Seminar on Advanced Computer Animation
CSE 888X14

Humans, Characters and Facial Animation - Overview

SIGGRAPH 08, CASA 08

Andrew Pamu

HUMANS

- ***Group Motion Editing***

  Taesoo Kwon , Kang Hoon Lee , Jehee Lee , Shigeo Takahashi *SIGGRAPH 08*
- ***Continuation Methods for Adapting Simulated Skills***

  Kangkang Yin, Stelian Coros Philippe Beaudoin, Michiel van de Panne *SIGGRAPH 08*
- ***Interactive Simulation of Stylized Human Locomotion***

  Marco da Silva, Yeuhi Abe, Jovan Popović *SIGGRAPH 08*
- ***Musculotendon Simulation for Hand Animation***

  Shinjiro Sueda, Andrew Kaufman, Dinesh K. Pai *SIGGRAPH 08*

Continuation Methods for Adapting Simulated Skills

Kangkang Yin, Stelian Coros Philippe Beaudoin, Michiel van de Panne

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- Modeling the large space of possible human motions requires scalable techniques. Generalizing from example motions or example controllers is one way to provide the required scalability.
- Continuation methods solve such problems using a progressive sequence of problems that trace a path from an existing solved problem to the final desired-but unsolved problem. Each step in the continuation sequence makes progress towards the target problem while further adapting the solution.
- Drawbacks of the data-driven approach for animated characters.
- Optimization is the main goal

Continuation Methods for Adapting Simulated Skills

Kangkang Yin, Stelian Coros Philippe Beaudoin, Michiel van de Panne

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- The idea of continuation methods is to solve a difficult problem by starting from the known solution of a related, but easier problem. For our problem domain, this also captures the intuition that motor skills can often be improved in a progressive fashion.
- Investigation of alternatives : gradient-descent, local-stochastic search, and hybrid continuation methods, each of which offer a different degree of coupling between the two problem features-style optimization and continuation advancement.

Continuation Methods for Adapting Simulated Skills

Kangkang Yin, Stelian Coros Philippe Beaudoin, Michiel van de Panne

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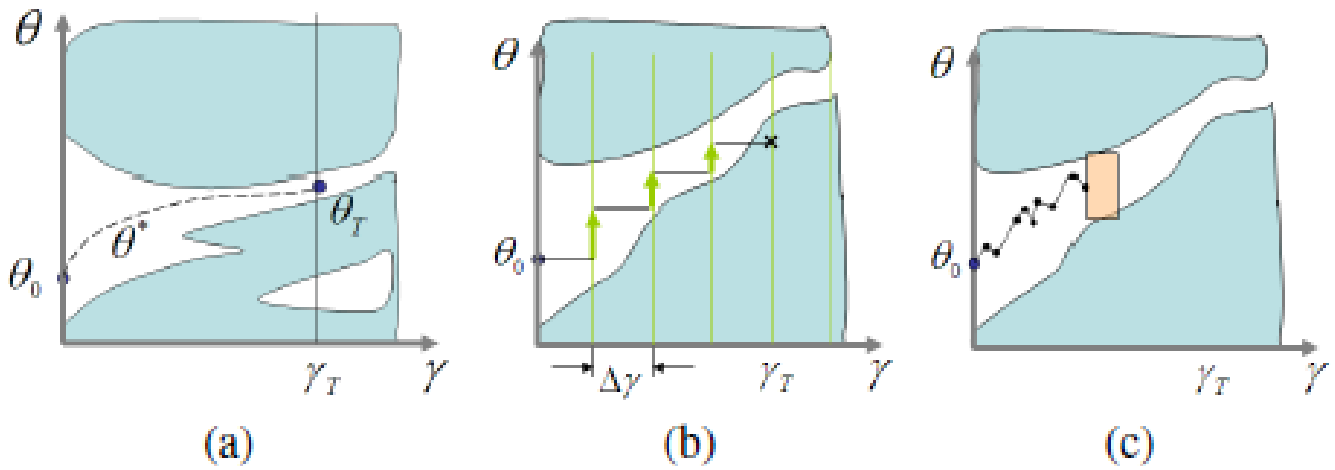

Figure 2: *(a) Abstract view of the continuation problem. The shaded regions denote failure regions where no meaningful gradient can be computed. γ is an environment-based continuation parameter. θ is the vector of free control parameters. (b) Gradient descent with fixed-step continuation (GRAD). (c) Stochastic local search continuation (STOC).*

Continuation Methods for Adapting Simulated Skills

Kangkang Yin, Stelian Coros Philippe Beaudoin, Michiel van de Panne

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Advantages :

- Continuation-based methods provide a natural way to adapt controllers to large changes in the environment. Continuation methods can be used to achieve surprisingly large motion adaptations.
- Problems that are seemingly very different, such as pushing furniture and walking on ice, can be treated within the same framework.

Current work :

- Investigation of multi-dimensional continuation methods-the extent to which the result of the multidimensional continuation can be represented in a factored form that supports linear superposition.

Interactive Simulation of Stylized Human Locomotion

Marco da Silva, Yeuhi Abe, Jovan Popović

SIGGRAPH 08

- Animating natural human motion in dynamic environments is difficult because of complex geometric and physical interactions. Simulation provides an automatic solution to parts of this problem, but it needs control systems to produce lifelike motions.
- This paper describes the systematic computation of controllers that can reproduce a range of locomotion styles in interactive simulations. Given a reference motion that describes the desired style, a derived control system can reproduce that style in simulation and in new environments.
- This paper describes controllers for interactive simulation of stylized human locomotion. This control design precomputes a balance strategy for the given style using automated analysis of linear timevarying approximations. By tailoring the balance strategy in this manner, a controller preserves the style better than a more cautious strategy.

Interactive Simulation of Stylized Human Locomotion

Marco da Silva, Yeuhi Abe, Jovan Popović

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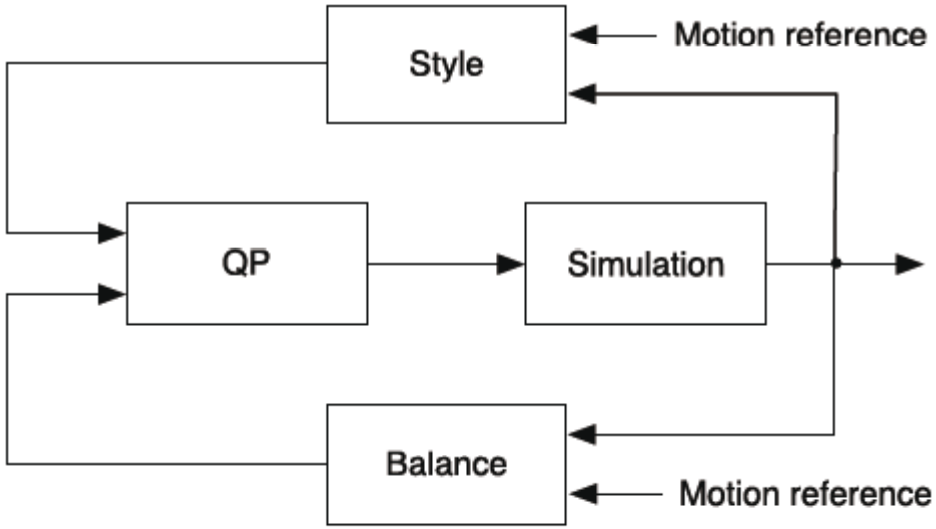

The automatic precomputation, which typically completes in less than two minutes, determines a linear time-varying state feedback that prescribes desired accelerations for the three largest body segments: the two legs and the torso. Simultaneously, the second feedback loop tracks individual joint angles to compute the accelerations needed to preserve the given style. As shown in Figure 1, reference motion guides both the style and balance feedback. The style feedback aims to preserve the nuances of the motion, while the balance feedback seeks to adapt the motion of three balance critical segments. The control algorithm computes a final set of forces by maintaining a desired tradeoff between the balance and style feedback.

Interactive Simulation of Stylized Human Locomotion

Marco da Silva, Yeuhi Abe, Jovan Popović

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Advantages:

- When paired with a control system that produces high-quality motion, these simulations can animate lifelike human motion in dynamic environments, which is difficult to accomplish with kinematics alone
- This process transforms a single recorded motion, valid for one environment only, into a general purpose action that can be used in many other settings or even composed with other actions to create versatile characters in games and other interactive applications.

Current Work:

- Higher-level planners should be developed to accomplish similar tasks automatically to improve robustness and respond to user input. Using a complex graph of simple actions, a higher-level planner could monitor the current state of the character, its environment, and the provided user input to simulate versatile characters in rich physically simulated environments.

Musculotendon Simulation for Hand Animation

Shinjiro Sueda, Andrew Kaufman, Dinesh K. Pai

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- An automatic technique for generating the motion of tendons and muscles under the skin of a traditionally animated character. This is achieved by integrating the traditional animation pipeline with a novel biomechanical simulator capable of dynamic simulation with complex routing constraints on muscles and tendons.
- An algorithm for computing the activation levels of muscles required to track the input animation. We demonstrate the results with several animations of the human hand.

Musculotendon Simulation for Hand Animation

Shinjiro Sueda, Andrew Kaufman, Dinesh K. Pai

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- When the body moves, tendons and muscles move under the skin in visually important ways that are correlated with both the movement and the internal forces. For example, the appearance of tendons on the back of the hand is related to how the hand is moving and how much force it is exerting. Even though there has been some work on incorporating muscles into animations it has been very difficult to incorporate biomechanically realistic subcutaneous movements into a traditional animation pipeline.
- Integration with a traditional character animation pipeline is important since, unlike secondary motion of inanimate objects, the movements of characters are of central importance to the story and are typically hand crafted by expert animators.

Musculotendon Simulation for Hand Animation

Shinjiro Sueda, Andrew Kaufman, Dinesh K. Pai

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Procedure :

- animators are given a rigged character, and animate it as they normally would, for instance, using key frame techniques or motion capture.
- The animation is then exported to our efficient biomechanics simulator, based on Lagrangian dynamics.
- We constrain the animated bones to follow the animator's chosen motion path.
- We perform an optimization onto determine the appropriate activation levels for each muscle throughout the animation.
- We then export the resulting physically based animations of musculotendons from our simulator and import them back into the rigged animation scene.
- The tendons are automatically skinned to the character's surface skin, providing complex secondary motion of the skin as a result of biomechanically realistic tendon motion.

Musculotendon Simulation for Hand Animation

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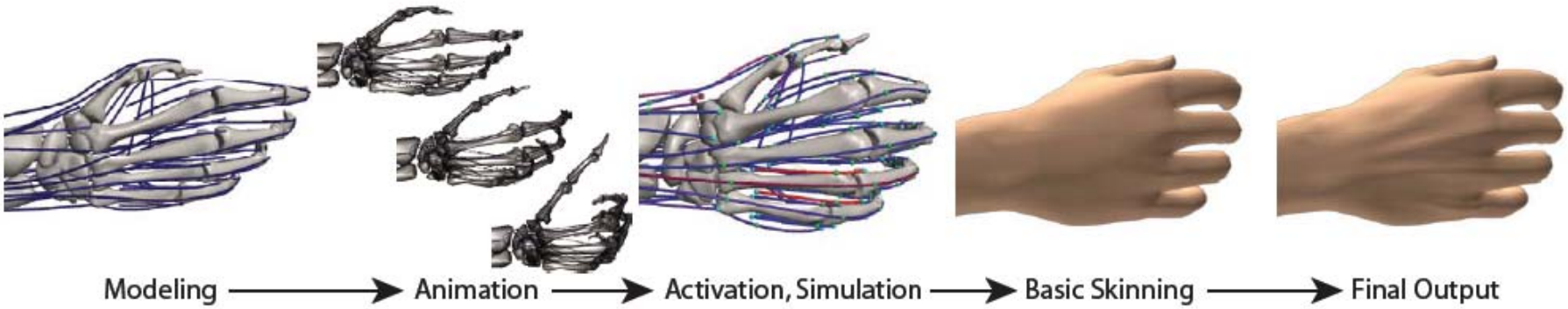

Figure 1: *Pipeline: The user specifies the model and its corresponding animation. Our system computes the required activations, and simulates the muscles, tendons, and bones. The skin is then attached to the skeleton, and the subcutaneous deformation from tendon motion is added as a post-process.*

Musculotendon Simulation for Hand Animation

Shinjiro Sueda, Andrew Kaufman, Dinesh K. Pai

SIGGRAPH 08

Advantages:

- A novel, efficient biomechanical simulator that can simulate thin strands including tendons and muscles, with complex routing constraints.
- Seamless integration of biomechanically realistic secondary animation into a traditional animation pipeline.
- An incremental algorithmic controller that determines the muscle activation levels required to dynamically track a target animation.
- Other than the hands, this method works well with areas where muscles and tendons are near the surface with little subcutaneous fat, such as the feet, neck, forearms, and hamstrings.

Current Work:

- More work needs to be done before it can be applied to areas of the body with volumetric muscles, such as the shoulder or the spine.
- Extending the controller to take into account neurally controlled muscle and joint impedances that are essential for manipulation

CHARACTERS

- ***Clone Attack! Perception of Crowd Variety***

  Rachel McDonnell, Micheal Larkin, Simon Dobbyn, Steven Collins, Carol O'Sullivan *SIGGRAPH 08*
- ***Animating Oscillatory Motion With Overlap: Wiggly Splines***

  Michael Kass, John Anderson *SIGGRAPH 08*
- ***Extended Spatial Keyframing for Complex Character Animation***

  Byungkuk Choi, Mi You, Junyong Noh *CASA 08*

Clone Attack! Perception of Crowd Variety

Rachel McDonnell, Micheal Larkin, Simon Dobbyn, Steven Collins, Carol O'Sullivan

SIGGRAPH 08

- In this paper, the ways in which an impression of variety can be created and the perceptual consequences of certain design choices are considered.
- In a series of experiments designed to test people's perception of variety in crowds, it was found that clones of appearance are far easier to detect than motion clones.
- Other factors that influence the ability to detect clones were examined, such as proximity, model type and characteristic motion. The results provide novel insights and useful thresholds that will assist in creating more realistic, heterogeneous crowds.

Clone Attack! Perception of Crowd Variety

Rachel McDonnell, Micheal Larkin, Simon Dobbyn, Steven Collins, Carol O'Sullivan

SIGGRAPH 08

- Problems of data driven crowd systems
- Therefore, a fixed number of template characters are usually deployed to generate large crowds using instancing, thus producing *Appearance Clones (AC)* that can often be easily noticed.
- As with the character models, the same set of animations is typically used multiple times, resulting in *Motion Clones (MC)* that look absurd and unrealistic
- the *perception of variety in crowds* have not been evaluated *to* date. Such information is however essential to allow for effective trade-offs between realism and resource wage, by ensuring optimal variety.
- The *Baseline Experiments* and the *Multiple clone Experiments*

Clone Attack! Perception of Crowd Variety

Rachel McDonnell, Micheal Larkin, Simon Dobbyn, Steven Collins, Carol O'Sullivan

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Results:

- Appearance clones were easier to detect than motion clones
- Increasing clone multiplicity reduced variety significantly
- No appearance model was more easily detected than others
- Certain gaits were more distinctive than others
- Color modulation and spatial separation effectively masked appearance clones
- Combined appearance/motion clones were only harder to find than static appearance clones when their cloned motions were out-of-step
- Appearance clones were also harder to find when combined with random motions
- Motion clones were not affected at all by appearance, even
- with random appearances

Clone Attack! Perception of Crowd Variety

Rachel McDonnell, Micheal Larkin, Simon Dobbyn, Steven Collins, Carol O'Sullivan

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Advantages:

- Useful thresholds were derived that could be used to balance the variety/resource trade-off mentioned above.
- While the concentration is on pedestrian like crowds in this paper, the results should also provide insights for many other types of crowds (e.g., stadium crowds or armies). The results will be mostly useful for developers of games and other interactive applications.

Current Work:

- Using an eye-tracker to analyze what it is that participants focus on when doing these experiments would be very interesting. This may allow for perceptually guided metrics to be devised for appearance and motion variation, to focus on varying parts of the body that are visually attended to the most when identifying clones.
- Future studies to analyze the effect of texture modulation and the addition of accessories would help to further our knowledge of the techniques that are most useful at disguising clones.

Animating Oscillatory Motion With Overlap: Wiggly Splines

Michael Kass, John Anderson

SIGGRAPH 08

- The paper introduces a new type of spline called the ‘wiggly spline’ for the purpose of oscillatory motion
- The spline generalizes traditional piecewise cubics when its resonance and damping are set to zero, but creates oscillatory animation when its resonance and damping are changed
- The spline provides a combination of direct manipulation and physical realism. To create overlapped and propagating motion, we generate phase shifts of the Wiggly Spline, and use these to control appropriate degrees of freedom in a model.

Animating Oscillatory Motion With Overlap: Wiggly Splines

Michael Kass, John Anderson

SIGGRAPH 08

- Oscillatory motion is ubiquitous in computer graphics and is an essential part of every animated feature film.
- Unfortunately, traditional animation tools are poorly suited to these types of motions, adversely impacting both the artistic quality and the cost of animating oscillatory phenomena.
- While these spline types are well-suited to many types of motion, their use is extremely labor-intensive for motion which is fundamentally oscillatory. Large numbers of knots are required to create oscillations, and moving them appropriately in concert to craft oscillatory motion can be both awkward and time-consuming.
- Physical simulation too, has its drawbacks

Animating Oscillatory Motion With Overlap: Wiggly Splines

Michael Kass, John Anderson

SIGGRAPH 08

- Wiggly splines - a generalization of the traditional animation splines that allow intentional oscillations.
- The Splines provide a familiar interactive interface supporting direct manipulation while at the same time embedding the physical realism of an oscillatory differential equation into the spline itself. They provide the mix we seek between realism and control.
- The key issue – “OVERLAP”
- overlap can be mathematically characterized through the notion of phase relationships of coupled oscillators. For ordinary splines, these phase relationships are not easily available. However, with Wiggly Splines, if one solves the optimization over complex numbers rather than real ones, there is a simple, automatic and natural assignment of phase angle to each point on the spline.

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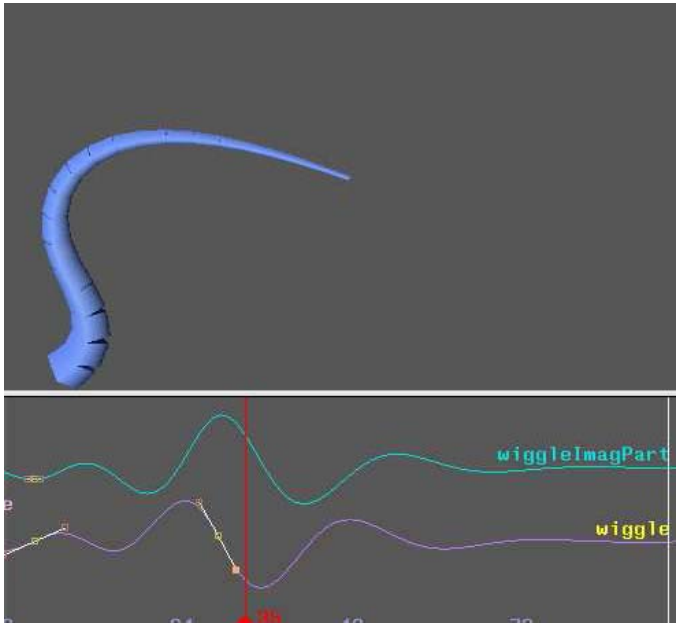

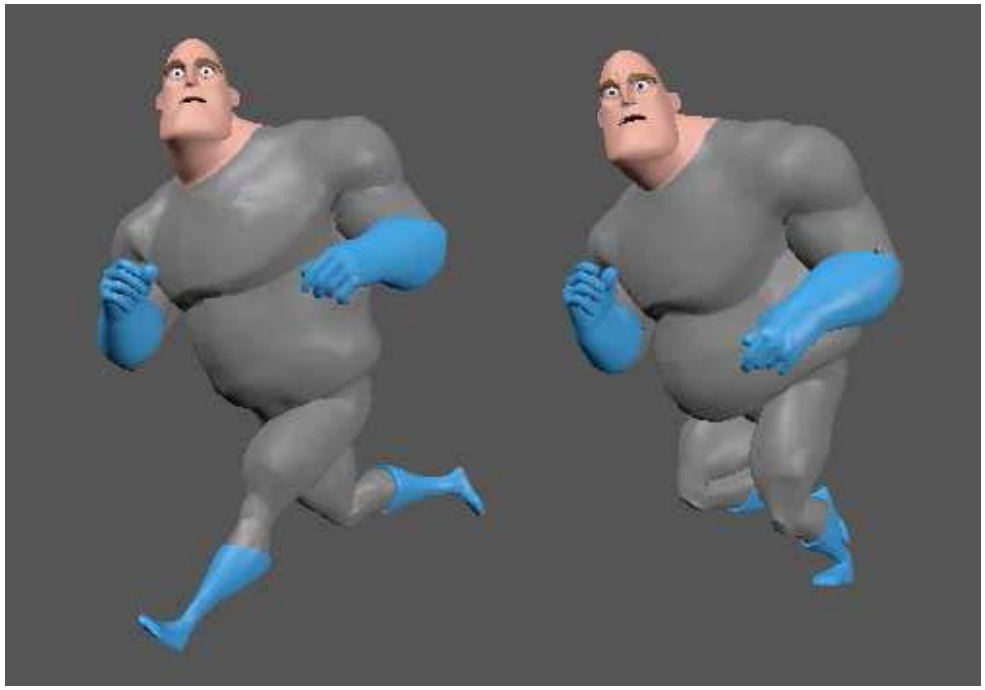

Animating Oscillatory Motion With Overlap: Wiggly Splines

Michael Kass, John Anderson

SIGGRAPH 08

Advantages:

- The representation of animation curves with complex values.
- The characterization of “overlap” by phase differences.
- The approach of extracting a canonical motion from a simulation and then generalizing it by altering parameters such as frequency, damping and rate of propagation.

Extended Spatial Keyframing for Complex Character Animation

Byungkuk Choi, Mi You, Junyong Noh

CASA 08

- This paper introduces a more powerful system to create highly articulated character animations with an intuitive setup then the previous research, Spatial Keyframing.
- It proposes Extended Spatial Keyframing that exploits a global control structure coupled with multiple sets of spatial keyframes, and hierarchical relationship between controllers.
- During the performance, the movement of the highest ranking controllers across the control hierarchy is recorded in layered style to increase the level of detail for final motions.

Extended Spatial Keyframing for Complex Character Animation

Byungkuk Choi, Mi You, Junyong Noh

CASA 08

- SK is a revolutionary idea that breaks the convention of existing keyframing. However, the produced motions are too simple to be used for practical character animation. A practical tool should be versatile enough to produce highly articulated complex motions while allowing easy creation of desired animation.
- ESK provides new features that give great flexibility by embedding a global control structure into a given 3D rigged character with multiple sets of spatial keyframes.
- ESK starts with designing multiple sets of spatial keyframes on desirable parts of a given rigged character with hierarchical relationships between the relevant sets. The hierarchical relationship, however, appropriately reduces the number of controllers by allowing the highest rank controller to move its subordinate controllers automatically.
- Once the sets are fully defined, a series of user actions that represents a target animation is recorded in multiple layers. Here, the user performs only with the highest ranking controllers.

Extended Spatial Keyframing for Complex Character Animation

Byungkuk Choi, Mi You, Junyong Noh

CASA 08

Advantages:

- The main contribution of ESK is that it automatically builds a global control structure by multiple sets of spatial keyframes.
- The hierarchical relationship and its control is another key contribution of ESK. A hierarchical relationship allows complex motions with the simple control of the highest ranking controller by synchronizing multiple sets of spatial keyframes.

Current work:

- how expressible ESK is across different types of motions? To create a meaningful story, it is essential to guarantee an easy transition across different types of motions.
- The interface for 3D control is also an important issue.
- Achievement of precise and detailed control over a character

FACIAL ANIMATION

- ***Facial Animation by Optimized Blendshapes from Motion Capture Data***

  Xuecheng Liu , Shihong Xia, Tianlu Mao , Yong Yu , Zhaoqi Wang *CASA 08*
- ***Efficient Lip-Synch Tool for 3D Cartoon Animation***

  Shinichi Kawamoto , Tatsuo Yotsukura, Ken-ichi Anjyo , Satoshi Nakamura *CASA 08*
- ***Generation and Visualization of Emotional States in Virtual Characters***

  Diana Arellano , Javier Varona , Francisco Perales *CASA 08*

Generation and Visualization of Emotional States in Virtual Characters

Diana Arellano , Javier Varona , Francisco Perales

CASA 08

- The aim of this paper is to model characters that have PERSONALITY, feel EMOTIONS and can MANIFEST EMOTIONAL STATES
- The motive is to create unique, real, distinguishable individuals depending on their personalities and emotional states

Generation and Visualization of Emotional States in Virtual Characters

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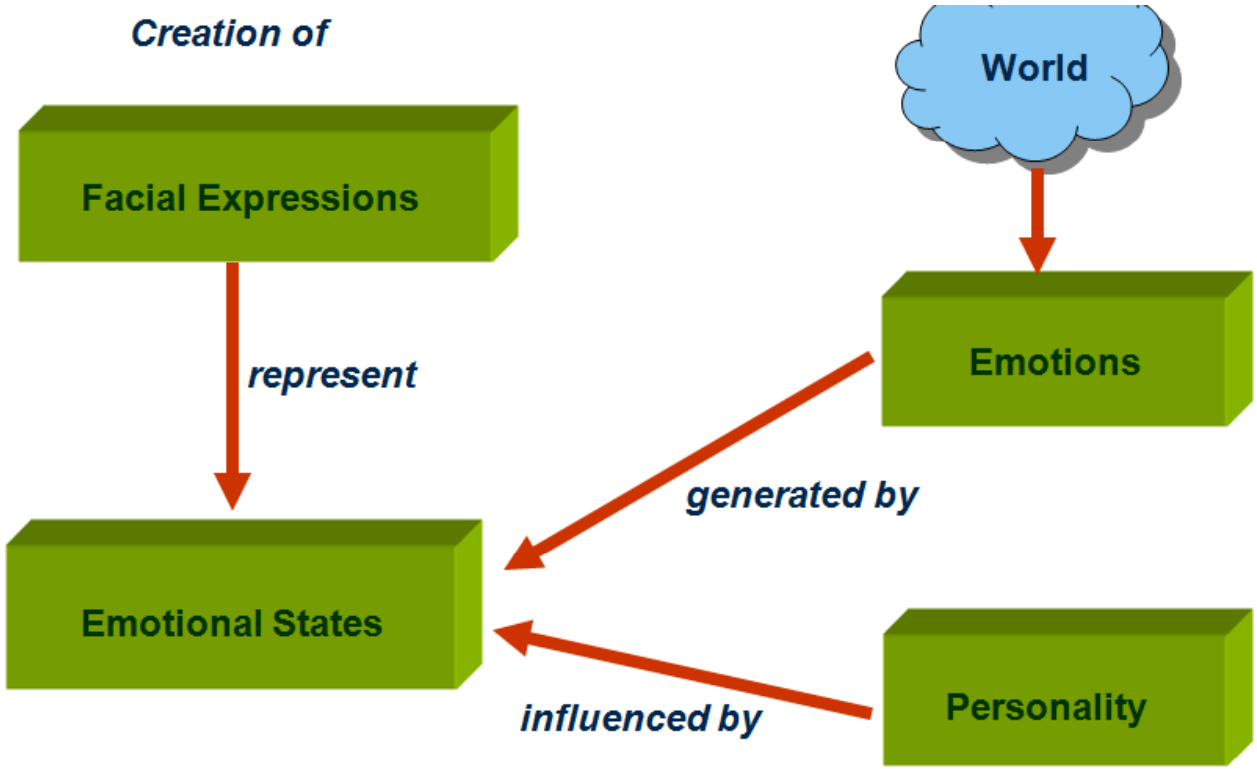

Generation and Visualization of Emotional States in Virtual Characters

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Personality: *Five Factor Model*

- **OPENNESS TO EXPERIENCE**
- **CONSCIENTIOUSNESS**
- **EXTRAVERSION**
- **AGREEABLENESS**
- **NEUROTICISM**

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Emotions:

- **Happiness**
- **Surprise**
- **Sadness**
- **Fear**
- **Anger**
- **Disgust**

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Emotional States : PAD space

- +P / -P = Pleasure / Displeasure
- +A / -A = Arousal / Nonarousal
- +D / -D = Dominance / Submissiveness

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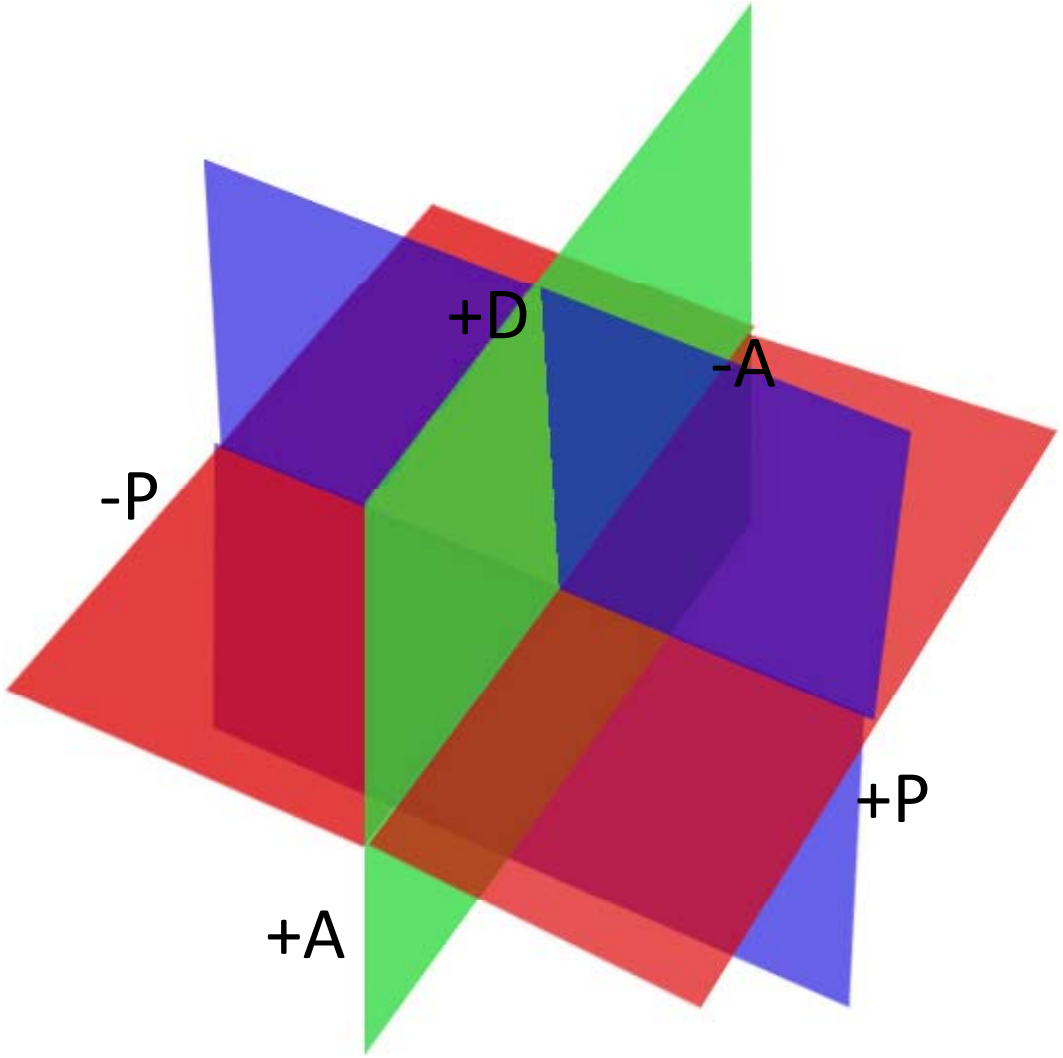

(+P+A+D) *Exuberant*

(-P-A-D) *Bored*

(+P-A+D) *Relaxed*

(-P+A-D) *Anxious*

(+P+A-D) *Dependent*

(-P-A+D) *Disdainful*

(+P-A-D) *Docile*

(-P+A+D) *Hostile*

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Personality → YEARS → FFM (Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism)

Emotional States → HOURS/DAYS → PAD (Exuberant / Bored, Anxious / Relaxed, Hostile / Docile, Dependent / Disdainful)

Emotions → MINUTES → Ekman + OCC

Generation and Visualization of Emotional States in Virtual Characters

Diana Arellano , Javier Varona , Francisco Perales

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Advantages:

- Satisfactory recognition of emotional states in facial expressions. Especially those in videos
- Generation of recognizable intermediate emotions using basic emotions.
- MPEG-4 allows low cost and real time facial expressions.

Current work:

- Head movement, eye movement, blinking = REALISM!
- Performance of more experiments to validate the obtained results.

The next presentation :

- ***Extended Spatial Keyframing for Complex Character Animation***

  Byungkuk Choi, Mi You, Junyong Noh *CASA 08*

- ***Clone Attack! Perception of Crowd Variety***

  Rachel McDonnell, Micheal Larkin, Simon Dobbyn, Steven Collins, Carol O'Sullivan *SIGGRAPH 08*