Automatic Evaluation of Boxing Techniques from Captured Shadow Boxing Data

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INTRODUCTION

We propose a fully automatic procedure to preprocess captured shadow boxing motion and evaluate the boxer's techniques. The captured shadow boxing motions are automatically segmented and classified into different actions such as straight punches, hooks, or translations. Then, it is possible to automatically evaluate their skills by checking the quality of their movements and finding out which kind of motions are available by the boxers. It is also possible to compose a MotionGraph of the fighters and simulate the matches of different boxers to find out their weak points. The proposed method is useful for boxers to periodically check their performances.

METHODS

Here we propose a method to automatically segment and classify the long sequence of shadow boxing into shorter meaningful clips called motion segments such as punches and translations. We observe that in boxing, a movement mostly begins and ends at double supporting states. Therefore, first we detect the frames when the double supporting states start and split the motion into segments at these moments. Such segments are defined here by $S=\{S1,...,Sn\}$. Next, the acceleration of the hands are examined. We can observe that whenever a punch is thrown, the acceleration of the hand is increased dramatically. Therefore, the durations where high acceleration of the hands are observed are extracted. These clips are defined here by $S_a=\{S_{a1},...,S_{am}\}$. Finally, whenever we find any clips of Sa are overlapping with the boundary of two segments of S, such segments are merged into one. This is because successive attack motions should be treated as a single attack. After this operation, every motion segment represents a meaningful fighting movement.

Now these segments are classified into different categories according to the trajectories of the end effectors and the stepping pattern. The trajectories of the hand of the attacking arm is extracted and transformed to that in the torso coordinate system. The Euclidean distance of two attacking motions are computed and if the distance is smaller than a predefined threshold, they are grouped together. For segments that only involve the movement of the legs, they are tagged as translation motions. After this process, all actions are segmented and classified into groups with tags such as "left straight punches", "left hooks", or "translations". As a result, the motions can be easily evaluated.

Using the segmented data, a hierarchical MotionGraph[1] system is generated. Then, we can use the method proposed in [2] to simulate the fight of two different fighters.

RESULTS AND DISCUSSION

We have used the MotionAnalysis Eagle system to capture the shadow boxing of seven amateur boxers who have experiences of one to seven years. Their motions were automatically preprocessed and segmented into meaningful actions. The results were compared with the ground truth data based on manual segmentation. The error rate was less than 15%. Based on the results, the trajectories of the hand of "left punches" of a novice and experienced boxer were compared. One of the results is shown in Figure 1. It is clear that the experienced fighter has a much higher acceleration and the overall trajectory is much thinner comparing to the punch by the novice fighter.

Finally, we simulated the fight of these two fighters. A snapshot of the fight is shown in Figure 2. The novice boxer had a lot of difficulties to hit the experienced boxer, and the simulation resulted in a situation as same as the two actually spar.
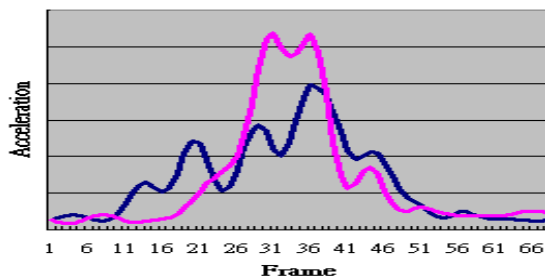

Figure 1: The acceleration of the left hand during a left straight punch by a novice fighter (blue) and an experienced fighter (red).
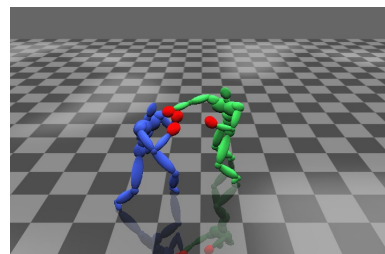

Figure 2: A snapshot of a virtual match

REFERENCES

1. Lau, M and Kuffner JK, Symposium on Computer Animation, 2005., pp271-280
2. Shum, H. and Komura T., *SCA '06 poster, Simulating Realistic Fight by Expanding the Game Tree*

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