A Database Construction and 3D Visualization of National Rider Athletes for Motion Analysis in Horse Riding Environment

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Abstract

This paper is concerned with a database construction and three-dimensional (3D) motion visualization for motion analysis of national rider athletes in horse riding environments. For this purpose, we use inertial sensor based motion capture system to collect the 3D skeleton points with BVH format of rider motion. Here, the horse riders consist of two national rider athletes. These coordinates points can be used to perform 3D motion analysis and real-time coaching when the rider has four riding steps (walking, trotting-t1, trotting-t2, cantering). Finally, we shall perform 3D motion visualization through three BVH viewers and show an angle information of elbow and knees from each skeleton point in Matlab environments.

Keywords: database construction, 3D motion visualization, motion analysis, horse riding

1. Introduction

Recently, Xsens has announced accomplishment of the world’s first 3D inertial motion capture of a free-moving horse. The joint project of Xsens and the Rothschild Fund has been completed using an advanced prototype system developed by Xsens to enable 3D motion capture of equine locomotion in real-world conditions. The system utilizes inertial sensors located on the horse’s body and GPS to track-full-body in any environment, indoors and outdoors, allowing the horse’s innate, voluntary movements to be recorded and viewed on a standard PC in real-time [1].

Meanwhile, the riding simulator simulates a real build horse. It allows the rider to ride to the screen in real-time. The horse is perfectly schooled and capable of doing advanced movements such as medium trot, medium canter, lateral work and rein back. The neck is moveable and the leg aids are detected by on the girth and behind the girth sensors. All movements are mathematically correct [2]. Recently, we have been developing the five-senses sports simulator (horse rider and yacht) based on multi-axis motion supported by the Ministry of Knowledge Economy (MKE) under the IT R&D program supervised by the Korea Evaluation Institute of Industrial Technology. For this purpose, a research consortium consists of three research institutes and two companies to perform successful project. Here, we focus on a database construction of rider’s 3D motion and real-time coaching under horse rider simulator environments.

In this paper, we construct the database based on 3D skeleton points for national rider’s motion analysis. This database is collected by 3D motion capture system based on 17 inertial sensors attached to the body by a suit (Xsens MVN [3]). We also obtain rotation and coordinate information of each skeleton point with BVH format. Furthermore, we shall perform the 3D motion analysis based on flexion angle of elbow and knee of national-class rider. This paper is organized into four sections. In Section 2, we describe a motion capture system and environment for database construction. In Section 3, we describe three BVH viewers used for 3D motion visualization [4][5]. In section 4, we show the experimental results regarding motion analysis of elbow and knee using Matlab program. Finally, the conclusions and comments are given in section 5.

2. Database Construction Environment

In this section, we describe the database construction environment to collect 3D motion with skeleton points and BVH format of national rider athletes under real horseback riding. Fig. 1 shows the horse riding of national rider athletes wearing inertial sensor based motion capture suit at the Seoul equestrian training institute and Gwangju high-tech riding track, respectively. Here, the motion capture system used in this study is Xsens MVN based on inertial sensors. This motion capture solution
consists of inertial sensors attached to the body by a lycra suit. It gives you freedom of movement because MVN uses no cameras. It is a flexible and portable motion capture system that can be used indoors and outdoors, not only on-set in the studio but also outside. It also requires minimal clean-up of captured data as there is no occlusion or marker swapping. The ease of use and short calibration time allows you to set up the system in less than 15 minutes. The advantages of this motion capture system are flexibility, clean and smooth motion capture data, real-time motion capture visualization, unlimited capture volume and quick turnaround time [3]. We collect the database through walking, medium trotting, trotting, and cantering mode in order turning in a wide circle. The database is constructed by five sessions during about ten minutes each athlete, respectively.

3. 3D Motion Visualization

In this section, we describe three BVH viewers used for 3D motion visualization. Fig. 2 visualizes three BVH viewers. We developed real-time BVH viewer based on Unity3D engine as shown in Fig. 2(a). Fig. 2(b) shows motion viewer by MVN studio [1]. MVN Studio is a software application for motion capturing with the MVN suit. MVN Studio is part of the Xsens MVN system. The functionality of MVN Studio is easy and quick calibration, real-time preview of motion capture, simultaneous recording, and replaying previously recorded motion data. Fig. 2(c) shows 3D skeleton viewer what is called BvhViewer downloaded in the internet [4]. The BvhViewer visualizes motion data in the BVH format. This format was originally developed by Biovision and has became a widely used format in many motion capture and character animation applications such as Blender and Poser. BvhViewer also used the OpenGL 3D engine so it runs very fast. BvhViewer provides an easy and straightforward user interface for viewing and editing motion of each human body joint at each frame. Fig. 2(d) visualizes BVH viewer with 3D skeleton points using Matlab [5].
4. Experimental Results

In this section, we cover the experiment results regarding 3D motion analysis such as the flexion angle of left and right elbow, the flexion angle of left and right knee each riding type (walking, medium trotting, trotting, cantering mode) in real horseback riding. Fig. 3 shows total rotation angles for 28 skeleton points and 3 rotation directions as the number of frame increases. Fig. 4 visualizes the flexion angle of two elbows and knees when the national rider athlete has four riding types, respectively. As shown in Fig. 4(a), the flexion angle of two elbows in working mode is about between 120 and 130 degree. The flexion angle of two knees is around between 110 and 120 degree. In the case of trotting mode in Fig. 4(b), the flexion angle of two elbows shows regular bound. On the other hand, Fig. 4(c) in medium trotting mode shows the unique characteristics with regular rhythm from the angle of two knees. Fig. 4(d) shows the regular elbow movement in cantering mode.

The experimental results on the motion of national rider showed the characteristics with regular movement and angle bound.
5. Conclusions

We have built the database using motion capture system to collect the 3D skeleton points of national rider’s motion and presented 3D motion visualization for motion analysis of national rider athletes in horseback riding. In order to perform the 3D motion analysis, we have used flexion angle of elbow and knee of national-class rider. From the experimental results, we can know the characteristics with regular movement and angle bound each riding mode. For further research, we have a plan real-time coaching on a wild screen based on 3D motion analysis in horse simulator.

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7. References