Materialization of Motions: Tangible Representation of Dance Movements for Learning and Archiving

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Figure 1: *(a) Design method for learning choreography. (b) Tangible representation of the choreography. (c) Zoetrope methods to render 3D animation of body movements.*

ABSTRACT

We propose a method to learn and archive dance movements by fabricating tangible three-dimensional (3D) human forms. We analyze the pattern of the tempo and rhythm of a music piece and fabricate the shape of a 3D body based on the motions of the dance performer by using a 3D printer. For the implementation, we employ a depth camera to capture 3D information of a dance movement. Appropriate movements are extracted from the file at every constant tempo by analyzing the tempo of the music piece played while the dance is performed. The 3D printer enables tangible modeling of the dance movements.

CCS CONCEPTS

•**General and reference** →*Design; Performance;*

KEYWORDS

dance, choreography, archive, tangible

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1 INTRODUCTION

There has been a focus on studies and projects that combine dance and technology. For example, the project named Lighting Choreographer [Fujimoto et al. 2011] is an LED performance system that expands the expression capability of the human body. Many of these studies on dance expression aim to extend a physical expression. In the research on choreography itself, it is common to use a two-dimensional display.

Capturing and saving videos using a general camera is the most common method for storing information that can be used for practicing and learning dance; this method is also used for live music. (Figure 2) However, these records are composed of two-dimensional information and three-dimensional information such as spatial information is lost. Spatial information is important while recording dance movements because the positions of hands and feet are important for learning choreography; however, without this information, it becomes difficult to understand the choreography in detail from

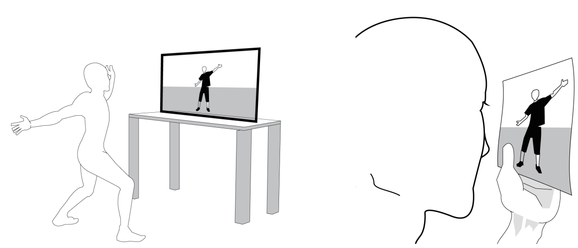

Figure 2: *Previous methods for learning or archiving dance movements.*

a three-dimensional point of view. It is possible to use a free viewpoint video; however, it is not suited for general users because of problems such as its display size and the necessity to input specific parameters constantly for varying the point of view.

If saving tangible three-dimensional information of dance movements can be made possible, learning and archiving these movements will become possible. Moreover, it can be helpful for blind people in addition to other dancers.

In this study, we acquire three-dimensional information of a performer's dance movements using a Kinect sensor and save it as a motion file. Appropriate movements are extracted from the file at every constant tempo by analyzing the tempo of a music piece played while the dance is performed. The 3D printer enables tangible modeling of the dance motions.

2 DESIGN

We propose a new method to learn and archive choreography through tangible 3D representation. Most people who want to enhance their dancing skills use movies or two-dimensional (2D) drawings. The merits of 3D fabricated choreography are as follows. (Figure 3)

First, the dancing postures are tangible. Therefore, users can touch and confirm the position of the body parts such as hands and feet. Moreover, blind people cannot obtain any information about these positions through two-dimensional displays; therefore, they feel uncomfortable when learning dance because someone will need to physically move their body parts by touching them for them to understand the postures. However, if they use 3D tangible representations, then they can touch and grasp these positions of body parts.

Second, users have a 3D point of view of the dance postures, which enables them to see these dance postures from any point of view, which is not possible in case of 2D videos.

Finally, users can change the position of 3D object by direct hand manipulation. This can be useful for choreographers when considering choreography, formation, or structure.

There are mainly two ways to implement tangible representations for dance forms. One is used to put the motion postures on a plate in a certain order. (Figure 1 (a)) The other is zoetrope methods that can be used to render 3D animation of body movements. (Figure 1 (b), (c)) In the former, there may be a lack of movements in some frames; however, it can handle and put several movements together. The latter has frames that are enough to render an animation of the choreography and users can understand the transitions of dancing postures.

When outputting three-dimensional models, appropriate movements should be selected. For learning choreography, the selection of the 3D-models is important. Specific movements like walking or swimming can be detected and extracted more accurately since the patterns of these movements have been recognized to some extent.

Some methods proposed for detecting movements use image processing and depth information captured by a depth camera such as a Kinect sensor. [Presti and Cascia 2016]

However, in the case of dance, there are various kinds of movements that are complicated. Accordingly, we focus on the process that choreographers follow while choreographing a dance. It is common to choreograph a dance to the tempo of a music piece. Therefore, instead of analyzing the image or depth information itself, we analyze the tempo of the music piece and extract dance movements based on the relationship between the movements and the tempo.

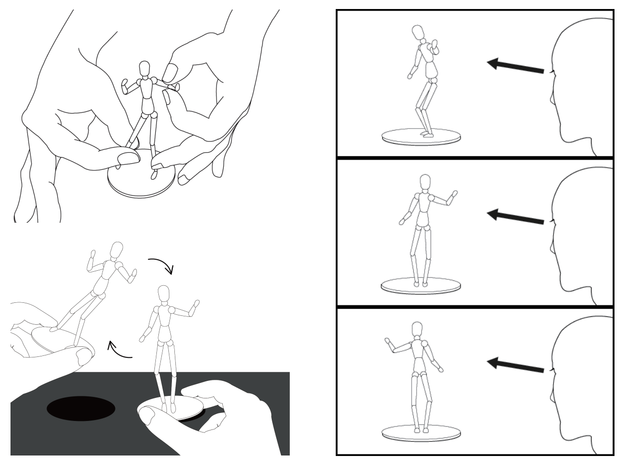

Figure 3: *(up) Tangibility of the posture during dance. (down) Ability to change the position of the 3D object. (right) A 3D point of view.*

3 IMPLEMENTATION

Figure 4 shows our implementation, where we use a Kinect camera to record the dance movements. We acquire the x, y, z positions of each joint detected by the Kinect Camera. The position information is saved as a motion file with BVH format (30 FPS). The motion file contains the definition of the hierarchy of 20 joints in a header and rotation angles in every frame.

We analyze the tempo of the music piece played while the dance is performed for selecting the frames from the motion file. These selected frames are printed by a 3D printer.

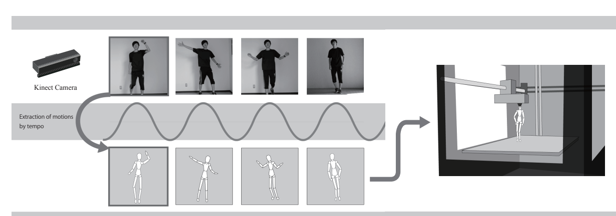

Figure 4: *Extraction of dance motions and printing tangible 3D models.*

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