From Video to Animated 3D Reconstruction: A Computer Graphics Application for Snooker Skills Training

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Abstract

This poster will present a computer graphics application for improving snooker skills training. We developed an automated modelling and rendering pipeline that converts video input data to a time-varying 3D graphical model that can be animated from arbitrary viewing positions. In addition, we introduced illustrative rendering capability that provides coaches and players with various annotated graphics as training aids. The reconstruction of 3D models relies only on a single camera view.

Categories and Subject Descriptors (according to ACM CCS):
I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Animation
I.3.8 [Computer Graphics]: Applications—

1. Introduction

This poster is concerned with a computer graphics application for snooker skill training. In order to meet the practical constraints, the model reconstruction has to replay action captured from a single camera, and the pipeline must provide both modelling and rendering capabilities in an integrated and automated manner. With this pipeline, coaches and players can study their performance using animated 3D reconstruction as well as illustrative graphics with various annotations to indicate, for example, played or optional ball trajectories, accuracy in cuing and cue ball positioning.

Snooker requires a variety of skills [Eve91]: two key skills being accuracy and repeatability. Guo and Namee [GN07] performed 3D reconstruction using a smallscale toy snooker table with a camera placed directly above, and so the obvious challenge of capturing real action from a full-size snooker table is already eliminated. Shen and Wu [SW10] also worked on 3D reconstruction from snooker video footage. They used a top-down camera placed above the centre of the table, and acknowledged that the captured image fails to cover the entire table because of the altitude of the camera. Our approach overcomes this limitation by allowing a more flexible camera position in conjunction with an inverse projective transformation and a series of model repair methods to correct undesirable reconstruction errors. In addition to animation of the time varying 3D model from arbitrary camera positions, we also introduced illustrative graphics as training aids.

2. 3D Reconstruction

Figure 1: *Video to top-down representation.*

The first stage of the pipeline is to reconstruct the snooker table automatically from the captured video. We use HSL colour space to detect the green table cloth, and the Hough transform to detect the table edges and corner points. Using the detected corner points, we perform an inverse projective transformation to achieve a pseudo top-down view, as shown in Figure 1. At the second stage, the system reconstructs each of the ball objects on the table. Since the top-down view introduces undesirable distortion, the reconstructed balls would be neither of a correct shape nor at a correct position without a correction process. To correct such reconstruction errors, we used the specular highlight on each ball to determine the normal vector at the surface point. Based on this normal, we can determine the central of the ball, since the size of each ball is known. We then assign colour to each ball by comparing the HSL values of the ball imagery against a pre-defined classification scheme. Once the first 3D model is obtained, each ball is tracked for subsequent frames. Our model repair capability also includes automated methods for removing unexpected objects in the scene (e.g., the player and cue).

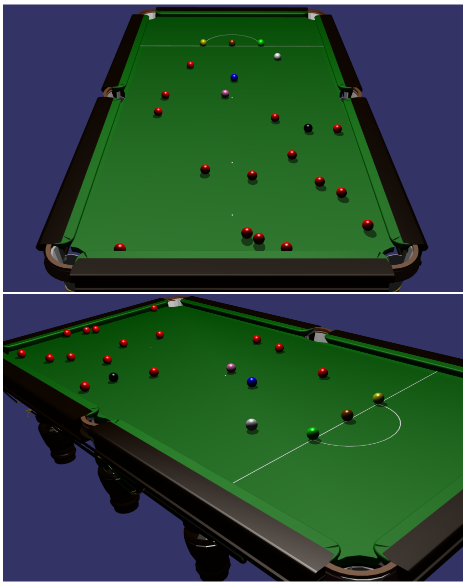

Figure 2: *3D reconstruction of captured scene.*

The rendering stage of the pipeline can generate an animation of the reconstructed time-varying model from a fixed viewing position or a series of positions on a pre-defined camera trajectory. The user can also render any specific time step by interactively specifying a camera position.

3. Illustrative Graphics

From the 3D time-varying model, we can produce illustrative graphics with various annotations. For example, a player often repeats a particular shot a number of times in order to perfect one's control of cueball power, potting and cueball positioning. The resulting videos are processed by our system to generate graphical feedback for the player. Figure 3 shows three such examples. The illustrative graphics annotates (a) the spread of the cueball finish spot, (b) the motion of the target ball, or (c) the finish spot of the cueball with regard to a particular target area.

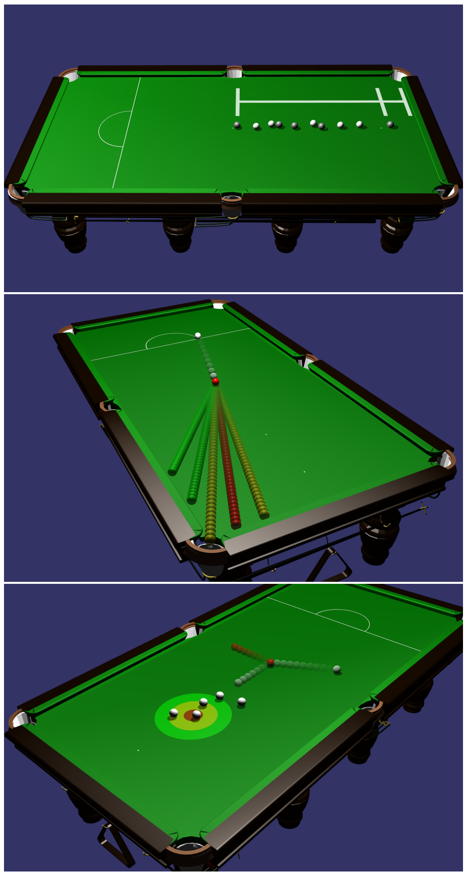

Figure 3: *Training tool using illustrative annotations.*

4. Conclusion

We have presented a novel graphics application for snooker skills training. We are in the process of evolving this prototype pipeline into a working system that can provide support to everyday snooker skill training. This work was carried out in conjunction with Terry Griffiths Matchroom Ltd., and was funded by the CIRP programme of the Welsh Assembly Government.

References

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