Body Motion Design for Maneuvering a Virtual Camera in 3D Soccer Game

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ABSTRACT

This paper discusses body motion design to maneuver a virtual camera in 3D soccer game where people want to move and rotate the camera three dimensionally. We propose to select four body motions each of which is assigned to a typical camera-work. These four body motions easily remind people their associated camera controls intuitively and naturally. Since the four popular camera-works we take up in this paper are going straight, making turn, tilting up/down, and climbing up/down, we selected stamping, twisting, leaning back/bending, and crawling as natural body motions. We have implemented body motion estimation method by Microsoft Xbox Kinect and succeeded in maneuvering the virtual camera over a soccer game. We have conducted a survey on preferred body motions for popular camera-works so that our selection of body motions can be verified. We also conducted an experiment of browsing soccer games by the proposed method and obtained subjective scores from participants.

Keywords: Motion recognition, motion estimation, free viewpoint, 3D video, virtual reality, depth camera, kinect.

Index Terms: H.5.2 [User Interfaces] - Input devices and strategies, User-centered design.

1 INTRODUCTION

This paper discusses appropriate body motion design in order to maneuver a virtual camera in virtual reality. We take up an application of browsing soccer games where not only planner camera-works on the ground but also aerial and cubic camera-works are preferred to see whole picture of the games.

Making a free viewpoint video in a virtual reality have a long history and the technology is getting popular [1] [2] [3]. It is a promising technology to browse sport games [4] [5]. We plan to build up an immersive display environment where large screen is set and people can feel as if they were in a game at soccer stadium. The most common request in this immersive environment is to move their viewpoint as they wish. Though off-the-shelf products such as game controllers, mice, joysticks, etc. are commonly used on maneuvering a virtual camera in a virtual world, we do not intend to exploit these devices because they degrade the immersive feeling of a viewer. The purpose of this paper is to design body motions to maneuver the virtual camera by their direct body motions.

This paper proposes to select four body motions for realizing four camera-works that are commonly used in cubic camera maneuvering. Since the four popular camera-works we take up in this paper are going straight, making turn, tilting up/down, and climbing up/down, we selected stamping, twisting, leaning back/bending, and crawling as natural body motions. Since these four body motions are carefully selected so that unique movement of different part of the body is observed, the body motion recognition method and its motion strength can be stably estimated.

We have implemented body motion estimation method by Microsoft Xbox Kinect. Positions and velocities of the body parts are used to estimate the strength of their body motion. Our preliminary system serves the function of maneuvering the virtual camera over a soccer game that are recorded and reconstructed from a real soccer game[5].

2 BODY MOTION DESIGN

As our final goal is to provide an immersive environment where viewer just comes in and start browsing without having any instruction, the key technology is the body motion recognition and estimation by which the virtual camera is maneuvered. Since the target content is a soccer game in our project, we expect viewers behave like players basically.

Popular camera-works on browsing a soccer games virtually are considered to be going straight, making turn, tilting up/down, and climbing up/down. The problem here is to select four different body motions to assign the four camera works. We have conducted a survey on 10 male subjects who understands the concept of virtual world and virtual camera. Each subject was explained how a camera-work is and then he was asked to make action by his body to represent the camera-work. Each subject was asked for four camera-works. Their words and behaviors were recorded. The result is shown in Table 1.

From the table, body motions for going straight and making turn can be selected uniquely; stamping and twisting his body. Since we need to check the exclusiveness between body motions so as to implement robust body motion classifier, we will not check leg motion on making turns. The rest two are sort of vertical motions that are not so required in our daily motion, and it turned out no unique body motion could be found for tilting up/down and going up/down. In order to avoid confusion, we do not refer head motion. Hence leaning back (and bending) is selected for tilting up (down) camera-work.

Table 1. Body motion preference for camera works.

ID	going straight	making turn	tilting up(down)	climbing up(down)
1	stamp	twist	lean back	crawl
2	stamp	twist	lean back	jump
3	stamp	twist	two hands up	expand arms
4	stamp	twist	head up	stretch
5	stamp	twist w leg	lean back	jump
6	stamp	twist	head up	jump
7	stamp	twist w leg	head up	head up
8	stamp	twist w leg	head up	bend knee - stretch
9	stamp	twist	one hand up	bend knee - std up
10	stamp	one hand side	one hand up	both hand up

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Then, for a camera-work of climbing up/down, we exploit crawling. By selecting these four body motions, the body motion estimation could be organized in a rather straightforward way because different part of the body represents its uniquely assigned body motion. It is shown in the next section.

3 BODY MOTION ESTIMATION

3.1 Estimation of four motions

Our preliminary system to estimate body motion utilizes Microsoft Kinect (Figure.1). As the display is set at the front, viewer is always facing his face to the screen even when they make turns.

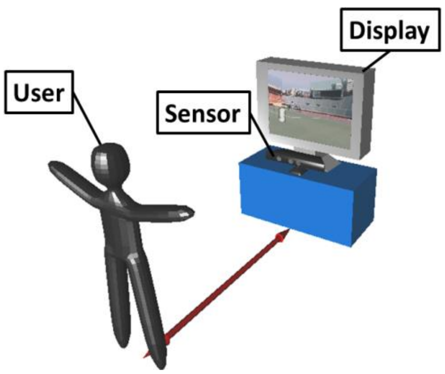

Figure 1. Layout of viewer and display.

The software library of Kinect for Windows SDK estimates the skeleton joint points on line. We exploit different set of joint points to estimate the strength of different body motion.

(1) Going straight : Stamping

Stamping is estimated by the vertical velocity of KNEE_L or KNEE_R joint point (Figure 2 left). Its velocity to the ground is counted as the speed of movement for every frame. Since FOOT and ANKLE joint points cannot be estimated precisely, they are not used. Note that negative velocity should excess some threshold to maneuver the camera.

(2) Making turn : Twisting

Twisting of the body is estimated by the relative positions of SHOULDER_L and SHOULDER_R joint point. As we assume legs and foots of the viewer is always facing squarely to the display, the relative rotation angle against the Kinect can be considered as the strength of twisting (Figure 2 right). The rotation angle is treated as angular velocity of the virtual camera. It means that the virtual camera makes turns at constant speed if the viewer holds his twisted pose.

(3) Tilting up/down : Leaning back/Bending

Motion of leaning back or bending is estimated by the angle between the line of HEAD to HIP_CENTER and the vertical line that goes through the HIP_CENTER (Figure 3 left). Like twisting, the angle is treated as angular velocity of tilting up/down of the virtual camera.

(4) Climbing up/down : Crawling

Motion of crawling is estimated by the averaged vertical velocity of HAND_L and HAND_R on the condition that the two joint points are distantly placed (Figure 3 right). The estimated velocity is treated as the speed of climbing up/down. Note that the velocity could be positive and negative, so it supports both climbing up and down. An snapshot of this motion is shown in Figure 4 left.

3.2 Motion Classification

The four body motions can be estimated simultaneously. The system activates only one camera-work at a time to avoid confusion of the viewer. A well trained viewer could activate some body motions simultaneously to realize his favored camera-work effectively. A view of the game of our demonstration system is shown in Figure 4 right.

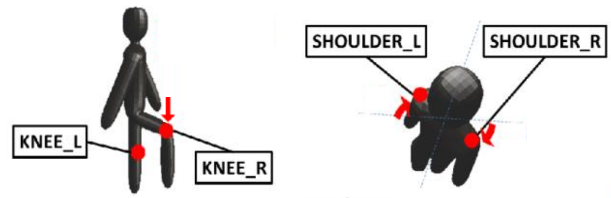

Figure 2. Stamping and twisting.

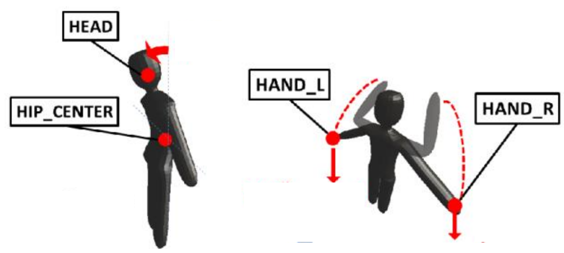

Figure 3. Leaning back and crawling.

Figure 4. Body motion / A snapshot of a game.

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