Game-Based System for Learning Labanotation Using Microsoft Kinect

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***Abstract*—This paper presents a serious game-based system for dance notation training. The system tracks the full body motion via Microsoft Kinect of the user while performing the movement according to the dancing score. The system provides two training modes which a practice mode and an examination mode. The practice mode is designed for users with less knowledge in the notation where movement of a virtual instructor is displayed according to the score for a user to follow. The second mode is the examination mode where users must perform the body movement according to the displayed Labanotation symbols within the provided time frame. The experiment showed that users without knowledge of Labanotation can enjoy the game while learning the fundamental of the Labanotation.**

Keywords—labanotation; Kinect; motion tracking; serious game;

I. Introduction

Labanotation is one of the most common dance notation systems for recording human movement, choreography, and dance training [1]. With Labanotation, all kinds of human motion can be described without having any reference to specific codified dance or style characterizations. This makes Labanotation adaptable to another type of movement analysis outside the field of dance, like sports, work, and others.

In Thailand, knowledge of dances often been passed to students by observing body movements of the dance instructors. The challenge with the intangible property such as dance, however, is that it is not preserving an object, but a process to pass it on to the next generation. We strongly believed that Labanotation can serve as one of the methods for describing and preserving dance movement. However, to introduce Labanotation as a common standard is an easy task because of its complexity and the lack of experts in the field of Labanotation in Thailand.

Recent advances in technology for gaming and motion tracking, virtual environments have the potential to create effective training environments and compelling entertainment experiences. With these technologies, we develop a serious game-based system that helps to teach Labanotation by giving actively entertainment participating in learning.

II. Methodology

A. System Overview

The system uses a Microsoft Kinect as an input device that captures user's movement. Fig.1 shows the overview architecture of the system. For each frame, the data acquired from Kinect are transformed into a body state list that represents body posture. After transforming the data from Kinect Device, the body state list is used for further comparison with the displayed Labanotation score from the system in real time. The system reads Labanotation data and transforms this data into body state lists that are comparable to the live data from Kinect Device. After the user complete game tasks, a report is generated to show the success rate of the user.

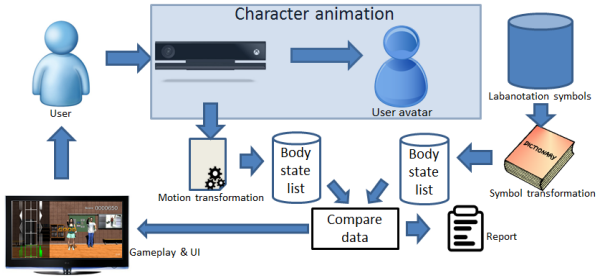

Fig. 1. Overview system diagram

B. Game Flow

The proposed system has two game modes, which are practice and examination. In each mode, four levels can be selected where are hand movement, leg movement, jumping and combination of all. At the start, the system displays a Labanotation score for the user to see and displays virtual 3d model representing the user that will follow all of the user's moves. Then, depending on the game mode, we differentiate the game logic as described below.

In practic game mode, a virtual instructor is displayed to show the correct move to the user (the female virtual instructor in Fig. 2). The user can follow the movement of the virtual instructor to complete each move and learn about the meaning of each symbol. This game mode is recommended for the users with no or little experience in Labanotation.

Fig. 2. Practice mode: The virtual instructor presents the correct movement.

While in examination mode the user has a specific time (based on the tempo of the track) to complete each move. At the end of the notation score, a report is generated to show user's success rate and details about the accuracy of each move that was completed. This mode is recommended for the users with some experience in Labanotation notation.

C. Motion Transformation

The system uses Kinect device to acquire live motion data from the user that can be used to compare with generated Labanotation scores. With Microsoft Kinect SDK, 20 human body joints position and rotation can be obtained. For every frame, the system calculates the relative position between the neighbor joints. This relative position is the distance of the neighbor joints for the 3D axis of the 3D space. Then, by setting limit distances for each axis and comparing these limits with the relative position values, we can evaluate the state (Left, Right, Down, Forward) of the specific part that is located between these neighbor joints.

Instead of reference to the states as "Left", "Down" etc., we use IDs that represent each of these states as shown in Fig. 3. If a part belongs to two or more basic states, then the IDs is the summation of these states. For example, if the IDs for each state as shown in Figure 4, we represent the state Left and Down with the ID = 16 (Left) + 1 (Down) = 17 (Left-Down).

In this current version, we used four limbs, which are left-right arms and left-right legs for describing human posture. One ID is assigned for one body part. In order to describe the whole body, we can concatenate the IDs of each body part, as shown in Fig. 5.

Down	1
Up	2
Forward	4
Back	8
Left	16
Right	32

Fig. 3. IDs of basic moves. We can add them to get combinations of them.

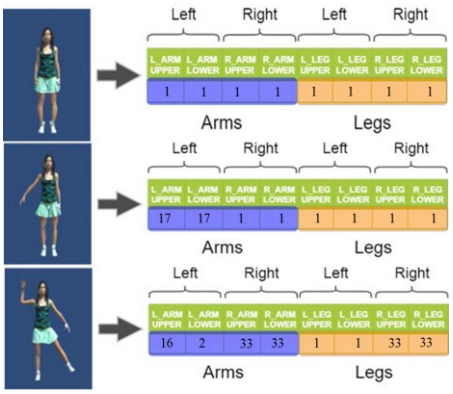

Fig. 4. An example of ID lists of various postures.

D. Symbol Transformation

1) Labanotation Data:

The system store Labanotation scores using a simple format called Labanotation Data (LND) [2], which uses alphanumeric characters to represent basic symbols. Fig 6. illustrates how a Labanotation score is converted to an LND structure.

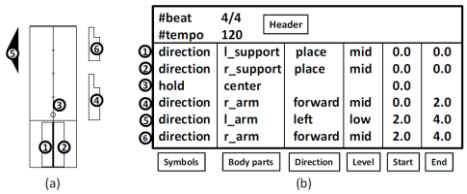

Fig. 5. Conversion from Labanotation score to LND

2) Labanotation & Kinect Connection:

After storing the Labanotation score to LND, all symbols are transformed to the body state list for every measure. For every frame, the state body list of those Labanotation symbols is compared with the body state list from Kinect.

III. Experiment

The evaluation was conducted using 25 subjects with no background on Labanotation. All subjects were asked to complete all four levels by first completed the practic mode then the examination mode respectively. Table 1. shows the evaluation result from examination mode.

TABLE I. Result of Examination Mode

	Average Correctness	*Std.*	*# of subjects failed (below 50%)*
Level 1: Arm movement	76.32	9.6	0
Level 2: Leg movement	54.2	22.0	10
Level 3: Jump	63.8	19.2	7
Level 4: Combination	58.5	19.2	8
All 4 levels	63.2	11.6	4

IV. Conclusions

This paper introduced a system that provides mirror-like animation for user movement that allows the user to train their knowledge in Labanotation. From the evaluation result, after completing four levels, only four out all 25 subjects preformed less than 50% correct movement. This showed that the system is a potential platform for learning fundamental of Labanotation.

Kinect is a great device to capture human movement. However, there are some limitations concerning accuracy and camera view. Therefore, these issues need to be further investigated.

References

[1] A. H, Guest, "Labanotation: the system of analyzing and recording movement," *Routledge*, 4th ed., 2014.

[2] W. Choensawat, M. Nakamura, and K. Hachimura, "GenLaban: A tool for generating Labanotation from motion capture data." *Multimedia Tools and Applications*, 74(23), 2015, pp. 10823-1084.