Tennis Real Play

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***Abstract*-- Tennis Real Play (TRP) is an interactive tennis game system constructed with models extracted from real game videos. The key techniques proposed for TRP include player modeling and video-based player/court rendering. Experiments show that vivid rendering results can be generated.**

I. INTRODUCTION

The research on video processing is interesting and full of challenges. With the progress in video coding, users enjoy high quality videos and are satisfied with the visual experience in watching videos. With the advance in the annotation of video contents, users can search videos and receive the video information immediately. Furthermore, we think that the interaction with video contents will be another important topic in video processing.

TRP is an interactive tennis game system constructed with models extracted from real game videos. The textures of players and background court are extracted from real game videos, and the postures of players are immediately rendered according to the user's control. For the contributions, users have more interaction with video contents and get more immersive experience and enjoyment from playing TRP. To show the smoothness of player rendering and background rendering, demo video is available on the website [4].

II. SYSTEM OVERVIEW

A. Player Rendering

The first step of building the system is to segment the players from game videos to build player database. The possible camera motions in tennis videos are panning, titling, and zooming, which make the segmentation process become more difficult. For methods in the previous works, the video frames were projected to sprite plane to generate the background scene [1], which could be used for player segmentation.

Although the player database has been constructed, it is still hard to render a vivid player's behavior. In our opinion, a model to simulate the behavior of tennis players is needed. Therefore, we propose a four state-transition behavior model for tennis players as shown in Fig. 1. The four states are Serving, Standby, Moving and Hit, and arrows stand for allowable state transitions. All the behaviors of tennis players can be composed by these state transitions. For example, a player moves right, waits for hitting and then performs a forehand stroke, which can be modeled as the state transitions by Moving, Standby and Hit.

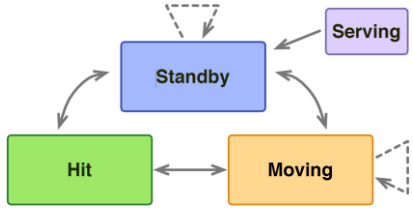

Fig. 1. Proposed four-state-transition behavior model for tennis players.

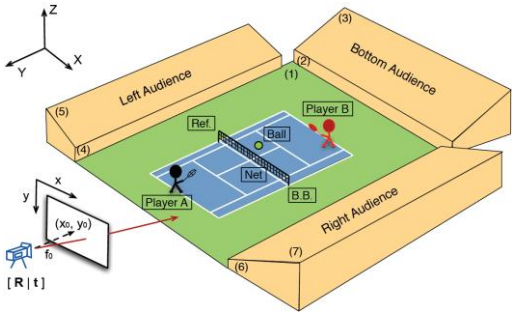

Fig. 2. The structure combining 3D model and video-based rendering.

To render various motions and postures of the player, the methods of clip cascading are proposed, where suitable clips are selected from database to form the various player motions and postures. For seamless connection between clips, some proposed approaches can smooth the transition in player's shape, color and motion.

B. Game Rendering

After player rendering, we integrate a game system with background court and foreground object. Inspired by the method in "Tour Into the Picture" [2], 3D scenes can be rendered from a 2D image after the user manually labels the 3D structure of the image. As the illustration in Fig. 2, the 3D structure of a tennis court can be roughly modeled by the seven boards: (1)floor, (2)bottom of the bottom audience, (3)top of the bottom audience, (4)bottom of the left audience, (5)top of the left audience, (6)bottom of the right audience and (7)top of the right audience. Combing foreground rendering in 3D structure, the rendering order of foreground objects is shown in Fig. 2: Player B, net, referee, ball boy, ball, and then Player A.

For a game system, the user dialogue is also a key component to improve the interactivity. We analyze the signals from Wiimote and transfer these signals into corresponding hitting gestures [3]. Finally, the tennis player would be rendered in real-time according to the user's control.

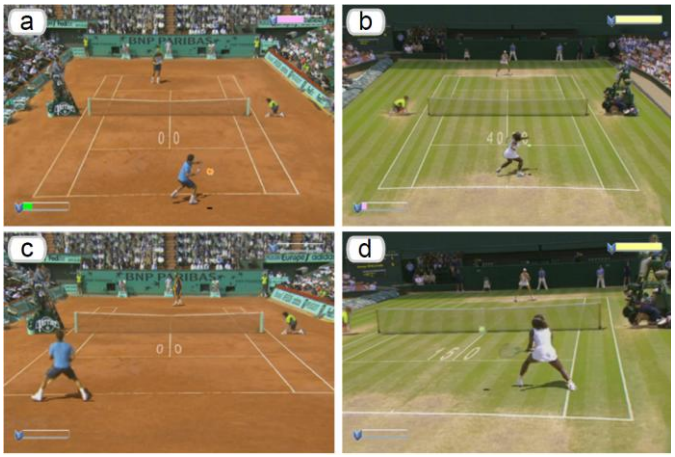

Fig. 3. Rendering results. (a)(c)Both players on the court of French Open. (b)(d)Both players on the court of Wimbledon Open.

III. EXPERIMENTS

A. Rendering Results

We design a graphic user interface to show the rendering results with resolution 720 × 480. Rendering results are shown in Fig. 3. Fig. 3(a) shows both players are playing on the court of French Open. To give more vivid visual effect, shadows of foreground objects are painted on the floor. Furthermore, the score is also seamlessly painted on the court with alpha blending. It demonstrates that the rendering effects are very realistic and looks like a real game video.

For the change of camera position, Fig. 3(a)(b) show the rendering results when camera position is far from the tennis court, and Fig. 3(c)(d) are the rendering results when camera position is behind the player. In addition, the demo video will show the smoothness of rendering results and the system operation in the live demonstration [4].

B. Subjective Evaluations

For the user study, we design the subjective evaluations for twenty undergraduates who play TRP in the first time. First, evaluators are required to watch the tennis game videos. After that, they are required to play TRP and give the score(1 to 5) of satisfaction for five questions. Average scores and standard deviations of evaluation results are shown in Fig. 4. Five questions are listed in the follows:

Q:1 Do you have more interaction with video content from playing TRP?

Q:2 Do you have more immersive experience with tennis game from playing TRP?

Q:3 Do you have more entertainment and interest?

Q:4 Do you think TRP is an innovative multimedia application?

Q:5 Are you willing to play TRP after watching game videos?

The results show that evaluators identify with the contributions of increasing interaction, immersive experience and enjoyment from playing TRP.

Next, evaluators are required to play the tennis games in Wii Sports(Wii) and Top Spin 3(TP3) on PS3. They are also required to give the score(1 to 5) for TP3 and TRP compared with the game experience of Wii. Four questions are listed as

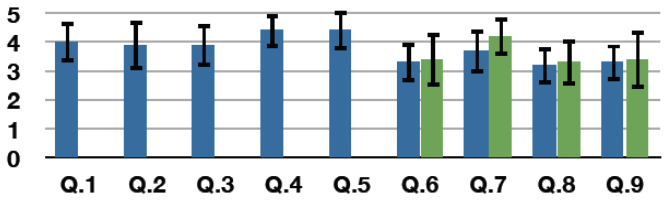

Fig. 4. Results of subjective evaluation. Blue bars are the average scores of TRP, and green bars are the average scores of TP3. The black lines show the standard deviations.

the followings:

Q:6 To compare the entertainment from each game, what do you think of the performance of TP3 and TRP?

Q:7 To compare the reality of visual effects, what do you think of the performance of TP3 and TRP?

Q:8 To compare the interaction from each game, what do you think of the performance of TP3 and TRP?

Q:9 To compare the preference of each game, what do you think of the performance of TP3 and TRP?

The result shows that the performances of TRP are slightly lower than TP3 in entertainment and visual effects. However, we think the performances of TRP are still outstanding because it needn't dozens of people to build the game model and draw texture; all the game materials in TRP are extracted from real game videos. Furthermore, this property can also bring a new framework in the game production; the latest game of TRP will be available after the real tennis game is finished.

IV. CONCLUSION

Tennis Real Play (TRP) is an interactive tennis game constructed with models extracted from real game videos. For the techniques in player model building, a 4-state-transition model for tennis player, methods of clips selection in player rendering and smooth connection in clips transition are proposed. For game rendering, a framework of combining 3D model with video-based rendering and signal analysis of Wiimote for gesture recognition are proposed. Experiments show that vivid rendering results can be generated. For user studies, the results reveal that evaluators identify the contribution of increasing interaction, immersive experience and enjoyment from playing TRP. Unlike building the complex scene models or drawing player texture in general video games, all the game materials in TRP are extracted from real game videos, bringing the property that the latest game of TRP will be available after a real tennis game is finished.

V. REFERENCES

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