Performatology: An Arts Approach to Designing Performative Embodied Agents (PEAs) for Procedural Character Animation

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ABSTRACT
This FDG 2011 Doctoral Consortium paper gives an overview of my Computer Science research approach and initial results in applying principles and theories from the Performing Arts to problems related to embodied agent design and animation for games.

Categories and Subject Descriptors
K.8.8 [**Personal Computing**]: Games

General Terms
Design, Human Factors.

Keywords
Performer Modeling, Character Animation, Embodied Agents.

1. INTRODUCTION
My research objective at UCSC's Computational Cinematics Studio is to work with my advisor, Arnav Jhala, to address the problem of a fundamental lack in gestural quality displayed by procedurally animated characters for games and interactive drama. Highly developed gestural techniques are displayed by performance artists in live theater and cinema, and exhibited in animated non-procedural characters in analog and digital media. But Non-Player Characters (NPCs) and avatars in games are still missing this fundamental essence of what makes human physical performers good actors. With a background in technical animation and the performing arts, I have begun implementing a novel Performatology approach to designing Performative Embodied Agents (PEAs) that draws from Intercultural Performance Studies, Theatre Anthropology, Principles of Animation, and Semiotics [13, 2, 16, 1]. My proposed agent architecture, IMPRSONA, is intended to procedurally represent the traditional mimicry process that performance artists have used to learn their craft, by using machine learning to model a live performer's gestural style.

My working hypothesis is that by modeling the behavior of embodied agents on the gestural technique of performance artists, procedural game characters for interactive drama can be made more believable, expressive, and appealing. My motivation is that performers in the arts have been using highly refined gestural techniques to successfully represent fictive characters for centuries, even without speech, and in a variety of media. In my research, I hope to develop tools that enhance the craft of embodied performers, so that they can extend their gestural technique into a new computational acting medium that has previously been unavailable to them due to technological barriers. My goal is to get the physical performer recognizably *in the game*, and enable the embodied actor to enter onto the virtual stage of interactive drama.

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2. RESEARCH APPLICATIONS
The potential impact of developing PEAs modeled on the gestural technique of good actors will be to evolve game characters that are more dramatic. My hypothesis implies that Computer Science problems such as the Uncanny Valley are primarily a result of bad acting on the part of agents, especially in regards to gestural technique, and not an inevitable result of human interaction with developed embodied agents. The negative appeal of the Uncanny Valley effect has been described as unnatural zombie-like movements that humans are sensitive to in an otherwise believably rendered embodied agent. However, human actors have frequently portrayed convincing zombies and robots by simply modifying their gestural technique. Conversely, there are countless examples of talented human performers, puppeteers, and animators who have employed gestural artistry to make uncanny fictive characters appealing and believable to audiences. Such professional performers undertake many years of disciplined training through repetitive practices to craft an instrument, or performing body, that is capable of uncanny expressiveness whenever it is turned on.

Performance artists have developed specific gestural techniques to make artifice look natural to the eyes of most spectators. As most performers know, the pros don't really move like everyday people, which is why we pay money to watch them. Studied by intercultural performance theorists since the 1960s [13], expressive artists the world over display consistent physical principles when they represent fictive personas [2]. Even traditionally animated characters have similar principles designed into their key poses that create a comparable illusion of life [16]. Consequently, I hypothesize that once we learn how to algorithmically represent these Performing Arts principles, by using machine learning to train embodied agents on the gesture of professional actors, the Uncanny Valley problem will simply evaporate as another illusion. An embodied agent trained to represent the dramatic gestures of a talented living actor like a Jim Carrey or Robin Williams will be too entertaining to cause concern about the source of the performance.

Conceptually, procedural performance is intended to merge the embodied liveness of theater with the iterative refinement of cinema editing and the plastic design of animation. This convergence in an autonomous system could lead to developing an iterative real-time acting medium that facilitates an error-free interactive characterization. As proposed in my poster *Roots of Performatology: From Craig's Uber-Marionette to Performative Embodied Agents* [7], this approach could solve live acting problems theater practitioner Gordon Craig (1872-1966) noted over a century ago, with PEAs realizing his Uber-Marionette or perfect actor concept. Such a tool could help live actors explore their characterizations, as well as give them a new way to archive, patent, and license their craft in a variety of computational media. In addition, modeling the gesture of exceptional human performers in multiple dimensions will provide far richer data than traditional media, to better study what makes a 'good' performer, and for training others in a particular performance style.

My approach also implies player modeling in games, using new Natural User Interface (NUI) devices like Microsoft Kinect to make a player's experience more customized, performative, and engaging. I expect that modeling a player's unique gesture will make avatars more natural to inhabit through proprioception, so that players feel more in the game. In addition, once a gesture style is learned for a player, the system could employ player recognition to provide more specific and personal interaction with NPCs. The recent proliferation of Open Natural Interface (OpenNI) devices and APIs, as well as the release of the Kinect SDK to academics, points the way to a rich platform for PEAs applications.

Another immediate application of PEAs in the entertainment industry will be for networked theme park characters, especially ones traditionally performed by live actors, to enhance guest experiences by providing more consistent interactions throughout the park. A Mickey or Kermit embodied agent, procedurally performed by a trained character algorithm, would always be on time and in as many places as are needed for maximum guest satisfaction. PEAs would be a technological extension of virtual puppets already being used at Disney, such as Crush in the Turtle Talk attraction, but employing a performer model to autonomously puppeteer a procedural performing body. The human performer would need to be retained as a trainer, licensing their source movement, but the resulting PEAs could be digitally replicated to perform throughout the park.

3. RELATED WORK

Turing himself stated that for an agent to pass the Imitation Game he proposed in 1950, it will require good acting [15]. In his day, a gestural Turing Test was not technologically feasible, but today it is not only feasible, I propose it is essential for the future of interactive drama. Although some preliminary experimental work was done by Ventrella at SFU on a Gestural Turing Test [17], my Performatology approach to the design of PEAs is specifically aimed at producing NPCs and avatars that will be good actors. To my knowledge, little work has been done to represent the craft of performance artists in an agent model. Instead, the majority of interactive narrative research takes a Psychology and Natural Language Processing (NLP) approach to designing conversational agents with performative elements, providing story tools for authors and game designers. Related research by Kipp et al [4, 9] modeled the gestural style of professional talk show hosts for a Virtual Character (VC) study, revealing in their results that professionals employ longer gesture units than non-professional speakers, which was perceived as more natural by study participants. Related work in this area by Neff et al [10] has shown that gesture can enhance the perception of personality traits such as extroversion in conversational agents. These studies did not, however, model the gestural techniques of performance artists.

Related agent research in the domain of interactive narrative, by Perlin [11], Mateas [6], and Seif El-Nasr [14], has primarily been towards developing tools for story generation using conversational agents, with gesture in a supporting role to speech. Perlin's most recent procedural agent tool, the Actor Machine [12], was designed for animators, not for embodied actors, and does not model the gestural style of performance artists. Research based on what performance artists do has been done by Magerko et al in conjunction with the Digital Improv Project [5], by developing improvisational micro agents, but it didn't extend to modeling gesture. Some related performer modeling research has been done in the machine learning domain using hidden Markov models to design Style Machines [3], but they did not apply this to agent performance in games.

4. INITIAL STUDY AND PROPOSAL

My current research developed out of my Digital Arts and New Media MFA work, which was completed at UCSC in 2010. My Avatar Theatre thesis performances were intended to informally assess contemporary audience reaction to seeing me playing the classic Marx Brother's Mirror Gag with my 3D avatar, which mimicked my gestural style in a shared theatrical space [8]. Audience feedback suggested that, in the context of a live theatrical performance, believable interaction and dramatic expressiveness can possibly solve Computer Science problems for embodied agents, such as passing a gestural Turing Test and offsetting the Uncanny Valley effect. There were times when audience members believed that a remote performer was controlling my avatar, as well as significant positive audience responses to perceived dramatic interaction on stage. I am using this initial study as a proof-of-concept for my current Performatology approach to designing PEAs.

My proposed agent architecture is IMPRSONA, which features a Mimic and Improv module for modeling performer gesture style. In our lab we have begun developing the Mimic module by training a neuro-evolutionary algorithm on NUI input gestural data from a live performer. Future work will be to use training data to isolate performance principles and build a style database that incorporates good acting technique for PEAs.

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