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From Virtual Bodies to Believable Characters

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Abstract

This paper presents an approach for creating believable characters. We use predefined animations and body postures that can be combined in real-time to generate a rich set of behaviours. Moreover, parameters like speed or spatial amplitude can also be modified in real-time to in¤uence the character's movement. Our ultimate goal is to create reusable synthetic characters that are able to express their inner-feelings using bodily expression.

1 Introduction

The last decade witnessed an impressive evolution of synthetic characters. The recent advances in technology, particularly the continuous increase of performance in computers, lead to broad use of synthetic characters in several areas. Computer simulations are a reality in many domains from warfare to rescue training. The use of synthetic characters allows safe exercises without putting anyone into harm. In education, synthetic characters have been used as tutors that are able to explain or guide a student through a task. Characters can also act as team-mates for individual training in tasks that need cooperation. In the cinema, the movie ”Toy Story” opened the door to a completely new generation of movies where the actors are computer generated. Recent examples are ”Shrek” and ”Final Fantasy”. Computer games bring us every day a full hand of new gaming experiences where synthetic characters assume the main role. As a brief example, look at ”Tomb Raider” and the impact of a character like ”Lara Croft”, or the amusing ”Guybrush Threepwood” from ”The Escape from Monkey Island”. Although purely fictional, these characters have a personality, likes and dislikes, friends, and many other things that drag us into the story and make us feel as a part of it. Computer games have also benefited with the development of accurate characters that simulate the reality, especially in sport simulations. Games like ”FIFA” or ”NBA Live” have models for most of the players and it is quite pleasant to recognise a star like ”Figo” or ”Kobe Bryant”. Likewise, many synthetic actors start to participate in artistic performances or TV shows, and start to play an important role in these domains. The future platforms of interactive TV and TV on demand will offer a ”workplace” for many virtual presenters, virtual entertainers and virtual advertisers. We are entering a new era where synthetic characters need to be more human-like and, above all, more believable.

The body assumes a natural relevance in this new generation synthetic characters. Humans, for instance, express their emotions and inner feelings with facial expressions, but also with gestures and behaviours that affect the body movement. If we take a close look into the roots of animation, we quickly conclude that skilled animators use the body and the way it moves to denote personality, express emotions and appear to have a certain inner life, which is sufficient to induce believability. They are able to create characters that easily delude our eyes. Therefore, a synthetic character should be able to express its emotions through bodily animation using the appropriate gestures and behaviours.

The overall goal of our work is to provide a simple way of creating and controlling reusable bodies of synthetic characters that can express emotions. That is, to develop reusable synthetic characters with an expressive bodily behaviour.

2 Background

Traditionally, synthetic characters were created using a pure computer graphics approach in which the visual realism is the ultimate goal. Different researchers, such as (Badler et al., 1993), (Fua et al., 1998), (Kalra et al., 1998), and (Aubel and Thalmann, 2000) look at believability as a strict visual problem. The approach is based on detailed geometrical models and advanced animation techniques that are able to assure a good visual accuracy. However, the generated characters and movements are computational expensive, and the results are often unrealistic. Characters lack a certain inner life that is essential to delude our eyes. Consequently, the idea that believability depends more on the characters' ability of conveying its inner-feelings lead to a different approach that relegates the visual realism to a second plane. Blumberg and Galyean in (Blumberg and Galyean, 1995), Perlin and Galyean in (Perlin and Goldberg, 1996), Russell and Blumberg in (Russell and Blumberg, 1999), and Johnson et al. in (Johnson et al., 1999) seek what can be called behavioural realism, and look at high-level architectures for real-time animation and interactive control. The generated characters are more expressive and more alive, but that richness is also very dependable on the animators' ability to maintain a certain behavioural coherency in the characters' library of pre-defined movements. Therefore, the characters can only express the feelings or the emotions that were previously modelled, and most of the animations cannot be reused in different characters.

In parallel, several researchers tried to find a way to change the movements in real-time to add expressiveness, personality or emotions. Some approaches propose secondary motions as a way to add naturalness to primary motions, like Perlin's work that uses periodic noise functions to add expressiveness (Perlin, 1995). Others used signal analysis techniques to capture and create new motions: Unuma et al. introduce a model to describe and manipulate human periodic motions based on a Fourier Functional Model (Unuma et al., 1995); and Amaya et. al. capture the difference between neutral and emotional motions, and allow the generation of new emotional motions (Amaya et al., 1996). More recently, results from movement observation have been used to define models that parameterise movements in real-time to achieve a rich set of variations: the EMOTE system proposed by Chi et al. uses results from the Laban Movement Analysis to modify arm and torso animations into more expressive movements (Chi et al., 2000) (Badler et al., 2000). However, all these approaches are still very limited and, most of the times, they are only applicable to certain body parts or to a single class of movements.

3 Our Approach

Our work is inspired mainly on Blumberg and Perlin's work, but uses some of the results of the other approaches, namely the Amaya's work on emotional transforms and how the speed and the spatial amplitude of the movement vary noticeably with different emotions.

The main idea is to use a set of pre-stored movements and modify them in real-time to reflect inner-feelings or emotions. These changes can result from the combination with specific body postures or secondary motions, or from variations of basic parameters like speed or spatial amplitude. For example, imagine a neutral walking movement that we want to modify in real-time to express sadness. The character can begin walking slowly and with smaller steps (and that denotes a variation in the speed and in the spatial amplitude of the movement), the torso could bend to the front (and that can be done by combining the movement with a body posture in which the torso is bent), and the head could occasionally turn to the left and the right alternately denoting a certain disappointment (and that can be achieved using a secondary motion that drives the head).

Moreover, the movement combinations and the variation in the speed and in the spatial amplitude can be parameterised to express different degrees of sadness. For instance, and recovering the above example, we could denote more or less sadness generating a movement more or less exaggerated. Thus, if the character is very sad, the walking movement should be very slow, with very small steps, the torso highly bent and frequent head movements. On the other hand, if the character is only a little bit sad, the walking movement could be moderately slow, with small steps, the torso slightly bent and rare head movements.

4 Architecture

The system has a three-layer architecture as depicted in Figure 1. The behaviour engine is responsible for the high-level control of the character, and it is typically implemented by the character's mind. It sends requests to the animation engine for activation/deactivation of animations or body postures, and for increasing/decreasing the speed and spatial amplitude. The animation engine is responsible for combining all the active animations and implements a simple re-source mechanism to avoid unwanted behaviours. It has direct control over the character's animations and body postures. Finally, the graphics engine is responsible for maintaining the geometric model and for controlling the rendering process.

4.1 Character Model

A character is defined by a geometric model and by a set of pre-defined animations and postures that can be combined in real-time as described above. We use a simple geometric model composed by a hierarchical joint skeleton (Figure 2) and a deformable skin layer attached to the joints (Figure 3). A posture reflects a certain joint configuration and an animation is the variation of the joints or a skin deformation over the time. Using this information, the animation engine is capable of calculating the contribution of multiple active animations and/or postures, and updates the geometrical model every cycle to reflect the desired behaviour.

4.2 Blending Animations

Typically, applications that use synthetic characters use libraries of animations that are mutually exclusive. For instance, characters used in computer games usually perform one action at a time, and that can be simply achieved using the appropriate animation for each

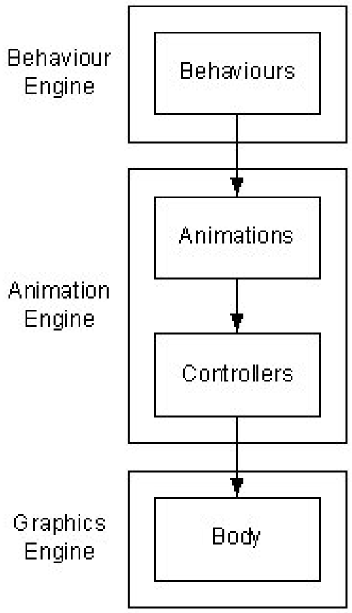

Figure 1: Architecture of the System

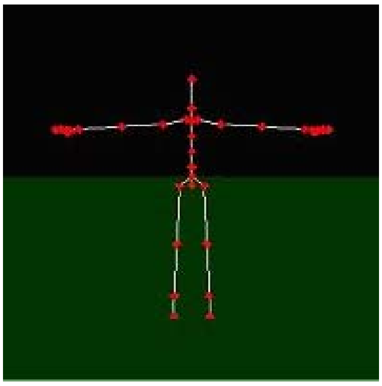

Figure 2: Hierarchical Joint Skeleton

Figure 3: Deformable Skin

action. However, these characters are often repetitive and predictable, unless you have a huge database of animations.

Our work combines animations and/or body postures in real-time to generate new movements that add a certain behavioural richness to the character. Basically, the animation engine generates a mixed movement of each active animation/posture using a linear interpolation algorithm. Each animation or posture has an associated weight that changes in real-time and that determines the contribution of that specific animation or posture to the generated movement.

This behavioural richness allows us to influence basic animations and create variations that otherwise would have to be created as independent animations. A good example is a ”walk movement” and the possible body posture variations to reflect different emotional states.

4.3 Speed and Spatial Amplitude

Amaya et al. in (Amaya et al., 1996) presented a work where they concluded that the speed and the spatial amplitude of the movement vary noticeably with different emotions. For instance, ”sad” movements are normally slow and narrow whereas ”happy” movements are fast and wide. Our work uses these results and allows variations in the speed (increase/decrease the number of frames per unit of time) and in the joint amplitude. Therefore, it is possible to parameterise an animation in real-time to denote inner-feelings or even personality. For example, a lazy person runs more slowly (Figure 4) than an energetic one (Figure 5).

Figure 4: Lazy Run

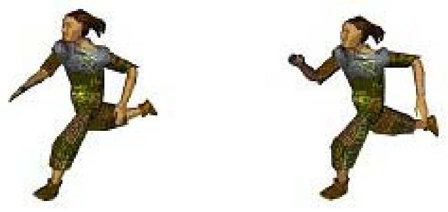

Figure 5: Energetic Run

5 Concluding Remarks

Our work does not intend to establish any mapping between emotional states and movements or movement changes. We intend to provide characters that have the ability of modifying their movements in real-time and, therefore, that are able to express emotions. How a particular emotion is expressed is out of the work's scope.

Therefore, the main contribution of the work to the research of expressive characters for social interactions is a simple method of manipulating the character's body to achieve more natural and believable movements. The most immediate advantage is the generation of a rich set of animations using a compact database of pre-defined animations. For instance, it will be no longer necessary to create a ”normal” walk, a ”sad” walk, a ”happy” walk, or a ”tired” walk. Using a neutral walk and the right set of parameterisations and body postures we can achieve new animations similar to those produced of¤ine. This allows a smaller dependence on the designers, and reduces the time necessary to create a character and its library of animations.

Another advantage is the possibility of visually identifying generic parameterisations for expressing a specific emotion, which could lead to the development of a broader model that establishes a matching between a theory of emotions and the parameters that affect the animations.

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