Proceedings of the Fifteenth AAAI Conference on Artificial
Intelligence and Interactive Digital Entertainment (AIIDE-19)

How Actors Can Animate Game Characters: Integrating Performance Theory in the Emotion Model of a Game Character

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Abstract

Despite the development of sophisticated emotion models, game character facial animation is still often completed with laborious hand-controlled key framing, only marginally assisted by automation. Behavior trees and animation state machines are used mostly to manage animation transitions of physical business, like walking or lifting objects. Attempts at automated facial animation rely on discrete facial iconic emotion poses, thus resulting in mechanical "acting". The techniques of acting instructor and theorist Sanford Meisner reveal a process of role development whose character model resembles components of Appraisal Theory. The similarity conjures an experiment to discover if an "emotion engine" and workflow method can model the emotions of an autonomous animated character using actor-centric techniques. Success would allow an animation director to autonomously animate a character's face with the subtlety of gradient expressions. Using a head-shot video stream of one of two actors performing a structured Meisner-esque improvisation as the primary data source, this research demonstrates the viability of an actor-centric workflow to create an autonomous facial animation system.

Introduction

Recent game titles have raised the aesthetic bar for naturalistic acting from non-player characters (Stuart 2016). But realistic animation is painstakingly labor intensive. This research proposes a new method for game developers to animate the face of photo-realistic characters using actor-centric techniques and an autonomous animation controller that modulates subtly between finite emotion-labeled facial expressions. Fields of psychology, communication and media provide models to implement an autonomous animation controller that elicits facial expressions. Game developers can use deep learning algorithms that capture, classify and elicit emotion expressions from actors for application to a 3d character's mesh data. This research proposes a multi-step process that integrates (1) Meisner's theory and method for role development, (2) the deployment of the computer vision application Natural Front for the construction of a photo-realistic avatar, (3) Affectiva's machine learning SDK that processes emotion data from a video stream of the face of an actor or player, and (4) the Appraisal Theory -based model FAtiMA as an "emotion engine" to control a character-specific emotion model. All components are deployed through C# for Unity3d, an off-the-shelf game engine. The research will evaluate if the live facial expression data of a performing avatar can resemble closely the data from the video of the actor's performance on which the avatar expressions were based. The workflow and emotion engine intends to be generalizable for integration in the production of photo-realistic character-driven games.

Related Work in Emotion Modeling

Psychological research in emotion modeling seeks to describe an inner working system using two approaches. Some theorists look at the outward traces of emotion first, and then rely on the culturally defined labels of those observations. Others instead consider first what is known or conjectured about the structure of the brain and the mind, and then examine the physiological signs of emotional expression. This dissertation considers the outward emotional behavior of the face and the inner emotion model of Appraisal Theory. The early work of Ekman and Friesen reveals evidence of the "universality" of "primitive" emotions (Ekman, Friesen, and Ellsworth 1972). Their renewal of Darwin's emotion theory (1965) shows that subjects could identify emotion inter-culturally from facial photographs and analogous semantic concepts. A subsequent generation of Ekman-affiliated psychologists, advanced by Freitas-Magalhães (2018), continues to expand Ekman's lexicon of subdivided facial expressions, called Action Units (AUs), currently used in emotion recognition algorithms deployed in this research.

Feldman-Barrett and Russell criticize emotional models based on labeled or "essentialist" facial expressions because they do not consider that some emotions fail to actuate on the body (or in the brain) in the same way for all subjects (Russell 1994, Feldman-Barrett 2019). Restraints of expression are enforced by skeletal-muscular distinctions, societal "norms" of gender, age, sexual orientation and inter-subject relationships. Cognitive psychologists, Ortony, Clore and Collins co-authored a study on emotion modeling that used Appraisal Theory. Their model was designed for ease of implementation in a computational system (Ortony, Clore and Collins 1988). It considers the goals, needs, likes and dislikes toward actions, objects and people and the desirability of consequences at events where such goals may be realized or lost. The Appraisal Theory model was augmented by others, such as Scherer (2005) and Russell (2009). Few game authoring tools have developed modules for emotion expression despite multiple models to choose from (Becheiraz and Thalmann 1998, de Silva, et al. 2006, Huang and Peng 2008, Alvim and de Oliveira Cruz 2008, Hudlicka and Broekens 2009, Bidarra, Schaap and Goossens 2010, Popescu, Broekens and van Someren 2014). FAtiMA, developed by Dias, Mascarenhas and Paiva (2014), is a recent emotion model for synthetic agents that draws from contemporary versions of the Appraisal Theory model and considers Lazarus' Mediational Theory (1991). This research implements much of the FAtiMA model and considers guidelines proposed by Hudlicka (2018).

The proposed application takes a video stream of the player's face as input that triggers emotion recognition algorithms. The player's expressions are interpreted through filters of the character's memory and appraisal in the form of data tables that describe beliefs, goals, consequences and praiseworthiness. These data tables hold the character parameter values of major components of the FAtiMA model. Emotions will be classified by a variant of the two-dimensional models provided by Russell and Scherer. The Circumplex model (Russell 1980) and the Geneva Emotion Wheel 2.0 (Sacharin, Schlegel, and Scherer 2012) allow for trigonometric calculations on normalized emotion label vectors within a unit circle to quantify a circular gradient of states, changes of states, and rates of changes of states.

Related Work in Performance Theory

Game characters are mediated through a screen and the aesthetics of the platform. Game players "read" the semantic performance "cues" given by an actor's motion and voice performance (Smith 2003, Wiley 2003) deployed in an animation. This "reading" allows animated characters to "mediate" the player's idea of realism as experienced in the unmediated world with an idea of believability as experienced in the mediated world that is aesthetically appropriate to the genre and presentation platform within its social, political, cultural and spatial context (Hallam and Marshment 2000, Carroll 2003). Thus a performance can diverge from "realism" while remaining "believable". Performance theory since Stanislavski contends that emotional expression is a conscious action, and not just a reaction (1936). For example, a character can deliberately show an angry expression to threaten, and not react angrily to a frustrated goal. Also, listening is an active task where a character does mental actions with back-channel feedback while appraising stimuli through filters of goals and beliefs. Computational emotion modelers have considered these mediated performance distinctions (Bates 1994, Gratch 2008, Paiva and Aylett 2012, Aylett et al. 2019).

Meisner (1987) and his mentor, Clurman (1972) dissect a role into Appraisal Theory -like components that trigger physicality. Insofar as words are quantifiable, Meisner's components are controlled by culturally specific syntax and labels (*actions* are verbs, *objectives/goals* are nouns, that can take convert to parameter values to infer physical velocity, speed, and bodily volume for the direction of actors (Stanislavski 1961, Clurman 1972). Meisner also develops improvisational techniques to allow the actor to experiment and choose specific variations appropriate to the performance of the moment.

Overview of Experiment Design

The system enables an animation director to send a video stream of one of two actors in a structured improvisation to yield a facial gesture data profile to drive future autonomous animation. The method will classify emotion-recognized facial expressions from an actor's performance. Re-mapping expressions for elicitation is triggered by an emotion recognition algorithm, then interpreted by algorithms in a FAtiMA-based emotion engine and character memory data tables. Resulting elicitation is a radian value from the linear combination of six "primitive" emotions as two-dimensional vectors (arousal and valence). Elicitation occurs when events of a behavior tree trigger physical response. Each dimension of each emotion vector is modified by coefficient weights derived from character-specific memory data tables. To validate the system, it will take as input a video stream of facial expressions of the player engaging in a behavioral-tree controlled improvisation of the same which the emotion model was based. Emotion elicitation as a vector from real time data of the avatar will be compared with the original video stream of the performing actor. Values of valence, arousal, direction, magnitude, velocity and acceleration at specific nodes in the behavior tree verify "emotional fidelity" (Gratch et al. 2009). If the experiment shows values of the character closely approximates those of the actor's, then the experiment demonstrates that the workflow design and emotion engine model are viable for further use in game character production.

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