Generating Realistic Fighting Scenes by Game Tree

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Abstract

Recently, there have been a lot of researches to synthesize / edit the motion of a single avatar in the virtual environment. However, there has not been so much work of simulating continuous interactions of mulitple avatars such as fighting. In this paper, we propose a new method to generate a realistic fighting scene based on motion capture data. We propose a new algorithm called temporal expansion approach which maps the continuous time action plan to a discrete causality space such that turn-based evaluation methods can be used. As a result, it is possible to use many mature algorithms available in strategy games such as the Minimax algorithm and $\alpha - \beta$ *pruning. We also propose a method to generate and use an offense/defense table, which illustrates the spatial-temporal relationship of attacks and dodges, to incorporate tactical manuevers of defense into the scene. Using our method, avatars will plan their strategies taking into account the reaction of the opponent. Fighting scenes with multiple avatars are generated to demonstrate the effectiveness of our algorithm. The proposed method can also be applied to other kinds of continuous activities that require strategy planning such as sport games.*

Categories and Subject Descriptors (according to ACM CCS): I.3.3 [Motion Control]: Motion Editing

1. Introduction

Fighting is an event of continous interactions of humans, that is difficult to be simulated on the computer. It involves various characteristics of humans, such as power, perception, and intelligence. When suddenly a person is attacked, he/she will try to get away from the offender by all means and will either try to run away or hit back according to the condition. After the enemy repeats the same attack a few times, a human will learn the pre-action of that attack and figure out an effective counter-attack. Therefore, the fighting style and strategies will change as the match goes on. As a result, modeling the planning process of fighting requires various techniques of artificial intelligence and game theory.

There is a great demand for creating scenes of fighting in the movie, television and game industry. For designing such a scene, there are people called "fighting choreograpers", who plan how the fighting scene should be carried on. There are also professional extras who are specialized in fighting scenes so that they can be hit and blown in a realistic way. For games or animations, the animators usually manually design the motions themselves and combine several characters to generate the scene. In either of the above cases, the cost and time required for creating the scene can be enormous. It will be far better if the computers can be used to simulate such scenes automatically.

Generating an artistic scene is a difficult task as the criteria for beauty is difficult to explain. Instead, in this research, we will assume that a well-planned, serious fight between characters will make the scene realistic. In this paper, we propose a new algorithm called the temporal expansion approach which maps the continuous time action plan to a discrete causality space such that turn-based evaluation methods can be used. As a result, it is possible to use many mature algorithms available to do strategy planning such as the Minimax algorithms or $\alpha - \beta$ pruning.

In addition to this, we propose to use an offense / defense table to let the avatars select the appropriate defense action to counteract the offense action by the opponent. In this table, for each entry of the attack, the appropriate defense motions together with the best timing to launch them are listed. The offense / defense table can be generated by capturing the motions of two people fighting with each other, and generating a histogram of the launched defense motions for each attack.

Using our method, avatars will plan their strategies taking into account the reaction of the opponent. By editing the parameters of the criteria for fighting, it is possible to

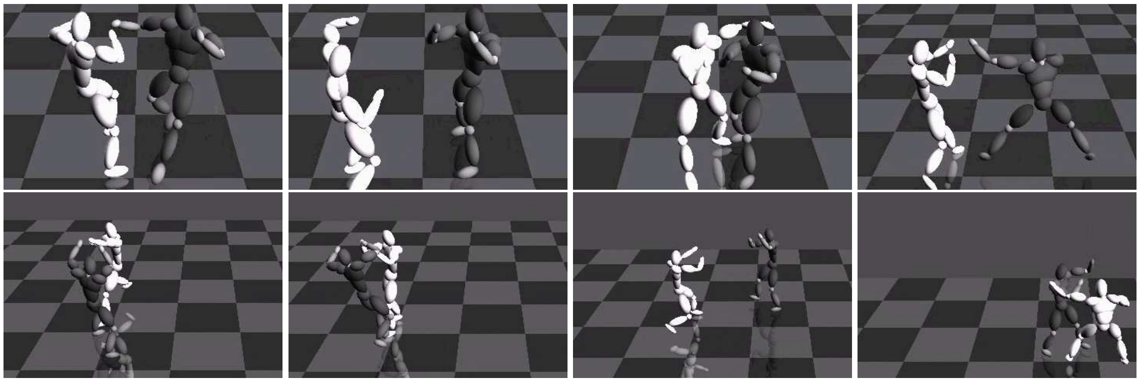

Figure 1: ***(TOP)*** *A fight of avatars with less expansion (white) vs. deep expansions (black) of the game tree (top); the avatar with less expansions continue to get hit by the one with deep expansions, and* ***(BOTTOM)*** *a fight of an outboxer (white) and an infight boxer (black); the outboxer's parameters are tuned so that he/she prefers longer distance and less interactions while those of the infighter are tuned so that he/she prefers shorter distance and more interactions.*

simulate various fighting styles, such as being more passive, agressive, or prefering kicks than punches. By increasing the depth of the game tree, it is possible to make the avatar to be more intelligent. The methodology can be used not only for fighting but also for other continuous activities such as dancing or sport games.

Although there are so much research work for motion editing and synthesis, there has been little work for generating a fighting scene that involves more than two characters. In the movie Lord of the Rings, the motion of background characters fighting with each other are generated by very sparse MotionGraphs [Gri03]. However, since the motions used are limited and the AI engine used is not smart enough, it can be applied only for background characters and not the main characters. The only academic work that is known for fighting is the work by Lee et al.[LL04], which is to generate a scene of two boxers fighting with each other. However, since the animations were based on singularly captured motions, the interactions of the characters were limited and different from real boxers.

The main contribution of this paper is that we propose a methodology called temperal expansion approach to enable avatars to plan for the fighting. By using the temperal expansion approach, the continous nature of the fighting is converted to a discrete strategy planning problem, in which AI techniques developed for games such as chess can be applied. We also have enabled to simulate various styles of fighting by changing the value of the parameters composing the objective function of the offense/defense actions.

2. Experimental Results

We have first captured the motions of boxers and kickboxers sparring with each other for several minutes and generated the offense/defense table, MotionGraph, and action-level state machine. Based on this data, we have generated various sequence of two avatars fighting by changing the parameters of the system. When expanding the game tree,it is necessary to specify the time in the future up to when we make the prediction. Say this time is defined by t_f. Once we reach this time limit, we stop inserting new nodes under the current edge and evaluate the route to proceed to the Minimax algorithm. In the first example, for one avatar, t_f was set to 1.0 seconds and for the other it was set to 3.0 seconds (Figure 1, top). When simulating the fight, the avatar with larger t_f will always succeed to hit the avatar with smaller t_f. Even though the avatar with smaller t_f launches an attack, the opponent always succeed to defend and counterattack. Once a response motion to fall down is launched, the opponent will successively hit the avatar as it is a naive action.

In the next example, we have tuned the objective function of the fighter so that one shows the characteristics of an outboxer and the other of an infight boxer (Figure 1, bottom). The outboxer's objective function was tuned so that he/she prefers longer distance and less interactions. On the other hand, the infighter's location function was tuned so that he/she prefers shorter distance and more interactions. In this example, the outboxer succeeds to move around the area while keeping some distance with the infigher.

References

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[LL04] LEE J., LEE K. H.: Precomputing avatar behavior from human motion data. *Proc of SCA 2004*, 79-87.