

Modeling and Analysing Computer Animations

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Abstract. Computer animation is a multifaceted field of computer graphics. This presentation explores one of these facets. At first computer animation will be surveyed through the use of a framework to help to order and classify its main approaches related to movement modeling. Then the use of Petri nets as a modeling and simulation tool to obtain some kind of foresight of a developed animation will be discussed.

Keywords: Animation Modeling and Analysis, Petri Nets, Behavioral Animation.

1 Introduction

Computer animation has many different modeling facets including for example objects movement, geometry, texture and illumination modification, rendering acceleration, etc.

Movement control strategies can be thought as driven by two categories of algorithms, one directed to the specific aspects of animating characters parameters — e.g. a character movement equation — and another to high level control aspects — where animation intentions are expressed as e.g. goal directed control strategies.

So at first both aspects of control strategies will be surveyed and some examples will be presented following ideas already presented in an early work. A more detailed description can be found in Magalhães [1].

After that, Petri nets (PN) will be presented as a modeling tool according to the ideas proposed in Magalhães [2]. Additionally PN and extensions will be studied as techniques to support animation analysis.

2 Modeling strategies and algorithms

This part of the presentation will study movement modeling techniques emphasizing the aspects of modeling classification and reusability. Fig. 1 resumes the main idea to be explored.

At first, movement modeling techniques can be considered strictly from its mathematical movement modeling capabilities. Paradigms like key-framing interpolation, kinematic and dynamic models, genetic techniques, etc. are examples of this class of solutions. These techniques provide tools to model both aspects of rigid characters movement: character trajectory and individual movement (respectively, movements related to the scene

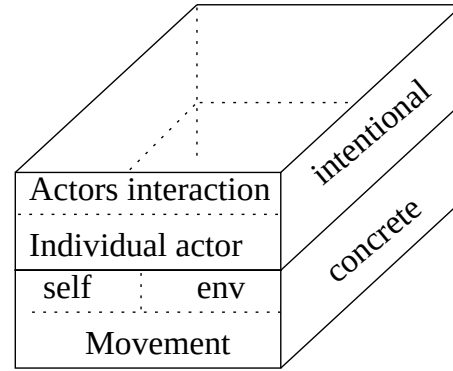


Figure 1: Modeling Techniques Framework

and character referencial; in Fig. 1 indicated as environment and self). These techniques can be expanded to model also non-rigid structures. In this case, considering a character decomposition, a rigid sub-character can be obtained and the same previous ideas can be applied. Fig. 1 represents these possibilities in the concrete level, where complex characters (non-rigid but decomposable in rigid sub-parts) can be refined using the trajectory (scene referencial) and the individual (character referencial) idea.

A typical example of this modeling class is provided by the following equation, where a shock-absorber is modeled by mean of the dynamic paradigm:

$$x_i = \frac{\Delta t^2 \cdot F_{ext} + (b \cdot \Delta t + 2m) \cdot x_{i-1} - m \cdot x_{i-2}}{m + k \cdot \Delta t^2 + b \cdot \Delta t}$$

The second level, the intention level, asks for tech-

niques to support more abstract (from the movement modeling point-of-view) necessities allowing to define events, restrictions, reactions, etc. Representative techniques in this context are: behavior based models, reactive systems, etc. The main objective at this level is not to define how movements will be performed but the sequence of events that will cause or will be affected by a movement.

In this case the animation intention in an example derived from Perlin [3] are explicated by means of high level assertives such as:

- walk to center;
- choose from (set of ...) based on “appropriate listening gestures”; or
- definition of Decision Rules, e.g., choose from (“Laugh” “Giggle” “Ignore”) based on “feelings toward player”

3 Petri Nets in Animation Environments

Petri Nets are a modeling tool specially suited to systems with concurrent events. Murata [4] presents a very extensive study to the theme; the presentation will explore the main characteristics of this technique and present the use of Petri Nets to model and analyse animation environments.

In the context of animation modeling, Petri Nets support definitions at the intention level as defined in Fig. 1.

Consider now an example of two spheres, A and B, each travelling in one of two possible trajectories which can be set by associated buttons. The animation has a behavioral restriction defined by the rule that only one of the spheres can travel its external trajectory at a time in order to avoid collision.

Fig. 2 presents the Petri Net model for the example, where each mark represents a sphere, A_i and B_i the four possible states, and t_i the transitions between the trajectories.

Analyzing the presented graph the following properties can be obtained:

- Reachability: Starting at one of the allowed system states all possible states can be reached;
- Boundness: The graph is 1-bounded; no place will have more than one mark at a time;
- Liveness: Each valid state has a following valid state for a firing sequence; there are no dead transitions;
- Reversability: It is always possible to return to an initial state by a firing sequence;
- Persistence: Firing t_2 will inhibit t_3 and vice versa; this express the mutual exclusion relationship between both events. The graph is not persistent.

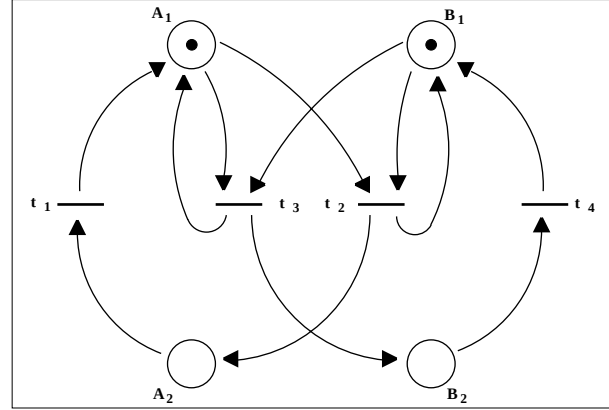


Figure 2: PN for the example with 2 spheres.

The presentation will explore the use of Petri Nets in both presented aspects using additional examples and situations.

4 Conclusion

The presented ideas are being currently explored in a research project aiming to develop a tool for animation control test and development using Petri Nets. The main objective is to save time, mostly rendering time, when developing animations by using a Petri nets based which will permit animators to explore control situations testing the robustness (avoidance of unwished situations) of a defined solution before to give any shoot.

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