文楽人形のモーション・キャプチャ・データと舞踊譜との相互変換における コンピュータ内での身体運動の記述形式

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The description of human movement in computer for transformation between the Bunraku puppets' moion captured data and the movement score

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The authors are researching the humanoids' movement, where humanoid means human beings, humanoid robots, human puppets, human CG characters and so on. This paper deals with the transformation system between the movement score (dance notation, Labanotation), the movement description in computer and the body movement data (including the motion capture data) which are used to generate Computer Graphics animation of the humanoid's movement. The authors propose a method to describe humanoids' movement in computer which are developed based on Labanotaion (one of the most famous dance notation in the world). The proposed humanoid movement description method can describe not only the movement information which are described by Labanotation but also more detailed movement information. This movement description is called movement MIDI and it exists between the Labanoation (which the choreographer can read but the computer cannot read) and the humanoid movement data (which the computer can read but the choreographer cannot read). If a choreographer or a dance researcher who is familiar with Labanotation input movement by Labanotation to this system, it is transformed into movement MIDI. This movement MIDI is transformed into humanoid body movement data and this data generates CG animation. Based on the advises of the choreographer or the dance researcher who sees that CG animation which is a result of her/his input, an engineer modifies the movement MIDI until the choreographer or the dance researcher satisfies the result CG animation. We report the results of transformation from the humanoid's motion capture data into the movement MIDI.

1 Introduction

As music is recorded by score, dance is recorded by dance notation (movement score) such as Labanotation[1][4], Benesh Movement Notation and Eshkol-Wachman Movement Notation. Labanotation is used in the field of dance research. Benesh Movement Notation [8] is used to record the choreography of ballet. Eshkol-Wachman Movement Notation [9] is used not only to record dance but also to describe animal's movement in the field of biology.

Labanotation is the most frequently used notation in the field of dance research in order to analyze the structure of folk dances or choreographies as art works.

There are some researches to develop Computer Graphics systems to visualize choreographies described by Labanotation. Prof. Don Hervison-EVANS had developed a software to edit Labanotation and translate it into CG animation on Unix including Linux [10]. Prof. Ilene FOX (Dance Notation Bureau [5]) is developing such software on Macintosh (MacOS)[11].

Such software must be used on many dance researcher's personal computers such as Windows computer, Macintosh and Linux computer. Thus Prof. Kouzaburo HACIMURA and NAKAMURA Minako Sensei are developing such software by Java using Java Developers Kit [12][13]. In their software, CG animations are generated Virtual Reality Modeling Language (VRML) and Labanotation, CG animation and video are synchronized and displayed by Synchronized Multimedia Integration Language (SMIL)[14]. Their software does not depend on commercial software.

They are also developing a system to transfer motion capture data into Labanotation [15]. They segment the motion capture data based on their acceleration, and find the element of Labanotation (direction symbol) which corresponds to direction of the motion of each segment. This method is reasonable, since the direction (the combination of high-down, forward-backward, left-right) of each movement and the time during the each movement are described in Labanotation. But detailed information are lost in this method.

In order to generate natural movement in CG animation from Labanotation, we need not only the rough information which is described by Labanotation but also more detailed information which cannot be described by Labanotation. Thus we propose a description method of humanoid movement in computer, which contains both kinds of information. The authors call this humanoid movement description in computer "movement MIDI".

Since the laboratory of the authors are researching actions of Bunraku puppets which are manipulated by experts of puppet manipulation [16], this paper discusses a description method of Bunraku puppets' movement in computer. The authors are analyzing the motion capture data of a woman puppet which is shown in Figure 1.

2 The concept of the transformation system between movement score, CG animation and humanoid movement data

The concept of the total system is shown in Figure 2. If a choreographer or a dance researcher who is familiar with Labanotation input movement by Labanotation to this system, it is transformed into movement MIDI. This movement MIDI is transformed into humanoid body move-

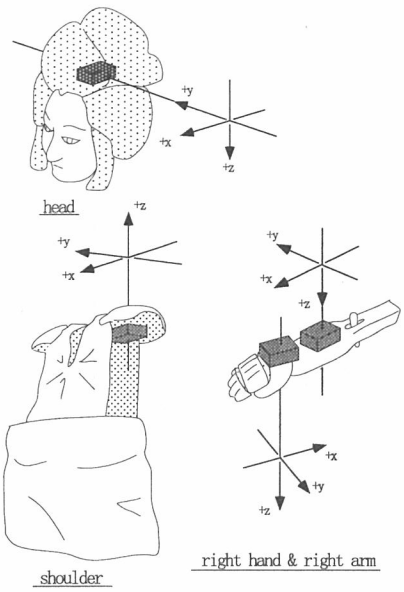

Fig. 1: Measuring the movement of each body part. (motion capture)

ment data and this data generates CG animation. Based on the advises of the choreographer or the dance researcher who sees that CG animation which is a result of her/his input, an engineer modifies the movement MIDI until the choreographer or the dance researcher satisfies the result CG animation.

As shown in the section 4 , the movement MIDI consists of the rough discrete description which expresses information described by Labanotation and the detailed continuous description which expresses the movement orbit of each part of the humanoid's body. One can transform Labanotation and the rough discrete description of movement MIDI mutually.

The information described by movement MIDI (which consists of the rough discrete description and the detailed continuous description) and the information described by the humanoid body movement data (motion capture data) are equivalent. The authors developed a software which transforms the humanoid body movement data into the movement MIDI. The transformation result are shown in the section 5 .

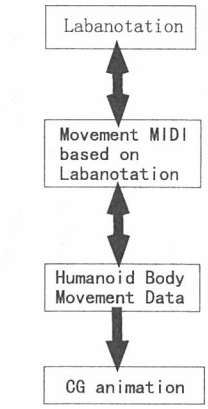

Fig. 2: The concept of movement MIDI.

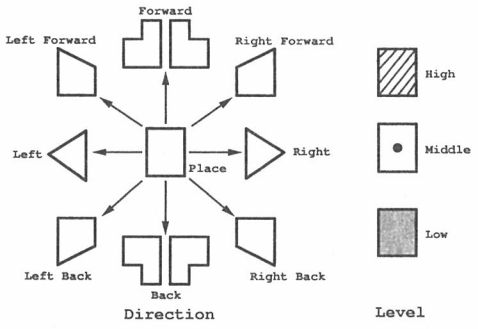

Fig. 3: Direction symbols of Labanotation

3 Description of Bunraku puppets' motions by Labanotation

Labanotation score consists of columns which correspond to body parts. On Labanotation, motions are represented as a stream of each element of motion. Each

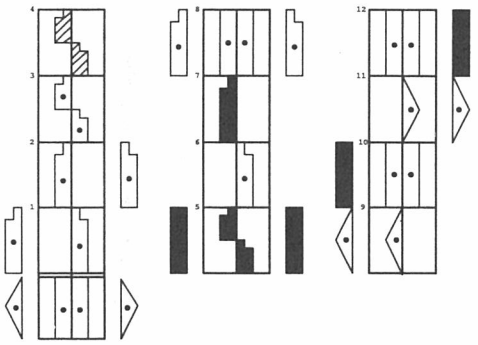

Fig. 4: Labanotation score

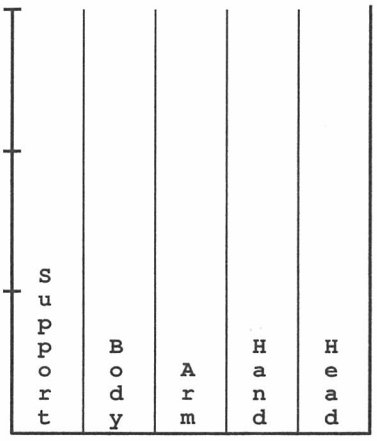

Fig. 5: Column for Bunraku puppet

element of motion is described by a symbol which is called by "Direction symbol" (Fig.3) The stream flows on the columns from bottom to top , and from left to right of the score (Fig.4). The time length of each element of motion is too short to have particular mean. But the sequence of some elements of motion has some mean. The shapes of Direction symbols express motions about horizontal direction and the patterns of Direction symbols express motions about vertical level.

Labanotation describes the motion clearly as a sequence of direction symbols. If one knows the mean of Direction symbols, one can understand the motion clearly by reading the description by Labanotation. The Labanotation scores which are described by choreographers or dance researchers become important sources to make valuable CG animations of humanoids' motions,

The authors decide a Labanotation score which corresponds to Bunraku puppet's body (Fig.5). Support column represents motions of the center of gravity of the Bunraku puppet, which decides a position of the whole body parts on the floor. Other columns represent motions of the body parts which each columns correspond to.

The motions in which the woman Bunraku puppet serves tea to some man with

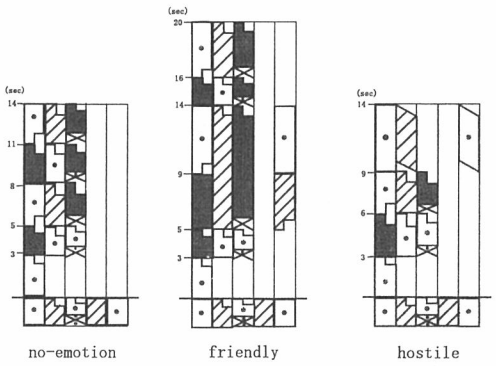

Fig. 6: Motion discription by Labanotation (Serving-tea)

3 different emotion (no-emotion, friendly and hostile) are described by Labanotaton in Figure 6. We can read the differences of motions with 3 different emotions by the length of Direction symbols which means the time length of each movement.

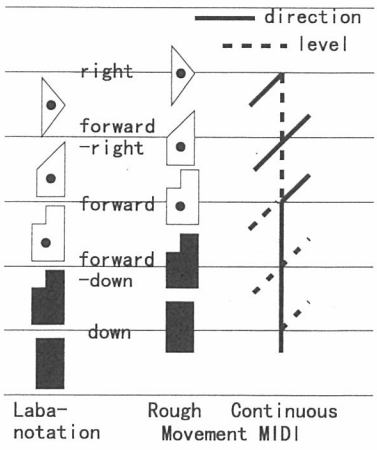

Fig. 7: Labanotation and Movement MIDI.

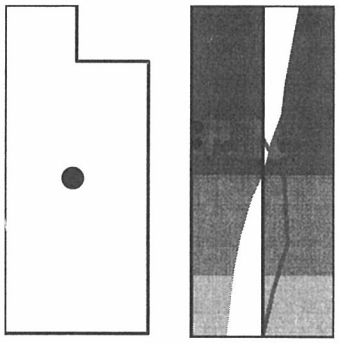

Fig. 8: Continuous representation of movement MIDI.

4 The description of humanoid movement in computer (movement MIDI) consists of rough discrete description and the detailed continuous description

As shown in the left part of Figure 7, Labanotation describes the goal of each movement by direction symbol and the length of each direction symbol represents the time length of each movement. Essentially speaking, Labanotation describes the sequence of movements and each movement is described by the start posture, the end posture and the time length which is shown in the middle part of Figure 7.

Strictly speaking each movement cannot be determined by only the start posture and the end posture. Between the start posture and the end posture, there may be the change of speed, fluctuation of the orbit and so on. These detailed information must be described in computer, in order to make valuable CG animation from Labanotation.

Thus the proposed movement MIDI describes the rough posture (the field of direction and level as shown in Figures 9 and 10) and the detailed continuous direction and level at continuous time as shown in Figure 8 .

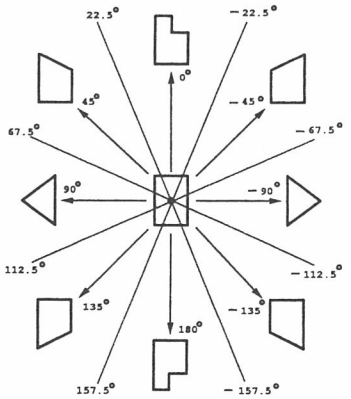

Fig. 9: Field of each direction.

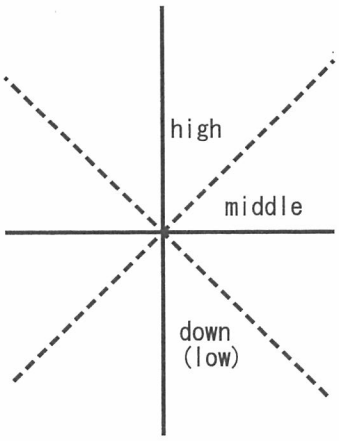

Fig. 10: Field of each level.

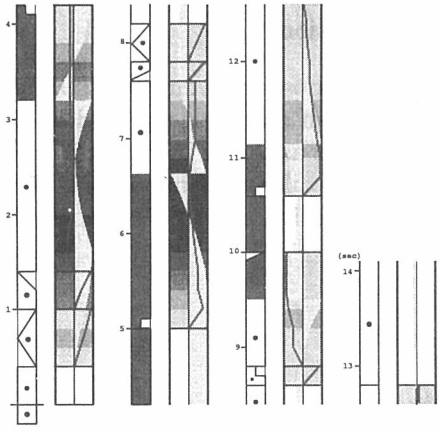

Fig. 11: Motion discription by movement MIDI of Support part

5 The result of translation from motion capture data into movement MIDI

The authors developed a software which transforms the body movement data (motion capture data) into the movement MIDI. Some examples of the result of this transformation software are shown in Figures 11 and 12 .

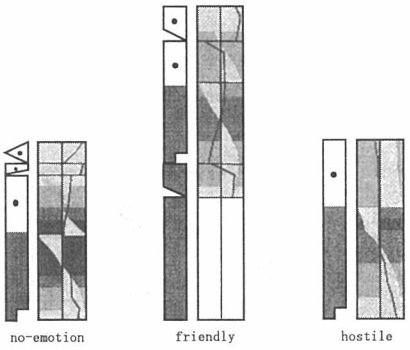

Fig. 12: Comparing movement MIDI of the motions with some emotions

6 Conclusions

Based on Labanotation which is one of the most famous dance notation in the world, the authors proposed a method to describe humanoids' movement in computer. This description is called movement MIDI. The movement MIDI can describe not only the rough information (the field of direction and level as shown in Figures 9 and 10) which can described by Labanotation but also more detailed information (the detailed continuous direction and level at continuous time as shown in Figure 8) which cannot be described by Labanotation. It can describe the movement orbit of each body part.

If a choreographer or a dance researcher who is familiar with Labanotation input movement by Labanotation to this system, it is transformed into movement MIDI. This movement MIDI is transformed into humanoid body movement data and this data generates CG animation. Based on the advises of the choreographer or the dance researcher who sees that CG animation which is a result of her/his input, an engineer modifies the movement MIDI until the choreographer or the dance researcher satisfies the result CG animation.

The result of the transformation from the motion capture data into the proposed movement description (movement MIDI) were reported.

Acknowledgement

The authors would like to express their thanks to KASUYA Satomi Sensei 糟谷里美先生 (Showa Academia Musicae 昭和音楽大学, Labanotation Study Group in Japan) for her valuable advises about Labanotation and other dance notations.

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