Performatology
A Computational Framework for Modeling Artistic Gesture

Research Proposal - Fall 2013, UCSC-SOE

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2. Interdisciplinary Background

- Professional experience in mime, dance, graphic design, and animation.
- BCA in figurative painting and drawing.
- DANM MFA in performative technologies.
- 25+ yrs as practitioner and teacher in the arts.
- 15 yrs teacher and technical author in 3D modeling, rigging & animation.
3. Performatology

- Critical technical practice (CTP, Agre 1997) evolved from my MFA *Mirror Game* performances.
- Character AI is an aesthetics problem best solved by modeling artistic gesture practices.
- Critiques intelligent virtual agent (IVA) approach to simulate gesture realism.

The new Theatre of the Avatar presents...

Mimesis & Mocap - The Magic Mirror Game
DANM 2010 MFA Exhibition: Things That Are Possible
April 30 - May 9

!Reflection
4. Artistic vs Natural Gesture

- The logics behind artistic and natural gesture are *not* the same!

- *Artistic* gesture composes the body to manipulate spectator attention, requiring skilled artifice and extra energy to perform. Aesthetic goals, driven by learned technique.

- *Natural* gesture is utilitarian and does not require years of arts training. Personal goals, driven by emotion.

- Artistic gesture is *represented* in figurative arts, including acting, puppetry, and animation.
5. Motivation & Overview

- Understand *how* skilled artists represent fictive bodies in media.
- Top-down *feature* design from figure arts theory.
- Bottom-up aesthetics *analysis* of skilled performer mocap data.
- Composition *metrics* that correlate arts conventions with media consumer preferences.
- Foundations of a *performative ontology* (performatology) to enhance virtual character control in videogames.
6. Complementary Work


- Other work that used machine learning to study *style in mocap data* (Brand and Hertzmann 2000)… *did not attempt to derive a performative ontology for figure composition.*

7. Drawing from Expressive Playable Media

- **Mateas’ (2004)** Expressive AI approach to a neo-aristotelean poetics; model enactment/spectacle.

- **Wardrip-Fruin’s (2009)** Expressive Processing textual instruments; develop performative instruments.

- **Laurel's (1993)** computation as a medium for dramatic action, Wardrip-Fruin and Mateas’ (2009) operational logics, and Hecker’s (2008) style/structure decomposition; avatar affordances/logics to design a role play instrument that is both intuitive tool and expressive medium.
8. Drawing from the Figurative Arts

- Craig’s Uber-Marionette; external figure control, not internal motivation.

- Decroux’ Corporeal Mime; pose attitudes, not continuous movement.

- Disney’s animation principles; key pose principles to convey an “Illusion of Life” or liveness.

- Barba’s Theatre Anthropology; figure composition rules related to pre-expressive presence.
Computational Aesthetics uses statistical analysis techniques to quantify photography conventions like rule of thirds (Joshi et al 2011); quantify similar pose conventions.

Infer photographer skill (amateur-professional) from image features highly ranked by viewers for perceived quality; infer performer skill from pose features.

Quantifying image composition skill to operationalize the art of photography; operationalize the figure arts for playable media.
10. Drawing from Computational Cinematography

- Jhala’s (2012) Panorama employed metrics targeted for photography features to score and annotate game generated photos; aesthetic meter to score figure composition.

- Preference studies were done on the corpus of images to rate aesthetic quality; preference studies on game generated pose corpus.

- Results begin to quantify features of skilled camera operation that can inform virtual camera logics; quantify for avatar control.
11. Proposal: Game Generated Poses & Preference Study

- A Kinect figure posing game designed with an **aesthetics meter** to target composition features from figure arts (balance, asymmetry, readability).

- Crowd-sourced preference studies on **annotated** poses in captured corpus to rate perceived quality.
12. Metric Design, Pilot Study, and DFS Experiment

Dance for Science!!!

- Volunteers needed in mid-April to play popular Kinect dance games in our motion capture studio in Baskin Engineering 2.
- All participants will be entered into a raffle for a $30 Amazon gift certificate.
- No previous dance or Kinect experience required. All levels needed for study, from beginner to pros.
- Sign up for a private 30-minute session on early weekday evening or weekend.
- Our system uses sensors like the Kinect to capture your movement, so no special equipment, just wear dark colored workout clothing.
- All data collected will be private and anonymous.

Contact: Topher Maraffi (topherm@soe.ucsc.edu).
13. BAR Metric Design

**Balance:**
- Skill in articulating the *torso* angle off the center line;
- Barba’s *Precarious Balance*;
- Disney’s *Weight* principal;
- creates the impression of movement in the torso posture.

**Asymmetry:**
- Skill in articulating the *limbs* differently across the center line;
- Barba’s *Oppositions* principal;
- Disney’s *Anticipation* principal;
- Mirroring is minimized while visual information is maximized.

\[ a_r^{(j)} = \sqrt{\left( \frac{(j)}{L_x} - \frac{(j)}{R_x} \right)^2 + \left( \frac{(j)}{L_y} - \frac{(j)}{R_y} \right)^2 + \left( \frac{(j)}{L_z} - \frac{(j)}{R_z} \right)^2} \]

*Figure 3: Illustration of the angles used for Balance (A) and Asymmetry (B) features.*
14. BAR Metrics & Pilot Study

**Readability:**
- Skill in composing the limbs in relation to the torso;
- Barba’s *Decided Body*;
- Disney’s *Staging & Exaggeration*;
- Occlusions are minimized while pose intelligibility is maximized for viewer.

**Pilot Study:**
- Test BAR features for representing artistic gesture;
- 3 motion sequences: lateral stretch, full-body rotation, and arm wave.
- Baseline: standard t-pose while facing the camera.
15. Pilot Study Results

- C4.5 decision tree implementation in the Weka machine learning library to learn the performers preferences given binary ratings for each pose along with its BAR features.

- Using a 10-fold cross-validation procedure, the resulting decision tree was able to rate “unseen” poses with an accuracy of 79.7 percent. (Maraffi, Ishikawa, Jhala 2013)

The results are summarized in the following confusion matrix:

<table>
<thead>
<tr>
<th></th>
<th>Good Pose</th>
<th>Bad Pose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Pose</td>
<td>45</td>
<td>17</td>
</tr>
<tr>
<td>Bad Pose</td>
<td>9</td>
<td>57</td>
</tr>
</tbody>
</table>

The accuracy is 79.7% correct.
16. Dance for Science (DFS) Experiment

**Setup:** Participants played Michael Jackson Experience (MJE) Kinect game on a markerless Organic Motion mocap stage, skeletal data captured into Motion Builder.

**Data:** 20 performances by male and female dancers age 18-47, a practice session followed by main dance, high game scores recorded, 4-choice self survey classified as 10 skilled and 10 unskilled dancers.

**Analysis:** Principal component analysis was done using our BAR metrics and 114 pose parameters.
A C4.5 decision tree classifier was trained on half the data of skilled/unskilled performers.

Predicted the skill level of the remaining (unseen) performers' poses with up to 81.3 percent accuracy.

The top-ten PCs were used, collectively representing 99.6 percent of the overall data variance.

A two-tailed test showed that performers who were considered "unskilled" and "skilled" had game scores from two distinct distributions (p-value = 0.0016)

<table>
<thead>
<tr>
<th></th>
<th>Skilled</th>
<th>Unskilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skilled</td>
<td>2872</td>
<td>208</td>
</tr>
<tr>
<td>Unskilled</td>
<td>946</td>
<td>2134</td>
</tr>
</tbody>
</table>

Table 2: Classification results of trained decision tree using C4.5 algorithm on unseen frames.

Distribution of in-game scores for players.
18. Research Question & Strategy

Can computational aesthetics analysis of artistic gesture data provide a performative ontology for virtual figure control in playable media?

1. Develop metrics that rank avatar poses according to figure arts skill, and then run viewer preference studies on avatar poses for perceived quality.

2. Design a performative ontology for virtual figure control from tested composition features that correlate procedural skill with aesthetic quality.
Computational aesthetics experiments to quantify artistic gesture data, consisting of composition metrics and viewer preference studies that correlate performer skill with pose quality, will provide a performatology model for operationalizing the art of figure control.
20. Proposed Schedule

Fall Quarter 2013:
• Continue aesthetic analysis of DFS data, and run preference studies on figure quality.
• Complete Poserama Kinect videogame design and prototype in Unity 3D.
• Organize written dissertation.
• Apply for faculty positions to start in fall 2014.

Winter Quarter 2014:
• Start Poserama game playtesting and data collection tests.
• Start written dissertation on performatology theory and design.

Spring Quarter 2014:
• Finish Poserama data collection, and start preference studies of pose corpus.
• Begin writing dissertation experimental analysis.

Summer 2014:
• Finish mocap data analysis and dissertation for thesis defense.
• Defend dissertation late summer.
## 21. Historical & Technical Context

### Roots of Performatology: The Evolution of Classical Acting, Puppetry, and Animation to Virtual Character Control

<table>
<thead>
<tr>
<th>Minimum Distance/Control/Quality</th>
<th>Increased Performer Distance/Control/Quality</th>
<th>Maximum Distance/Control/Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commedia del Arte</td>
<td>Delsarte’s “Science of Applied Aesthetics” and “gestural semiotics” taught in first acting schools of New York and Hollywood shaping theatre and cinema performance style at turn of the century.</td>
<td>Computational “performatology” approach to the formal study of aesthetic features in gestural data (acting) to derive figure composition logics (animation) for virtual character control (puppetry) in videogames.</td>
</tr>
<tr>
<td>Classical Greek Art &amp; Postures</td>
<td>Craig’s “Uber-Marionette” concept of the ideal actor inspired by Delsarte instructor and modern dance originator Isadora Duncan (his lover).</td>
<td>Barba’s Theatre Antropology studies of the “anatomical science of performer bios” inspired by Decoux’ exercises.</td>
</tr>
<tr>
<td>External “Ritual” Acting</td>
<td>Decoux’ “Corporeal Mime” technique inspired by Uber-Marionette challenge. Craig acknowledged Decoux was on right track.</td>
<td></td>
</tr>
</tbody>
</table>

### 1900
- Disney’s “Principles of Animation” inspired by rotoscoped studies of dancer Marge Beicher for Snow White. Disney “golden age” master classes reference Delsarte’s method. Disney was also inspired by Chaplin and mime.

### 1950
- Henson externalizes puppetry using TV monitors. Jurassic Park marks the transition from stop-motion puppetry to digital rigs animated by puppeteers.

### 2000
- Lasseter applies Disney’s animation principles to key-frame animation techniques for digital character control at Pixar.

**Arts Problem:** How can a fictive body be consistently articulated for maximum aesthetic affect on a spectator?
Distance the performer from the audience, both physically and psychologically, using technology as a medium.

The performative experience of control flow is not the same as the aesthetic affect felt by a spectator, just as adrenaline is not the same as emotions.

Cathartic emotions (laughing & crying) reduce body control, and are therefore not conducive to reproducing figure composition quality in a live performance.
23. Performatology Research Context

Three Dimensions of Expressive Play

Narratology:
- "Play as Story Composition"
- Theatre, Cinema, TV
- Cinematics in Videogames

Ludology:
- "Play as Games Composition"
- Spectator Sports
- Kinect Dance & Sports Videogames

Performatology:
- "Play as Figure Composition"
- Model Performer/Spectator 1D
- Model Player/Player 1D
- Role* Play 3D
- Text-based Adventure RPGs
- Pong, Asteroids, etc.
- Solitaire, Dice
- Automatic Writing Literature

* Avatar Role Play in Cinematic Videogames
24. Procedural Content Generation (PCG) Context

Additive Layers of PCG in Avatar Role Play

- **Style**
  - Performatology:
    - Figure Articulation
    - Acting, Posture, Attitude
    - Performative Aesthetics
  - Ludology:
    - Scenic Direction
    - Blocking, Business
    - Interactive Dynamics
  - Narratology:
    - Story Motivation
    - Script, Dialogue, Beats
    - Communicative Mechanics

- **Structure**
25. Performative Design Model (invert MDA)

Performatology ASO Framework

Artifact → Re-play as Spectator

Aesthetics (Symbolic: HOW) → Semeiotics (Indexic: WHAT) → Ontology (Iconic: WHY)

Physiological Perception → Anatomical Articulation → Technical Motivation

Infer Viewer Affect in Media → Quantify Artist Flow in Data → Derive Arts Conventions

Body Instrument (PofAI) → Composition Skill (Style) → Pose Rules (Structure)

Re-present Liveness → Figure Control Affordances → Performative Logics

Support → Artistry → Role Player-centric Design → Science

System → Role as Procedure

Authorial Design → Support

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26. Videogame Design Context

Expanded MDA Framework

Game as System
- Mechanics
  - "Rules"
  - "Procedures"
  - "Constraints"
- Logics (code)

Player as Support
- Player-centric Design
- Skin (media)
  - "Affect"
  - "Experience"
  - "Fun"

Designer as Support
- "Interaction"
  - "Flow"
- Affordances (events)

Video as Artifact
- "Play"
  - "Interaction"
  - "Interaction"
- Aesthetics
  - "Rules"
  - "Procedures"
  - "Constraints"
27. Intuitive Instruments for Artists

- Pose-to-pose “won” over straight-ahead animation > compute motion between key poses. Art of *Timing*.

- Polygons “won” over NURBS for modeling > compute curvatures between meshes. Art of *Sculpting*.

- Bitmaps “won” over vectors for texturing > compute resolution between renders. Art of *Painting*.
28. Performative Instrument Design

- Pose inference will likely “win” over motion blending > compute transitions between meaningful body states. Art of embodied *Attitude*… a “Photoshop of AI”?

- Should be designed for *how* figure artists practice their craft through embodied composition… not through textual language or math.

- Andy Serkis and Jim Carrey will never type code… no cognitive remapping for artists!
29. Performative Decomposition Model

Intuitive Instrument Design

Craft as Control

Artistic Gesture → Pose Inference → Movement Calculation
Body Position in 4D → Key-frame Blocking → Inbetween Trajectories
Surface Model in 3D → Mesh Sculpting → Surface Curvature
Skin Texture in 2D → Map Painting → Shape Resolution
Represent (medium) → Style (tool) → Structure (compute)

Tool-user to Skilled Artist

Tool as Remote

Artist as Engineer

Support as Support

Artist-centric Design
30. Proposal: Initial Experiments in Pose Logics

1. Identify key poses from transitions in player avatar data.
2. Use composition metrics to rate the key pose according to skill features derived from figure arts conventions.
3. Infer the optimal skilled pose by calculating metrics in context to incoming-outgoing vectors for the pose based on neighboring frames.
4. Generate new joint angles for the inferred pose on the avatar (or a ghosted second avatar for training).
5. Conduct user preference studies to rate aesthetic quality of player and inferred pose.
31. Motivation: Figurative Arts (19th-20th Century)
Francois Delsarte (French, 1811-1871) on art:

“Science is the possession of a criterion of examination against which no fact protests. Art is the generalization and application of it.

Art is not, as is said, an imitation of nature. It elevates in idealizing her... in one word, it is the search for the eternal type.

The object of art, therefore, is to reproduce, by the action of a superior principle (ontology), the organic signs explained by semeiotics, and whose inherent fitness is estimated by aesthetics.” (Stebbins 1902).
Gordon Craig (British, 1872-1966) on the need for an artistic acting instrument:

- “If you can find in Nature a new material, one which has never yet been used by man to give form to his thoughts, then you can say that you are on the high road towards creating a new art… Theatre, as I see it, has yet to find that material… what the wires of the Uber-Marionette shall be, what shall guide him, who can say?” (Craig, 1907).

Etienne Decroux (French, 1898-1991) on Craig’s influence:

- “I entered Jaques Copeau's school. The echoes of Gordon Craig's theories had reached it. There, students, with nude bodies, faces veiled, composed scenes without words. And that's how I got pointed in a certain direction.” (Decroux, 1950).
Decroux on mime poses as artistic *attitudes*:

“The viewer's impression is artistic only if he makes comparisons. To give the idea of movement by attitude… one can conceive of a movement as a succession of attitudes.” (Decroux, 1968).

Barba on Decroux: “He did not merely teach the ‘scientific’ principles of acting, but a way to *position oneself* which from posture and movement radiated to an all-embracing ethical and spiritual stance.” (Barba, 1997).

Eugenio Barba (Italian, 1936) on pre-expressivity as “process logics”:

“"The level which deals with how to render the actor's energy as scenically alive, that is, with how the actor can become a presence which immediately attracts the spectator's attention, is the pre-expressive level and is theatre anthropology's field of study."” (Barba, 2003).
Georges Melies is credited with inventing stop-motion puppetry (1907), which has been central to the creation of memorable characters in cinema. Jim Henson revolutionized the field using TV technology (1960s-80s). Jurassic Park (1993) marked the transition to digital puppet rigs.
Disney Principles related to *pose composition*…
- Squash and Stretch
- Staging (or Readability)
- Solid Drawing (or Weight)
- Anticipation
- Exaggeration
- Appeal

“Illusion of Life”
= “*Liveness*”
…arts solution to *Uncanny Valley*

Problem!
Semi-autonomous avatars for role play are converging all figure control methods into a new super-instrument for virtual performance (Uber-Marionette = Mickey or Kermit?).

While there is some intelligence in digital rigs (breathing, cloth & hair dynamics, muscles, and fingers), what is missing is low-level figure composition logics.
"An operational logic defines an authoring strategy, supported by abstract processes or lower level logics, for specifying behaviors a system must exhibit in order to be understood as representing a specified domain to a specified audience" (Mateas and Wardrip-Fruin 2009).

Popular videogames (Skyrim, Tomb Raider, Portal, Mass Effect…) vary widely in genre, narrative, and mechanics, but display an emerging family of performative logics related to playing a role in the tradition of cinema.
39. Low-level Figure Composition Logics

- **Authoring Strategy**: “A player’s embodied interaction drives real-time character control that intelligently calculates the most visually interesting poses for an avatar according to figurative arts rules, ..., in order to simulate an improvised performer subscore not specified in the narrative or scenic constraints”.

- **Abstract Process**: “given a stream of mocap values from a NUI input device like a Kinect, generate relational values that rotate skeleton rig joints to a series of transformation vectors that maximize figure composition and camera metrics, and then render the result as real-time character poses in screen space”.

- **Domain**: “the representation of articulated bodies as interactive videogame characters that display gesture features associated with skilled performers in the arts”.

- **Audience**: "the aesthetic experience of cinematic videogame players whose preferences have been shaped by figurative arts practices in traditional media".
Role Play *should* provide:

“Affordances for control flow with fictive body instruments, to generate affective figure compositions in media, that follow artistic gesture logics”.

A performative ontology will provide an *operational model* for artistic gesture control (style) of avatar role play instruments (structure) that is consistent with figure arts practices.
Q&A

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