window that displays the deformation. The relationship between the 2D and 3D domains, defined by the mapping functor $\mathcal{F}$, determines the correspondence between $<\mathcal{C},\mathcal{D}>$ and $<\mathcal{M},\mathcal{W}>$.

3. Facial Sketching Workflow

Based on the sketching concept, we have implemented an easy to use control system for facial animation. The workflow is divided in two stages: setup and interaction. The *setup* is the initial step, where the user must define the different canvases, represented by boxes on the background image of the drawing window, and afterwards associate the bones of the 3D face rig to the corresponding canvas. Then, the system is ready to *interactively* sculpt facial poses and generate animations. The workflow of the second stage consists of:

1. **Select facial region.** The *drawing window* is composed of several canvases, which are depicted as boxes on the background generic face image. Each *canvas* represents a different facial region of the 3D model: eyes, brows, nose, cheeks and mouth (see Figure 1). These regions are enabled every time the user draws a *stroke*. Strokes outside the canvases will not deform the 3D character mesh.
2. **Sculpt facial poses.** Deforming the mesh of the face model on the *scene window* is an interactive process. First, the user draws a stroke on a canvas; this stroke is then mapped into the model on the scene window, which automatically deforms the mesh of the character. The user can continue to draw strokes on different regions of the face to generate new deformations. The user can also modify a stroke, all or just a section of it, that is already on the drawing window.
3. **Create shapes.** The user saves the pose to create a shape.
4. **Animate.** The user generates animations based on interpolation of the shapes or by key framing a pose.

4. Results and Discussion

Reproducing the subtleties of a face through animation requires developing a sophisticated character rig with numerous shapes. But, creating by hand all the facial poses and key animation states of each character is a slow and manual process. We present a sketching system that allows *easy*, *rapid* and *interactive* prototyping of facial poses by drawing strokes. The system allows creating facial shapes on the fly. It supports non-hierarchy rigs, which makes it very convenient to control 3D models with complex structures, like a face. Our system can handle symmetric and asymmetric characters and is independent of the underlying rig structure. Our facial sketching system can be integrated into existing animation production pipelines; it improves the workflow as it speeds up the creation of facial poses, which means increased productivity and reduced costs. Our method allows artists to redefine the shape by simply drawing a new pose. The system is implemented as a stand-alone application developed in C++ with Ogre and as a plug-in for Maya 2010.

Testing and Validation We performed an informal study with young children and experienced artists. First time users from both groups were able to create facial poses in seconds, without any training period. This is possible because the sketching process is intuitive and similar to how we draw by hand. Experienced artists created facial shapes with production quality in less than a minute. We showed the results to Technical and Art Directors, who approved the quality of the poses and animations. This is a crucial result: if the output still requires a lot of tuning, then the system is useless in a production. Our system allows changing the background image on the drawing window. For young children, having an image close to the character's look served as guide and improved the drawings. For experienced artists, changing the image to reflect each expression they have to generate, helped the mapping of the 2D expression to the 3D pose.

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