ラバン・エディタ

── 舞踊記譜のためのグラフィカル・エディタ ──

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LabanEditor : Graphical Editor for Dance Notation

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Abstract

Today, intangible cultural properties like ballet and dance have been a target of digital archiving. Our laboratory is developing comprehensive data processing system to input, describe, record, search, and display human body movement. This system can record and reenact human body movement using the data format based on Labanotation, which has been used for recording human movement of dance with several types of graphical symbols. This paper describes LabanEditor, which is an interactive graphical editor for writing and editing Labanotation scores. By using LabanEditor, a user can input and edit human body movement of dance and also display animation of a human body model in 3D graphics.

Keywords: Dance, Labanotation, Human body motion

1. Introduction

Information processing related to human body motion has been gathering attention in terms of developing advanced man-machine interfaces and virtual reality environments. In processing information about human body motion, there are several principal issues, i.e., issues on measurement, description, databasing and display, but the description or coding of the motion of complex human body is the most principal problem.

Meanwhile, digital archiving or digitally preserving various cultural properties like historical documents, pictures, photographs by using multimedia and database technology has been planned throughout the world. Up to now, two dimensional materials like pictures, patterns and documents have been the main targets of digital archiving, but measuring and digitizing three dimensional objects like potteries, architecture and historical remains are becoming quite common. Furthermore, digital archiving of intangible cultural properties are argued lately. Music is one of the subjects of archiving, but digital archiving of intangible properties concerning human body motion like ballet, folk dance, performing arts are the matters of great interest.

From this viewpoint we are doing research on a method of digitally storing and utilizing information of human body motion. Direct approach for this is using motion capture systems, by which the precise numerical data about positions of some specific points on the human body can be measured. We have already introduced a motion capture system for this purpose. We also have been using a different method, i.e. method of making "coded'' description about human body motion.

In the field of dance, describing dancer's body motion has been a problem for a long time. Several different approaches have been devised, but among them, the notation scheme called Labanotation has been used most widely[1]. This is something like music score which describes music graphically. Similarly, Labanotation describes the motion of the human body graphically in the form of the staff on the paper sheet.

Being devised in early 20th century, Labanotation was, of course, not intended to be computerized. Also, it is not necessarily easy to learn because it is capable of describing complex human body motion like motion of fingers. Many choreographic works, ballet, contemporary and ethnic, have been recorded and published, and are available as a heritage to future generations.

The description of Labanotation is not necessarily accurate compared with the motion capturing technique. However, because motion is described by graphical symbols, it is not very difficult for us to understand. Besides, the fact that there is a community of Labanotaion users who are specializing in dance and performing arts must not be ignored. There have been lots of experiences and methodologies.

Based on this standpoint, we are utilizing the concept of Labanotation for the data processing of human body motion[2]. This paper describes LabanEditor, which is an interactive graphical editor for writing and editing Labanotation scores. By using LabanEditor, a user can input and edit human body movement of dance and also display animation of a human body model in 3D graphics.

Several attempts have been made for computerizing Labanotation. One of the oldest ones is in [3]. The software LabanWriter[4] is a graphical editor of Labanotation and has been widely used by dance performers[5]. LED[6] is also a editor running on Unix X window system. CALABAN[7] is a plug-in software to the CAD system AutoCAD for preparing and archiving Labanotation scores. However, all of them are just for inputing and editing scores. Functions of displaying human body motion by the 3D CG model are not included.

2. Labanotation

Figure 1 illustrates an example of a Labanotationscore, which is extracted from a Labanotation textbook written by Hutchinson[1]. Labanotation score is drawn in a form of vertical staff whereeach column represents motion of a part of a body. We read the staff from bottom to top, and from left to right. Figure 2 shows the basic arrangement of columns in the staff. In the staff, horizontal bars are placed regularly which represent tick of time just like vertical bars in the musical staffs. A column of the staff consists of three vertical lines. The center line represents the center of the body, and the right side and the left side from the center line are used for describing the motion of the right and left side of the body, respectively.

Each of the vertical subcolumns formed by three main lines corresponds to the part of the body as shown in Figure 2. For instance, the movement of the left arm can be interpreted by just following the left arm subcolumn from bottom to top.

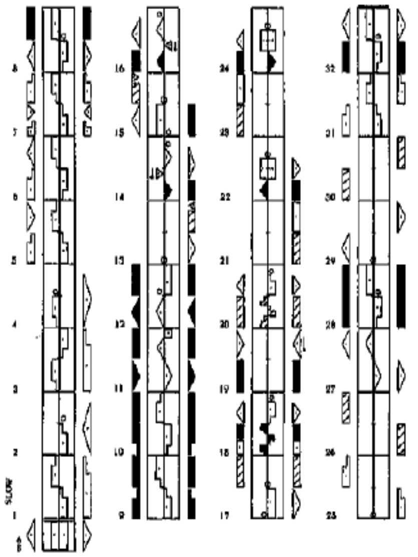


Figure 1: Example of Labanotation score

Subcolumns labeled “support” are used for representing movement of body parts which support the weight of the body.

Usually, the arrangement of the staff shown in Figure 2 is used, but much more elaborated staff arrangement which is called *expanded staff*, may be used for describing in detail.

Movement of each body part is expressed by a sequence of geometrical symbols placed in the corresponding column. These symbols for movement expression are classified into five categories, but the most fundamental ones are the *direction signs* and the *rotation signs*. Direction signs describe the translation of joints with achievement of a position in space by the joint, or with movement of the joint in that direction. Rotation signs describe various forms of rotational motion.

Direction signs are represented by polygonal symbols. Figure 3 shows the structure of the symbol for direction signs. A single symbol for a direction sign represents three basic items of information about a motion : Direction of horizontal motion is expressed by its shape, vertical motion (levels) by its inside shading, and the duration by its size (i.e. length).

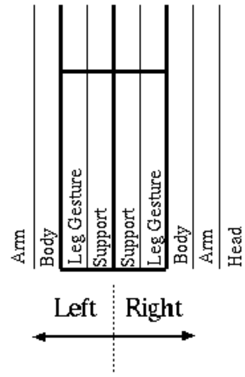


Figure 2: Staff of Labanotation

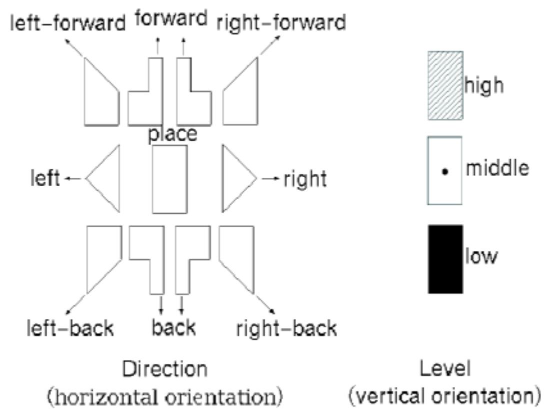


Figure 3: Symbols used in Labanotation

3. Internal representation of Labanotation

Internal representation for Labanotation called LND has been designed with reference to the structure of Labanotation. We use alphanumeric characters to represent basic symbols.

Figure 4 shows the format of LND representation. Lines followed by # are for specifying fundamental parameters of Labanotation, and lines followed by // are comments. The directional motion of a body part is specified by a line followed by a command direction, which corresponds to the Labanotation direction symbol. The body part is specified in the second field, which is followed by the fields of direction, level, time of start and end of the movement.

```
// Notated by K.Okamoto , Dec 1 2001
#rhythm 4/4
#speed 120
#unit_per_line 7
#unit_total 56
#unit 0
direction l_support    place mid              standard
direction r_support    place mid              standard
direction l_arm        left  mid              standard
direction r_arm        right mid              standard
#unit 1
direction r_arm        right high  0.00  1.00  standard
direction l_arm        left  high  0.00  1.00  standard
direction l_support    place mid   0.00  1.00  standard
direction r_support    left  low   0.00  1.00  divided_r
direction r_support    right low   0.00  1.00  divided_l
```

Figure 4: Example of LND

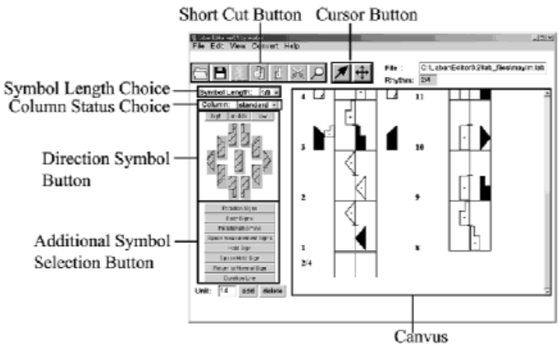
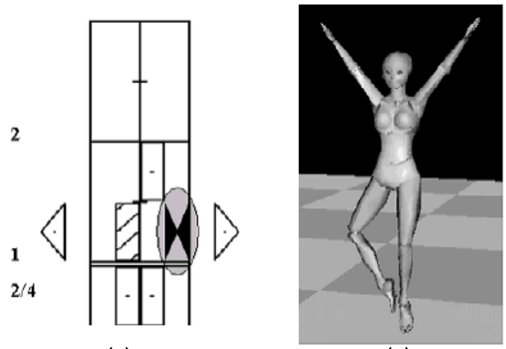


Figure 5: Main window of LabanEditor



(a) (b)

Figure6: Divided column

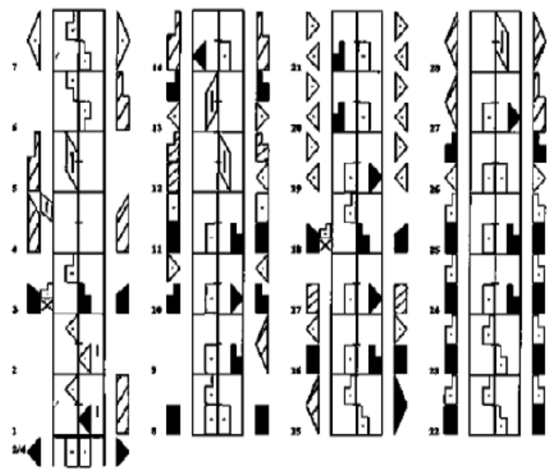


Figure 7: Print out of Labanotation staff

4. LabanEditor

The LabanEditor prepares scores of Labanotation by interactive graphic operations with a mouse. LabanEditor has five main functions: input, edit, print, display and export data. Input and edit functions are used to draw scores of Labanotation interactively. Prepared labanotation scores can be printed on a sheet. Animation of human body motion corresponding to the Labanotation

score can be displayed. Export function is used to convert and output the score of Labanotaion into a VRML2.0 format file, which can be read and displayed with Web browsers.

4-1. User Interface

Figure 5 shows a main window of the LabanEditor. A user can describe a score by placing the symbol in the staff. Direction symbols can be input by the operation of "Direction symbol buttons".

After specifying length and level of symbol, the user selects a direction symbol by clicking one of the direction symbol buttons displayed. Then, by clicking an appropriate column position in the staff the direction symbol is placed there. Some additional symbols of Labanotation can be placed by using "Additional symbol selection buttons".

Style of divided column, which is one of the expanded staff convention, is also possible. Just successively inputting two symbols in the same position of a column makes the column a divided column. The shaded area shown in Figure 6(a) is an example of divided column. The posture of the model shown in Figure 6(b) corresponds to the Labanotation description of Figure 6(a). As shown in the figure, the motion of the right leg is expressed in proximal part (upper leg) and distal

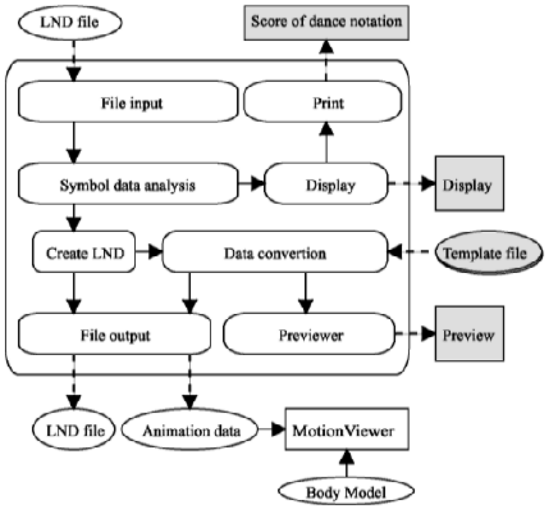


Figure 8: Structure of LabanEditor

part (lower leg) separately.

Labanotation staffs prepared on the display screen can be printed out. Figure 7 shows an example of print out of Labanotation score.

4-2. Internal Structure

The internal structure of LabanEditor, which is programmed with Java, is shown in Figure 8.

When inputting, the user first specify the type and length of a symbol, and then indicates the column position where the symbol has to be placed in the staff. A “Symbol data analysis” part receives the requests from the user entered through the user interface. By analyzing the requests the symbol data analysis part derives internal data containing name of the symbol, start and end time of the symbol, and consequently generates objects data of vector class of Java for drawing symbols in the staff.

LND data file already prepared can also be read into LabanEditor. A “File input” part reads a LND file and converts LND into object data of Java’s vector class by analyzing the LND line by line.

A “File output” part works in a reverse direction: Object data are analyzed and converted

```
#Symbol sign name              #direction
#Column name                   #r_arm
#LND                           #forward    high
Joint name Rotation angle      R_Shoulder  -135,0,0
Joint name Rotation angle      R_Elbow      0,0,0
          .                             .
          .                             .
          .                             .
      (a)format                    (b)example
```

Figure 9: Example of template file

into LND format.

A “Data conversion” part converts LND data, which are currently displayed on the screen, into the animation data used for displaying human body motion by 3D CG. The detail of this will be described in the next section.

A “Previewer” reads the animation data, and displays human body motion in the preview window in a stick figure body model.

4-3. Generation of Animation Data

In order to make 3D motion display of human body model, we have to convert LND into animation data. It is understood that Labanotation in principle describes the human body motion in the same manner as key frame animation. Namely, Labanotation symbol shows a pose at the time corresponding to the end of the symbol. LND also describes a pose of the body at each timing just like key frame animation. Thus, Labanotation and LND conform well to key frame animation technique. Conveniently, key frame animation is supported by the VRML.

A motion conversion template file is used for the conversion of LND to animation data. The motion conversion template files describe the relationship between the direction symbol at the particular joint and the rotation angle around the joint, i.e. pitch, roll and yaw. The format and example of the template file is shown in Figure 9. Usually, the default template file is used, but we can choose another one from some of the

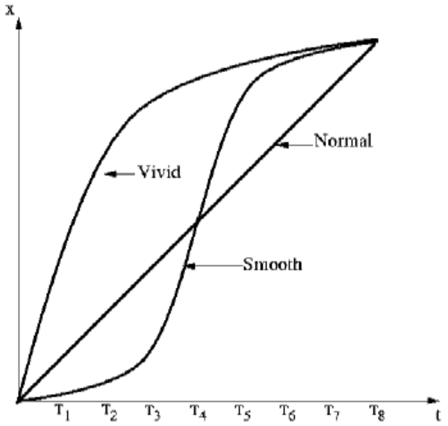


Figure 10: Mode of motion expression

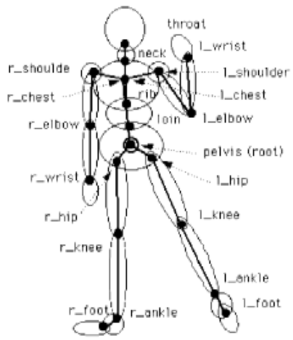


Figure 11: Body model

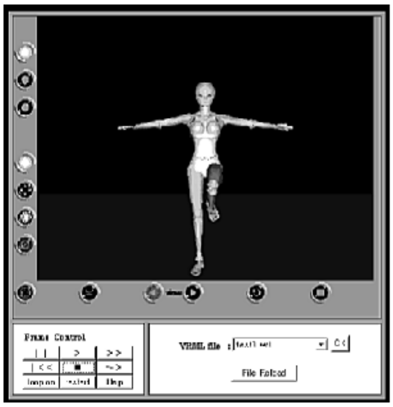


Figure 12: Motion Viewer

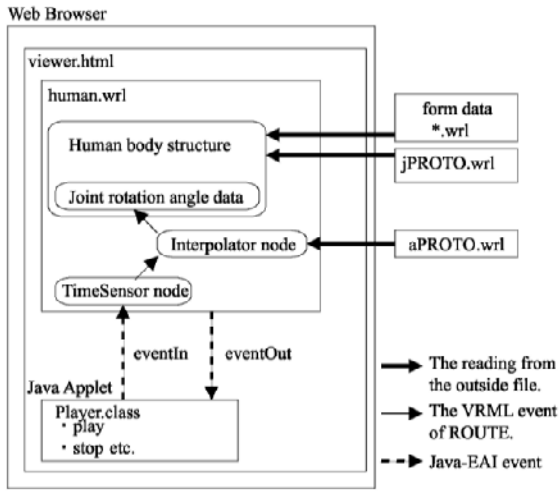


Figure 13: Data used in Motion Viewer

customized template files. Customized template files may be used for expressing more precise body motions.

Some options can be specified when starting conversion: the geometrical data of the body segments, the movement template file and the mode of motion expression. Option of the mode of motion expression changes the style of the body movement. This can be done by internally altering the pattern of joint speed change. At the present time, one can select among “Normal”, “Vivid” and “Smooth”. When we select “Smooth”, the speed of joint motion is made slow both at the beginning and at the end of the movement as shown in Figure 10.

The animation data are generated in the form of data for Interpolator node of VRML. Interpolator node holds key timing and corresponding key frame values such as coordinates, values of joint angles etc. Values between key frames are generated by a linear interpolation.

4-4. Motion Viewer

Motion Viewer is designed to display the motion of the 3D human body model. Figure 11 shows a structure of the body model, which has 21 joints.

We use VRML2.0 for modeling 3D environment, which is quite popular and can be handled by a Web browser and a VRML plug-in for the browser without difficulty.

The screen of Motion Viewer is shown in Figure 12, and the relationship between data used in the Motion Viewer is shown in Figure 13.

A main body of the Motion Viewer is a HTML file “viewer.html”, which is composed of a VRML file “human.wrl” and a Java applet program “player.class”.

Animation description data “aPROTO.wrl”, which is produced from LND, is read into “human.wrl”. In addition, “human.wrl” reads joint definition file “jPROTO.wrl” and VRML files “*.wrl” defining forms of each body segment. This way, a VRML file is formed by combining the body model data and the animation data.

As mentioned before, movement of the body model is specified by Interpolator nodes of VRML. When activated, TimeSensor node feeds time events to Interpolator. Then Interpolator sends out events and interpolated translation values to the joint of the human body model.

The frame control of animation is realized by a Java applet program. The control panel for animation is shown in the bottom-left part of Figure 12. For this purpose, a Java-EAI plug-in is included in the Web browser. As shown in Figure 13 “player.class” (frame control applet) and “human.wrl” are included in “viewer.html” which is activated on the Web browser.

The applet controls the field of the TimeSensor node by the Java-EAI function. Sending control data to the VRML data is realized by the “eventIn” method, and receiving information of change of VRML data is done by the “eventOut” method of EAI.

An example of displaying body movement is shown in Figure 14.

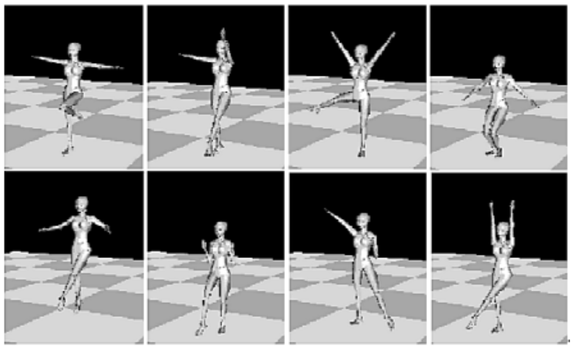


Figure 14: Display of body movement by Motion Viewer

5 Conclusion

The system for interactive editing of Labanotation dance score was developed. The body motion corresponding to the Labanotation score can be displayed by a 3D CG human model. Although all of the Labanotation functionalities are not yet supported by the LabanEditor, even beginners can easily input, edit and display body motion by the system.

Being developed under Java development environment JDK, this system runs on several platforms, e.g. SGI IRIX, Sun Solaris and Microsoft Windows. The system can be used as a multimedia teaching tool in Labanotation education as well as choreography.

However, some of the problems left to be solved, which are described in the following.

First, although the whole functionality of the Labanotation itself is very rich, we have implemented its fundamental functions. Extension for handling many extensive symbols must be done. This will make more detailed motion description possible.

A method of key frame interpolation has to be improved. We have only implemented a simple interpolation method just considering a single Labanotation symbol. We have to devise much more sophisticated method considering a sequence of symbols to produce smooth movement. A format of much more elaborated movement template file has also to be introduced, in which a particular sequence of symbols is related with an appropriate trajectory of a corresponding joint.

At the present time, treatment of interaction between the body parts and the environment is not explicitly implemented. In order to produce much more natural movement, this and dynamic simulation have to be implemented, which are now under development.

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