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# Automatic Dance Generation System Considering Sign Language Information

Wakana ASAHINA<sup>1,†</sup> Naoya IWAMOTO<sup>1,‡</sup> Hubert. P. H. Shum<sup>2,§</sup> Shigeo MORISHIMA<sup>3,¶</sup>  
Waseda University<sup>1</sup> Northumbria University<sup>2</sup> Waseda Research Institute for Science and Engineering<sup>3</sup>

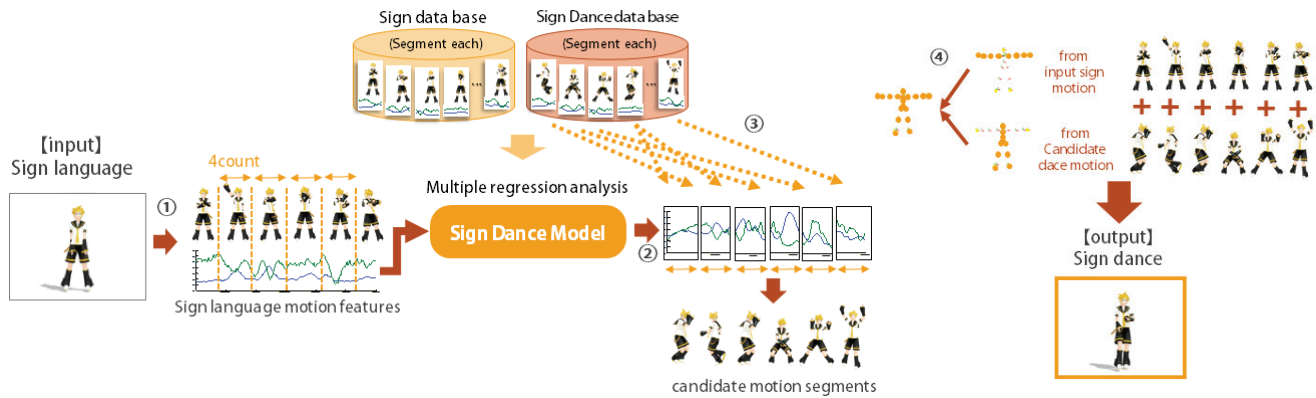


Figure 1 :The overview of our work

## 1. Introduction

In recent years, thanks to the development of 3DCG animation editing tools (e.g. *MikuMikuDance*), a lot of 3D character dance animation movies are created by amateur users. However it is very difficult to create choreography from scratch without any technical knowledge. Shiratori et al. [2006] produced the dance automatic generation system considering rhythm and intensity of dance motions. However each segment is selected randomly from database, so the generated dance motion has no linguistic or emotional meanings. Takano et al. [2010] produced a human motion generation system considering motion labels. However they use simple motion labels like “running” or “jump”, so they cannot generate motions that express emotions. In reality, professional dancers make choreography based on music features or lyrics in music, and express emotion or how they feel in music. In our work, we aim at generating more emotional dance motion easily. Therefore, we use linguistic information in lyrics, and generate dance motion.

**Concepts:** • Computing methodologies~Motion processing

**Keywords:** sign dance, motion analysis, linguistic information

<sup>†</sup>e-mail: [2236-wakana@fuji.waseda.jp](mailto:2236-wakana@fuji.waseda.jp)

<sup>‡</sup>e-mail: [iwamoto@toki.waseda.jp](mailto:iwamoto@toki.waseda.jp)

<sup>§</sup>e-mail: [hubert.shum@northumbria.ac.uk](mailto:hubert.shum@northumbria.ac.uk) (corresponding author)

<sup>¶</sup>e-mail: [shigeo@waseda.jp](mailto:shigeo@waseda.jp)

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In this paper, we propose the system to generate the sign dance motion from continuous sign language motion based on lyrics of music. This system could help the deaf to listen to music as visualized music application.

## 2. Sign dance motion synthesis

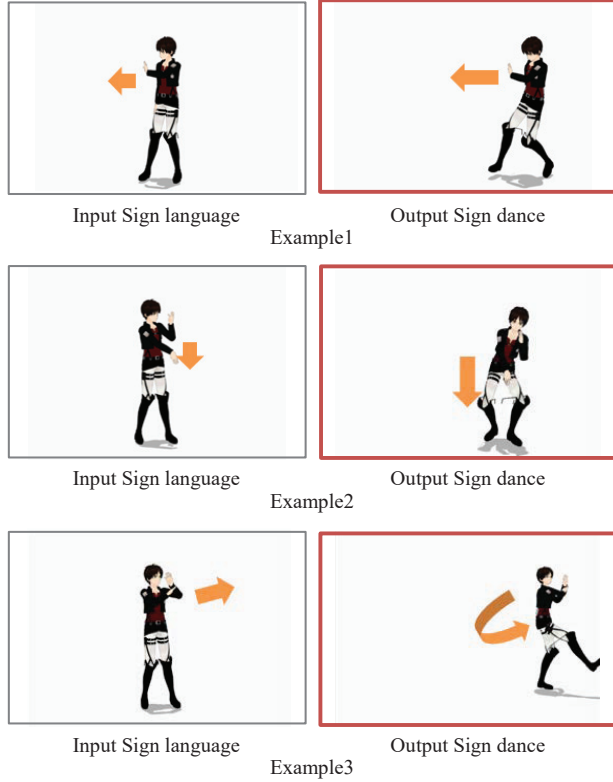
Fig.1 shows the outline of our system. In our system, the input is a sign language motion and by using our Sign Dance Model, we can generate a new sign dance motion as output automatically. First, we divide the input sign language motion into 4 count segments each (①). Then, based on Sign Dance Model, we estimate the sign dance motion features (②). Next, we choose the candidate sign dance motion segments from the sign dance database, which is the most similar with estimated dance motion features (③). Finally, we synthesize hand joint motion from input sign language motion and other joint motion from estimated sign dance candidate motion (④).

### Construction of learning motion data:

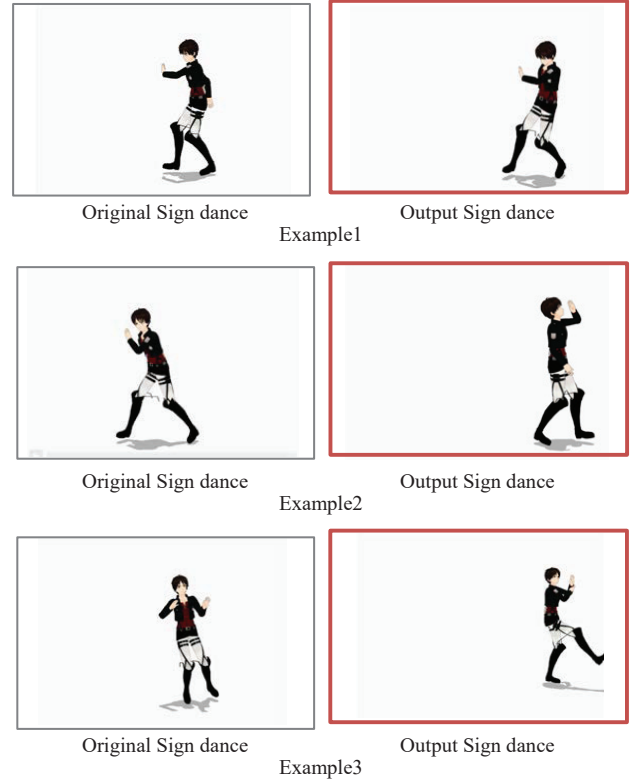
To build a Sign Dance Model, lots of learning motion data is required. Therefore, by using marker-based motion capture system, we captured the movement of a professional sign dancer. Then, we got sign language motion and sign dance motion data of 10 pieces of music each. For those ten pieces of music, we used j-pop music with lyrics which is around 2 minutes each. Then, we cut those each 20 motions into 4 count segments. Finally, the database includes 360 segments each (only sign language: 360 segments, sign dance segments: 360).

### Build the Sign Dance Model:

We use multiple regression analysis to estimate a sign dance motion. In particular, we use sign language motion as an explanation variable, and use sign dance motion as an objective variable. Here, we use the quaternion of 6 joints (24 dimensional vectors) that is related to hand, arm and roots as motion features. We decided to use these joints based on the assumption that there is a correlation between the orientation of the pelvis and the hand joints of sign language motion and those of sign dance motion.



**Figure 2 : Comparison with input sign motion**  
We got the output dance which emphasizes input sign motion.



**Figure 3 : Comparison with original dance**  
We got the similar output dance motion with original dance motion.

### Choice of the candidate segments

Here, we describe how to choose the appropriate candidate segments from learning sign dance motion data.

First, we defined the similarity variable  $\alpha$  as:

$$\alpha = \sum_k^{N_s} \sum_i^{N_f} \sqrt{(Fe_{i,k} - Fd_{i,k})^2} \dots(1)$$

where  $Fe_{i,k}$  denotes estimated sign dance motion features, and  $Fd_{i,k}$  denotes sign dance motion features of motion segments in sign dance database (segment:  $k$ , frame:  $i$ ). Next, we narrow the candidates down to top 5 candidates by thresholding the beats per minute (BPM) of each dance segment according to the music BPM. Moreover, to connect each segment naturally, we use a posture similarity variable  $\beta$  as:

$$\beta = \sum_l^N v_l(i^k) \cdot v_l(j^{k-1}) \dots(2)$$

where  $i^k$  and  $j^{k-1}$  denote frame number of segment  $k$  and segment  $k-1$ .  $v_l$  denotes direction vector of each joint link. Finally, we select the first candidate segments that minimize the degree of  $\gamma = w_1 * \alpha + w_2 * 1/\beta$  from 5 candidates. Here, we decided to use  $w_1$  as 1.5, and  $w_2$  as 1.0.

### 3. Results and Conclusions

To evaluate our system, we compared our results dance motion with the input sign language motion and the original sign dance motion. First, we found that in our results, dance motion segments that emphasize the input sign language movement tend to be selected (Fig.2). In addition, in our results, a lot of motion segments that are similar with the original sign dance motions were selected (Fig.3). This means our sign dance estimated model works well.

However, there are some foot gliding motion and physically incorrect motion, which happens when the character turns around. To solve this problem, we plan to analyze the stepping pattern and apply inverse kinematics on the supporting feet in the future.

This paper presented an automatic sign dance generation system. By this system, we can generate a dance motion that includes linguistic information in lyrics. The generated sign dance motion can express the emotion in music and dance more richly by using sign language and dance motion that emphasize sign language motion. As a future direction, we want to consider using music features like beat or timbre of a song. In addition, by conducting a user study, we plan to evaluate the precision of our system. Moreover, by building the large sign language database that is corresponding to each word, we wish the system to take lyrics only as the input, instead of the sign language motion. We believe that our work can help people with hearing difficulties to enjoy music.

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