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Kinect based Real-time Body Motion Analysis for Remote Physical Training

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Abstract: The Kinect sensor gives computer eyes. It can capture 3D coordinates of human body joints. This provides a convenient way to track human body movement. This paper proposes an on-line physical training system using 3D sensors (Kinect) so that the exercise instructor and the athletes who are not in the same location can collaborate and fulfil training tasks remotely. The system captures the motions of the instructor and the athletes via Kinect Skeleton Tracking. Pre-created 3D avatars are used to simulate the motions of the instructor and the athletes. The motion differences between the instructor and the athletes are generated by analyzing and comparing the motion data from the both sides. Finally visual feedback is provided to the instructor and the athletes. This poster presents initial design of the system.

Key words:

INTRODUCTION

3D sensors have recently created a revolution in the human-computer interaction field by embracing the human body as interactive object. The Kinect sensor, an example of such a natural user interface, can capture data at a rate of 30 frames per second. Six people and 20 joints per player can be tracked simultaneously (Jarrett Webb,).

In this paper, we propose an on-line physical training system using Kinect sensors. In traditional physical remote training systems, the athletes just can watch the video from the instructor, and no feedback is provided from the system. This paper proposes an online interactive training system using Kinect sensors. The main target of the system is to improve training accuracy by analyzing and comparing the motions of the instructor and the athletes. The instructor and the athletes can see the 3D avatars of each other. After viewing the motion of the instructor, the athletes mimic the motion of the instructor. The comparison results of the system are sent to both of the instructor and the athletes. Consequently, according to the feedback, the instructor can help the student to refine his/her motions. The athletes can correct his/her motions by themselves.

System Architecture:

The purpose of this work is to support a large range of users, including amateurs at home. An exercise instructor can create a class where athletes can join in. A Kinect is needed for each of the instructor and the athletes to capture their motions (Fig. 1). The skeletons of the instructor and the students are captured and displayed on the browsers of the both sides. The instructor is free to illustrate the important points of a motion to online students. Students can watch the movement of the instructor from different perspectives in a virtual 3D environment. After knowing the motions from the instructor, students can mimic the motions of the instructor. The motion data of the instructor and students is sent to the Server (Fig. 1). Then, the Server analyzes these data, compares the motions from the both sides, and sends feedback to the instructor and students. Consequently, the instructor can know which part and which student did wrong based on the feedback, and then help the student to refine his/her motions. The instructor can also record some motion templates. Students can mimic these motion templates, obtain feedback from the system, and refine his/her motions by themselves.

System Design:

The input data from users include Kinect depth streams, skeleton streams and colour streams. After receiving these datasets, firstly, the system pre-processes them, such as sets standard Coordinate system, smoothes it by Gaussian processes (Antoine Liutkus, 2012), processes delay and creates 3D Avatar. Afterwards, the pre-processed datasets from the instructor and a student are compared. Finally, the system produces a visual feedback - scores. The scores contain real-time scores and the average score that indicate the accuracy of the student. A score distribution chart is provided to review the accuracy of the whole motion. Highlighted errors are presented to the instructor and students to find the errors. Three-dimensional avatars are displayed to users so that the motions can be viewed from multiple perspectives.

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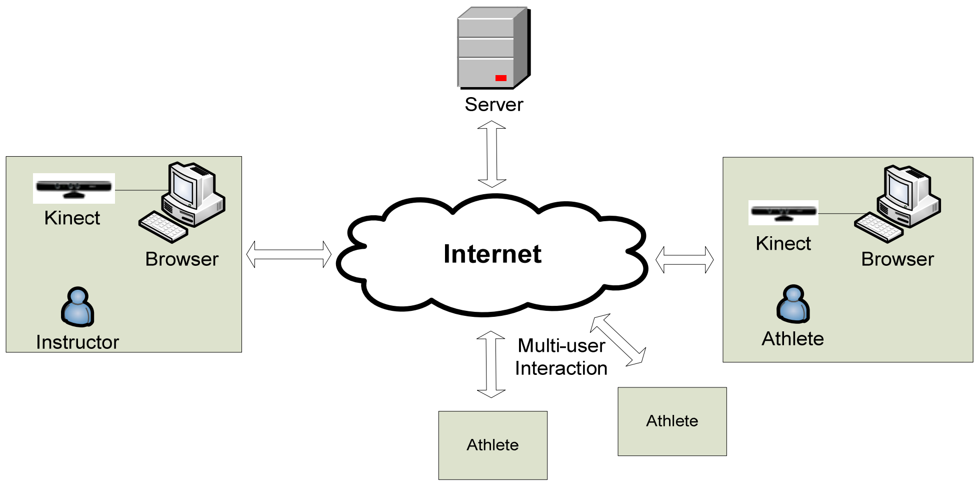

Fig. 1: Architecture of Kinect based Real-time Body Motion Analysis System

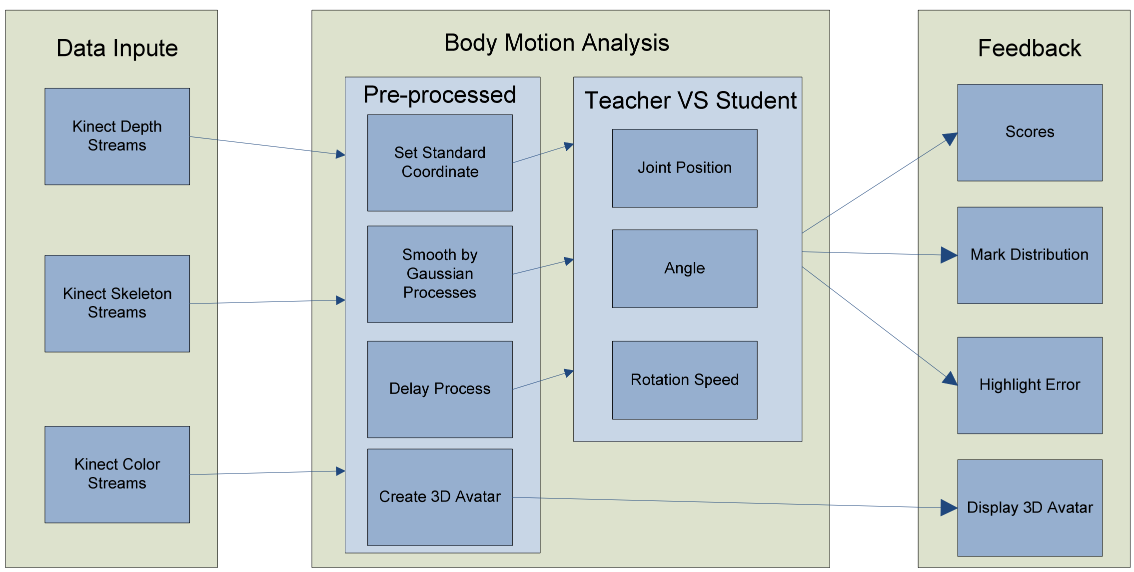

Fig. 2: System Design

Implementation:

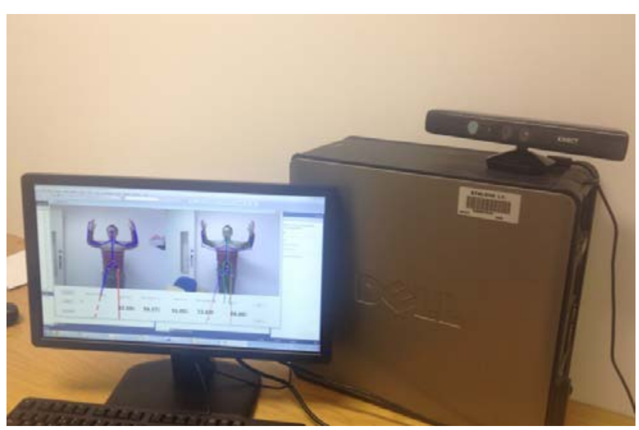

Fig. 3: The Evaluating Result of Comparing Two Motions

This prototype operates on a computer running Windows7. A Kinect for Windows sensor and a Kinect for Windows SDK v1.5 are needed for the system. Figure 3 shows the initial evaluating result of comparing the student's motion (the left window) with a recorded motion (the right window). The skeleton of body is tracked and drew using the joint positions provided by Kinect. There are two blue skeletons and one green skeleton in the screen (Fig. 3). The blue skeletons represent the student's current motion. And the recorded motion is green. The student can mimic the instructor's motion by matching the blue skeleton to the green one. Five scores are displayed in the bottom (Fig. 3). The first two scores are the current score and the average score by comparing the angles between every two bones of the student motion with those angles in the recorded motion. The 3rd and 4th scores are the current score and the average score of comparing the rotation speeds of every bone in the student motion with the rotation speeds in the recorded motion. The 5th score is calculated by combining the previous two average scores.

Conclusions and Future Work:

The Kinect skeleton tracking technology provides 3D coordinates of human body joints. This provides a convenient way to track human body movement. This poster presents a real-time body motion tracking and analysis system using Kinect. The system is designed for remote physical training. The system architecture and detailed designed are presented. A prototype has been developed which can record and compare motions from the instructor and students. In the next stage, we are going to enhance the motion comparison algorithm.

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