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MotionNote: A Novel Human Pose Representation

Dubeom Kim Bharatesh Chakravarthi Seong Hun Kim Adithya Balasubramanyam
Young Ho Chai Ashok Kumar Patil*

Chung-Ang University, Seoul, Republic of Korea

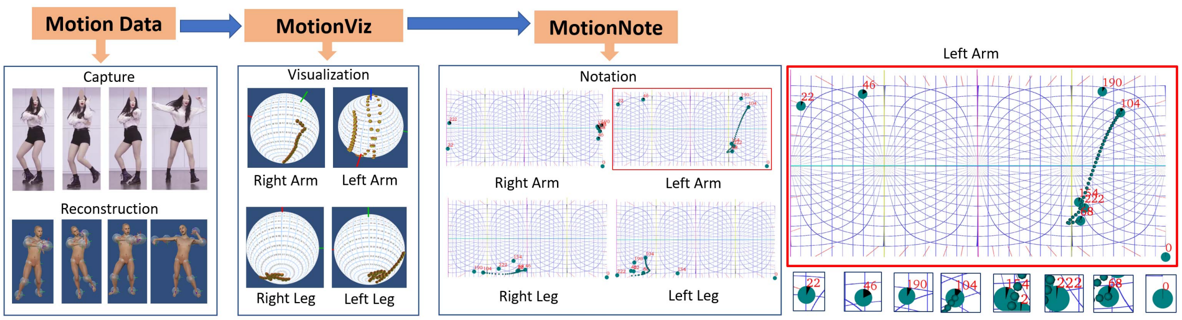

Figure 1: An overview of MotionNote.

Abstract

Three-dimensional (3D) avatar/humanoid models and their motions are extensively used in robotics, human-computer interaction, digital entertainment industry, fitness training, rehabilitation, animation and virtual reality (VR). This paper presents ongoing research work on developing a novel motion notation approach called MotionNote for a pose of human bone, like Labanotation and Musical notes are used for dance and musical sound. The representation of motion using MotionNote includes motion data capture and reconstruction on avatar/humanoid model, motion visualization and representation on a unit sphere, and finally motion notation on a two-dimensional (2D) equirectangular perspective grid (EPG). Our preliminary results show that MotionNote is feasible for understanding human motion using the motion notation on 2D EPG.

Index Terms:

Computing methodologies—Computer graphics—Animation—Motion capture; Human-centered computing—Human computer interaction (HCI)—Interaction techniques—Gestural input

1 Introduction

In recent years, research works on motion capture (MoCap), recognition and representation of human action are greatly emphasized. Understanding a complex human motion in detail from the 3D stick model's, keyframes lined up in timeline sequence, representing as a trajectory [2] and so on are challenging tasks. For instance, in fitness training, a user carries out a simple rotating biceps curl action multiple times, but each time the user does the same action they may have a slightly varied posture based on bone axis rotation. Representing human motion of a specific bone in a particular pose with its position and orientation symbolically is challenging. Such representation can offer a detailed understanding of motion by defining a notation for poses in a continuous motion. The overview of the proposed novel MotionNote to represent human pose is shown in Figure 1.

*e-mail:ashokpatil03@hotmail.com

2 Background

Human action or a pose representation and recognition have had significant attention over the past decades [3], representing and understanding human pose with notation in detail is new research. Labanotation [4] has a notation for each movement of dance steps depending on the direction and level of the movement, part of the body, duration and dynamic quality of the movement. Similarly in Musical note, each musical sound [6] has its own representation depending on the pitch and duration of the sound.

The skeletal of the human body is constrained by fixed bone lengths and joint angle limits. The human-specific pose or complete motion details are involved within axis and orientations changes by each bone. This paper visualizes human motion on the unit sphere as a trajectory and further motion can also be represented on the 2D EPG [1] as key poses.

3 Proposed Method

The depth camera and inertial sensors are commonly used to capture human motions. In this work, we used inertial sensors to capture the motion data and it is reconstructed on an avatar (Figure 1).

3.1 Motion Visualization

We present a MotionViz representation technique for visualizing human motion as a continuous trajectory on a unit sphere. The trajectory on a MotionViz represents accumulated motion data from each limb of the human body. i.e. for instance, the left upper limb is included with the shoulder, elbow and wrist joints. These three combinations of motion data are accumulated into a single trajectory by multiplying the motion data in the hierarchical order. Figure 2 shows the trajectory (highlighted bead represents a single motion data frame) visualization on a MotionViz from dance sequence motion data shown in Figure 1.

A bead yields a positional and orientation information of a single frame. The filled red color in a bead gives the rotation and direction of the limb. The alphanumeric code on the unit sphere gives the positional information. For example, the code *U5 FL2* (highlighted bead) means 50° to the Upperside and 20° from the Front to the Left. The positional information defines one of the eight regions [5] around the human body. Likewise, the unit sphere has eight divisions of 90° each and with a grid size of 10°.

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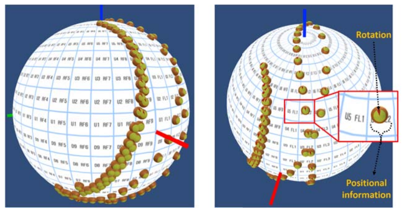

Figure 2: A left upper limb motion trajectory on a MotionViz. The complete trajectory in two different views

3.2 MotionNote

This section discusses MotionNote representation. The represented sequence of motion trajectory on the unit sphere is visually intuitive while visualizing it from the viewing point, but it does not give complete trajectory information due to the curvature of the sphere. To understand the motion data fully, an EPG [1] is used as shown in Figure 3. An EPG can be seen as a baseline similar to staff in a musical note.

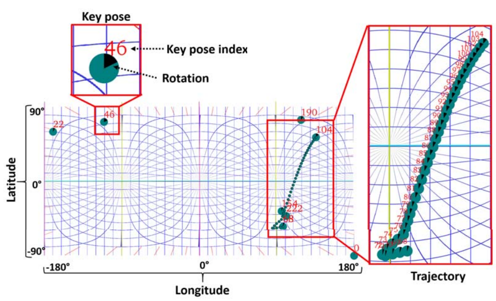

Figure 3: Detailed key pose and a trajectory representation between two key poses on a 2D equirectangular perspective grid.

The highlighted section (Key pose) in Figure 3 shows 46^{th} key pose. The filled section of the circle in black indicates the extent of rotation (64°) of 46^{th} key pose index. The changes in the degree of rotation during the action from $68^{th} - 104^{th}$ key pose indexes is shown in the highlighted section (Trajectory) of the Figure 3. The 2D circle's position on the 2D EPG, the filled area, and the frame number collectively give out the position, orientation and speed of the limb while in motion.

4 Experiments

Eight key poses are considered in a dance sequence. The key poses are indicated in Figure 4(a) by the avatar. The MotionViz are the four spheres each representing a complete set of the dance sequence data for the right and left arm, right and left leg respectively in Figure 4(b). Corresponding 2D EPG is also shown in Figure 4(c) highlights eight key poses represented by the avatar. The angle of the limb as indicated by the filled section of the circle starts from the 12^{o} clock position of the circle and the angle of rotation is 0° for the first frame as indicated in the 0^{th} key pose. The direction of rotation is clockwise for positive rotation of the limb and anticlockwise for the negative rotation of the limb.

Using this representation to understand the human motion by its limb orientation, the speed of motion, the sequence of key poses is intuitive and easy. The proposed notation can be a stepping stone for a fully mature motion grammar that can be used for defining any human body motion.

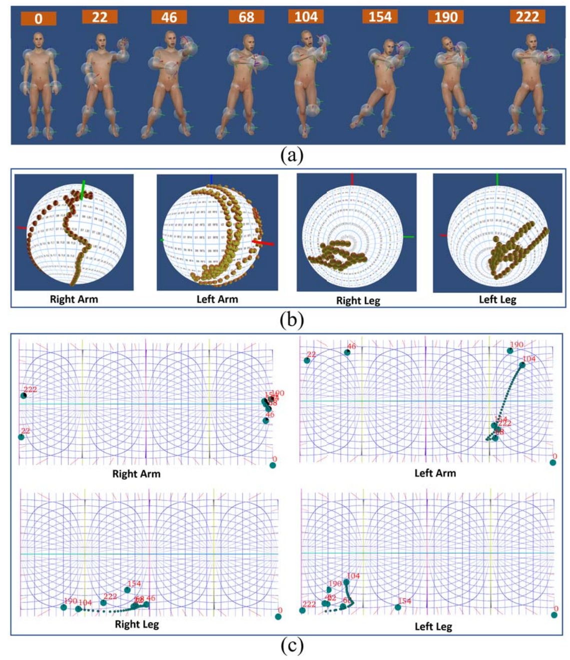

Figure 4: Representation of motion for dance sequence. (a) Key poses (b) MotionViz representation (c) MotionNote on a 2D EPG.

5 Conclusion

In this paper, we have presented our ongoing research work on developing a novel MotionNote representation for a pose of human bone. The proposed work includes MoCap and reconstruction on an avatar, motion visualization on a unit sphere (MotionViz), and motion notation on a 2D EPG, acts as a ruler for MotionNote, similarly as the staff is used in a musical note. Our preliminary result shows that MotionNote is feasible for understanding the human motion using the motion notation on 2D EPG. MotionNote can be used for defining a well structured human motion grammar.

Acknowledgments

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