Towards Believable Interactions between Synthetic Characters

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Abstract. Believable interactions between synthetic characters are an important factor defining the success of a virtual environment relying on human participants being able to create emotional bonds with artificial characters. As important as the characters being themselves believable is that the interaction with or between such characters is believable. In this work, we bridge affective computing and traditional animation principles to create *3Motion*, a model for synthetic character interaction based on anticipation and emotion that allows for precise affective communication of intention-based behaviors. We present an exploratory study with 52 participants supporting that our approach is able to increase overall interaction believability.

Keywords: Virtual Agents, Synthetic Characters, Believable Interactions, Anticipation, Emotion, Traditional Animation

1 Introduction

In movies, when characters perform an action, intentions are generally clear to the viewer and supported through eye or body movement. This flow creates anticipation and a sense of presence in the audience, leading to the suspension of disbelief, the notion that the implausibility of something can be suspended for the sake of enjoyment. While videogames strive to achieve such level of engagement with their player audience, we are still far from been able to achieve, in real-time, such believable interactions.

To mitigate this problem, we propose an anticipatory and affective behavior model for synthetic characters that bridges traditional animation principles[2] with modern affective and anticipatory modeling. Our main hypothesis is that by explicitly modeling the traditional three-stage split of an action animation into anticipation, action, and follow-through stages, we will be able to communicate the intentions of a character in a clearer way and give a richer emotional context for all the characters involved in the scene, consequently improving the overall believability of the interaction.

2 3Motion

Our approach to the creation of a believable interaction is to give structure to the way a virtual agent's behavior is modeled and change the way an action is executed in the context of all that is happening in a scene at that moment.

2.1 Behavior Cycle

Our agent's behavior is a 4-step *anticipation-based* cycle: (1) the agent *perceives* changes in the world based on its *expectations*, (2) *reacts* to them emotionally based on what was *anticipated*, (3) *decides* what to do next and *anticipates* what will happen, (4) and *performs part* of an on-going action, then repeats. This cycle occurs multiple times in the course of an action allowing the virtual agents to perceive events and express different emotions, among other things, while performing a same action that gives context to that expression.

Our main contribution with *3Motion* is how our approach deconstructs the traditional atomic action generally used when implementing synthetic character behavior, into three explicit and distinct stages: *anticipation*, *action*, and *follow-through*. Each stage may take a certain time to play out, and interaction at different points in the sequence will have a different meaning for the other agents participating in the scene, as well as for the viewer passively watching or actively interacting with the scene, allowing for the creation of a richer interaction.

2.2 Sample Execution Flow

To better showcase the expressive potential of our approach, we present an example of its execution flow (depicted in Figure 1). In our example, three agents take part in the action: Bob, Hanna and Steve. We join the action as Bob, currently in a happy mood, decides to throw a ball (decide step). In the perform step, the action is initiated: raising his arm in preparation for the throw, Bob enters the first stage of the expression of an action, *anticipation*.

The *anticipation* stage serves the purpose of communicating the intent so every other agent understands it and can expressively prepare for it. In this stage, an agent broadcasts its intent and associated emotion, and receives feedback in the form of emotions from the other agents that are aware of the expression: Bob is happy and wants to throw the ball, Hanna responds she is happy for Bob, while Steve is afraid Bob will miss his mark. This allows Bob to interpret the emotional reactions in the context of his intentions and modulate his behavior accordingly.

Anticipation is further subdivided into two substages: an *interruptible* stage in which the agent is still able to cancel the initiated action, and an *uninterruptible* stage in which the action reached a point where it cannot be stopped. While Bob has the ball in his hand, he is able to cancel the throw. While Steve is fearful, Hanna is happy for him, so Bob decides to proceed with the throw. He releases the ball and enters the uninterruptible stage, in which the action is still not finished and the agent creates an expectation about its outcome, which is broadcast as an emotion and provoke an affective response from the other

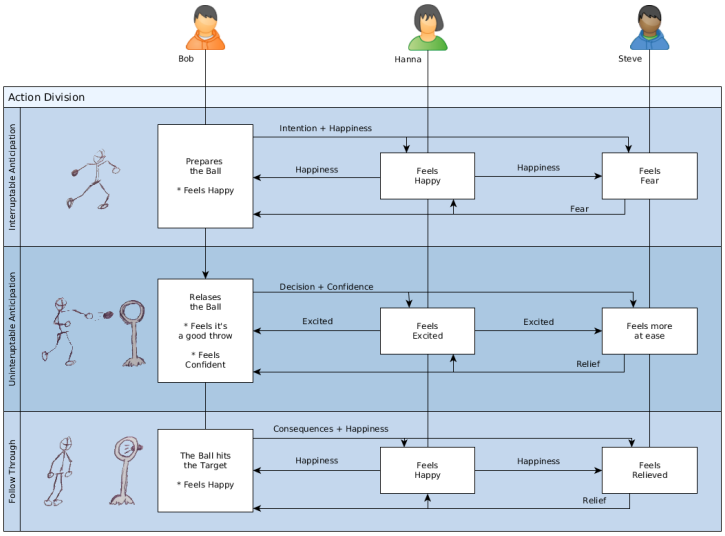

Fig. 1. Example of *3Motion* execution flow in action

agents: Bob is confident about his throw, which gets Hanna excited and Steve more at ease. The precise timing of the expression and affective responses is crucial in this stage, otherwise, the audience may not be able to understand how decision-making took place in this shared affective context.

The *action stage* is instantaneous and only exists conceptually. This stage represents the moment the action is resolved and the state of the virtual world changes. In the example, this would occur when the ball hits or misses the target.

The *follow-through stage* is entered after the action is resolved and broadcasts the result of the action, which will meet or challenge the expectations of the agents. As in the anticipation stage, the agent sends its affective appraisal to others along with the result, allowing them to feel happy, sorry, etc. and receives their affective feedback to perform a final appraisal of the action: Bob hits the target and is very happy! Hanna rejoices sharing on the happiness; Steve is now relieved because all went well.

Since we focus on non-verbal communication, emotions play a very important role on the communication of the actions progression. With the use of emotions, we hope to improve the believability of the interaction without compromising other forms of communication.

3 User Study

To understand the expressive power of *3Motion*, an exploratory study was conducted where users were asked to watch one of three different videos depicting

interacting agents implemented using three different approaches and fill a same questionnaire measuring various dimensions of believability.

Sample: Testing involved 52 participants with ages ranging from 18 to 55 ($M = 25.10$, $SD = 6.06$, 14 female). Each participant watched one video before filling the questionnaire and each session had a duration of 15 to 20 minutes.

Procedure: Three different videos were shown to the participants: (*classic*) agents implemented without action subdivision, emulating a classic approach to behavior control; (*3Motion*) agents implemented with action subdivision and using correct timing when expressing emotions, and; (*misguided*) agents implemented with our model but with incorrect expression timing. The last video controlled if having more information (even if not well timed) would make the interaction perceived as more believable. The questionnaire was based on the work from [1] and essentially measured the following dimensions: awareness, behavior understandability, predictability, behavior coherency, change with experience and social metrics, but also measures the ability of an agent to perceive and interact with other agents.

Results: Participants rated the interaction supported by *3Motion* as more believable in almost every statement of the questionnaire when compared to both the *classic* and *misguided* video, between which no statistically significant differences were found on the dimensions of believability explored by the questionnaire.

4 Conclusions

In this paper, we presented *3Motion*, an approach to synthetic character interaction explicitly modelling the three-stage split of an action animation from an anticipatory and affective perspective. We also described an exploratory study with 52 participants supporting that *3Motion* was able to create interactions perceived as more believable than more traditional approaches. Encouraged by these results, we are now looking at how this model could help with real-time interaction with both users and synthetic characters simultaneously.

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