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Motion synthesis for controlling a virtual ball in real-time

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Abstract

Manually creating and editing the motion of a character handling a ball is a very cumbersome task because the character's motion must be synchronized with the movement of the ball in time and space according to the laws of physics. Thus, we propose a convenient way to automatically synthesize character animation for the control of a ball by using motion capture data. Because it is difficult for a beginner to control a ball skillfully, we do not use an actual ball. Instead, we capture motions that mimic the control of a ball. We analyze the motion capture data to find the frames and locations where the character interacts with the ball and create ball movement that follows the laws of physics. We can then synthesize character animation for the depiction of ball control in real time.

Keywords: *Character Animation, Physics-Based Animation, Virtual Reality.*[1]

1. Introduction

In previous research, motion analysis has been applied to the synchronization of music and character motion. For example,[1][2] classifies a character's motion, inputs the music according to the strength of the music, and creates dance motions that match the music. In addition, [3][4]proposed a method of controlling the trajectory of a rigid body according to the laws of physics. They created natural trajectories of objects by optimizing various constraints and calculating initial values such as position and velocity. Similarly, [5] proposed a method of simultaneously editing the movement trajectory of an object and the movement of a character. Controlling the motion of a character via user input has been studied actively in example-based character animation research. [6][7]synthesized the animation of a character to move it to a goal position or along a path that a user has specified by generating a motion graph from a large motion capture database, while [8]controlled a character by mixing similar motions effectively.

When an athlete handles a ball, similar motions appear repeatedly. This fact can be used to create character animation depicting the skillful control of a ball. In this study, we use motion that mimics the control a ball without using an actual ball. We use the method from [3] to create a natural ball trajectory according to the laws of physics. We analyze the character's motion and extract constraints to create ball movement. We can then create character animation for the handling of a ball by connecting the motion clips together in the order that the user selects and generating the ball trajectory. Our research is divided into two sections: first, we analyze motion capture data and then we generate the ball trajectory according to the laws of physics.

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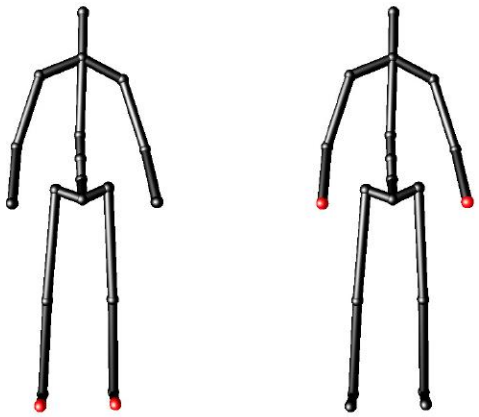

Figure 1. Interaction bones for a character.

2. Motion Data Analysis

In our research, the exact movement of the ball cannot be known because an actual ball is not used. Instead, motion capture data is analyzed to extract information that can be used to generate the ball trajectory. This information needs to cover the cases where the ball is attached to the interaction pattern and when the ball is separate from it. We thus use a velocity graph of the interacting bones to generate this information. Figure 1 shows the interaction bones of a user-specified character. The left character designates a pair of legs, and the right character designates both hands for use in the interaction bones.

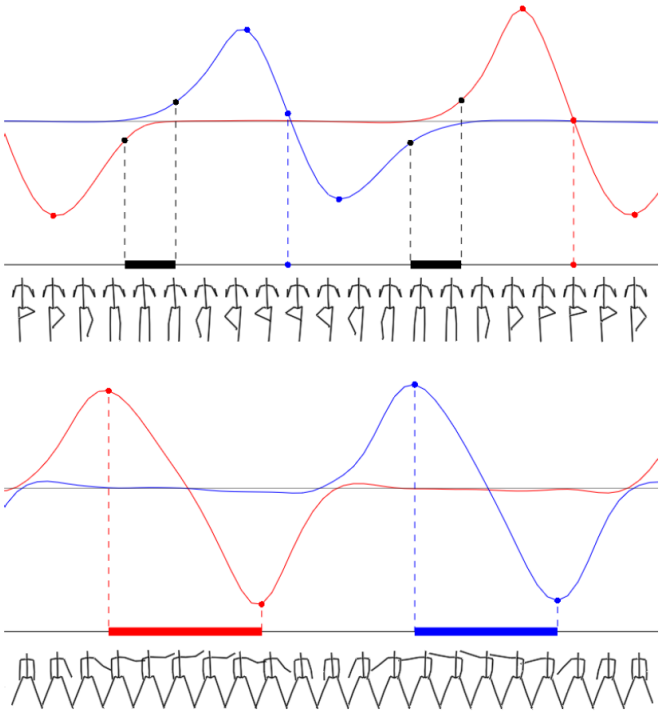

Figure 2. Motion data analysis

Figure 2 presents the motion data generated using our method. The top graph shows the velocity of the two feet when a ball is juggled between them. The solid red line indicates the left foot and blue indicates the right foot. The red and blue dotted lines represent the blow frame. The thick black line indicates that the figure is standing on both feet. The bottom graph shows the velocity of the two hands when a ball is bounced on the ground from one hand to the other. The red line indicates the left hand and the blue line indicates the right hand. The thick red line along the x-axis indicates when the ball is touching the left hand, and the thick blue line indicates when it is touching the right hand.

3. Character Motion Synthesis

We present a convenient way to control a ball by compositing the movement. We use a method similar to the one in [9] to generate the motion of the character. The motion capture data is divided into motion clips, which are the smallest units that can be connected to each other. The motion clips are then categorized according to the interaction patterns used, and information is generated to link the motion clips together. Finally, the selected motion clips are connected to create an animation of a character handling a ball. Figure 3 shows a connection graph that creates a group of classified motion clips. L denotes a motion clip that employs an interaction pattern involving a left interaction bone, and R denotes a motion clip that employs an interaction pattern involving a right interaction bone.

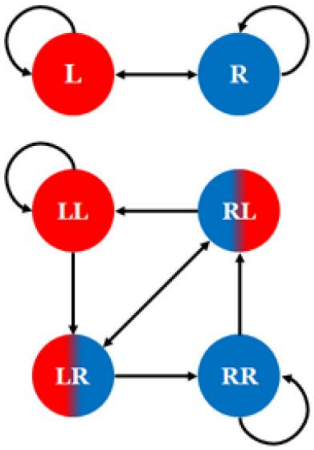

Figure 3. Connection graph for classified motion groups

4. Ball Trajectory Generation

To create the trajectory of the ball, we use the information from the attached and detached sections extracted in Section 2. We create detached trajectories for the ball in the attached and detached sections. Because the ball movement with the interaction pattern in the attached section, sequentially connecting the ball movement that is generated according to physical laws in the detached section can create a natural trajectory for the ball. Figure 4 shows the movement trajectory of the ball generated in the detached section, represented by the dotted line.

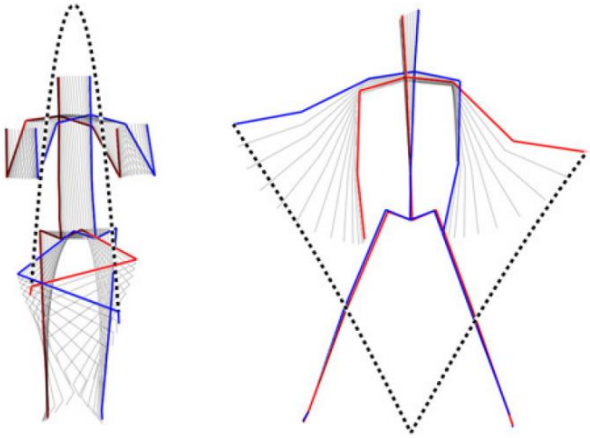

Figure 4. Ball trajectory in the detached section

5. Experimental Results

We used our method to create an animated character that skillfully controls a ball, including juggling a soccer ball with its feet and dribbling a basketball. In order to create natural character motion, we divided the motion data into motion clips and seamlessly connected them. The motion clips that the user selects are connected in selected order and the desired character motion is generated in real time. The left side of Figure 5 shows the animated character controlling the ball with its feet, and the right side depicts the character controlling the ball with its hands.

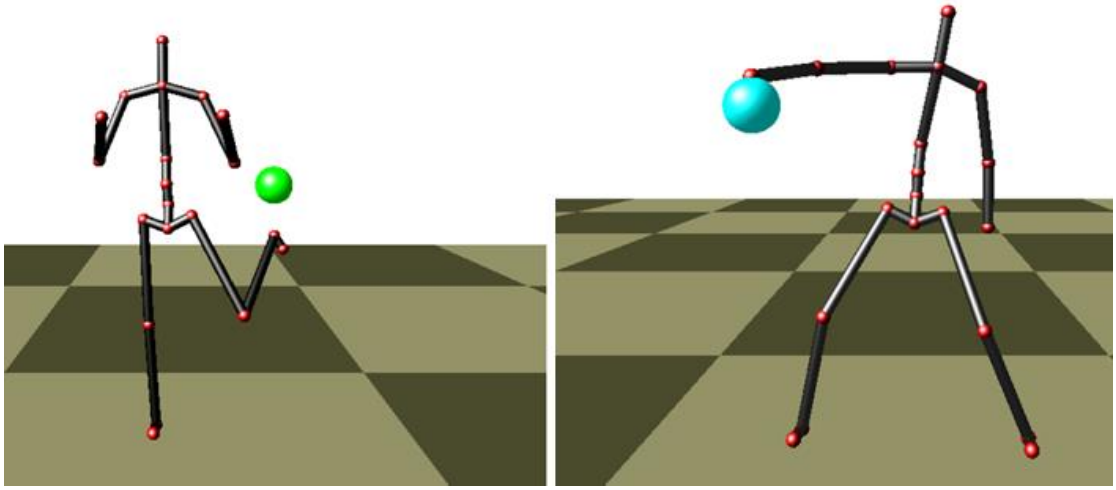

Figure 5. Synthesized character animation

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