Translation Process of ThaiDanceXML into a 3D Animation Representation

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Abstract— **Thai dance is a beautiful yet complicated movement, delicate gestures and unique performing arts in Thailand which has been inherited from generation. It requires every part of the body to move, especially the hands and fingers. To record Thai dance movements, it is hard to find the dance notation system to capture all of body part such as hand and fingers and the body movement such as direction, level, rhythm etc. Nevertheless, Labanotation system proved that the system provides the abstract symbol to record all the movement of human body, and is widely used in Europe, America and Asia. Therefore, representing the dance movement in 3D animation had not been done for complicated movement such as Thai dance. This paper is focused on translating process from ThaiDanceXML, translate ThaiDanceXML into Unity 3D, Model preparation, 3D character transformation and 3D animation presentation to display Thai dance movements using Unity 3D program.**

Keywords— *Thai dance; dance; dance notation system; Labanotation system; dance notation; translating process; ThaiDanceXML; Model preparation; 3D character transformation; 3D animation; Unity 3D;*

I. INTRODUCTION

Thai dance is a significant intangible cultural heritage for Thai people. The movement has been created by the human knowledge that is very delicate and beautiful. From the beginning, Thai dance is published and inherited in specific groups of people and pass on to the next generation. In the present day, Thai government wishes to preserve such Intangible Cultural Heritage and pass it on for generations. The Ministry of Education, Thailand is focusing on educating Thai dance knowledge to the young generation in every primary school. It is a combination of Arts and Performing Arts. Consequently, there are various research using the technology to archive the dance movement in Europe and America. Labanotation is the standard dance notation system which is used widespread around the world. Correspondingly in Southeast Asia, many countries have been using the system to capture their own traditional dance movement such as Noh dance in Japan [1], Korean Dance [2], Ganapati Kavutham Dance in India [3], Vietnam Harvest Dance in Vietnam [4]

etc. Thai Dance is one of the most delicate movement in Southeast Asia which focuses on hand and finger movement. To capture Thai dance movement is limited on data collection due to the delicacy of movement and accuracy of gesture.

Nowadays, Thai dance knowledge is archived using photography and video recording. Though, the issue with photography and video recording is that photos and videos do not provide enough specific information such as scale, direction and rhythm to measure the Thai dance gestures accuracy. Thai dance has been a complicated movement in relationship between hand and finger gestures. It is difficult to understand through pictures or videos. Therefore, Labanotation is a dance notation system for recording and analyzing human movement created by Rudolf Laban in 1928 [5]. His work has been developed by Ann Hutchinson Guest and others and used as a standard dance notation system in Europe, America, Asia and even in Southeast Asia.

Labanotation score uses a staff of three vertical lines. The vertical dimension of the staff will represent the timing of dance. The part of the moving body is represented by the position of the staff that is marked or placed in or outside the center line. Labanotation is a way to write a dance notation represented as a symbol in which the author can record the dance movement using a pen and a piece of paper. As well as a software called LabanWriter to write the dance notation score as fast as using Microsoft word [6]. To be able to record accurately, the dance notator must have a high level of knowledge on Thai dance and how to notate the dance notation by using Labanotation system. For archiving Thai Dance, Dr. Dharakorn Chandnasaro is the expert in recording dance movement with Labanotation system, as a contributor with accurate information [7]. To translate Thai Dance notion scores into representing it into digital 3D animation is one of the AniAge Project supported by EU H2020. The objective is to develop novel techniques and tools to reduce the cost of production and improve the level of automation without sacrificing the control of the artists, to preserve the performing arts-related ICHs of Southeast Asia.

Therefore, to interpret Human-Readable Information such as Thai Dance Notation Score into Machine-Readable Information is our focus, using Extensible Markup Language also know as XML. XML can be defined as a set of rules for encoding documents that both human-readable information and machine-readable information. Researcher have tried to use XML to interpret dance notation as a ThaiDanceXML standard. To translate ThaiDanceXML and represent it into 3D Animation, Unity 3D program is the system to translate ThaiDanceXML tagged to an object data, store object data to dictionary list, convert dictionary list to array and rotate the Thai 3D figure's joints. This process will allow the translation of the XML information and processing it into Unity 3D program. The program will be able to read the XML file and define the movement gestures of the character model in each part of the body. As mentioned above, Thai dance is relatively tricky in each movement. Thai Dance Labanotation gestures must verify the accuracy of Labanotation from Dr. Dharakorn Chandnasaro who has experience with Thai Dance and also an expert on recording Labanotation score. His research is about Labanotation: The Development of Western Dance Notation by Using Symbol. [7]. The challenge of this work is that we need to be able to use ThaiDanceXML that can accurately collect the Thai dance data such as beat, beat-type and notation to represent in 3D animation, as well as the rhythm of gesture with the original.

II. LITERATURE REVIEW

A. Thai Laban Notation Score

Performing arts is what every county refers to as arts, cultures, history, folk and rituals. In some country, the performance has been used for entertaining the audiences. In some countries, the performance act as an activity to represent the identity of the nation. For instance, Khon dance is the stylized form of Thai dance which is performed by groups of non-speaking dancers on stage to entertain the audience and it is well known as the Thai performing arts. To preserve such intangible cultural heritage, Thai government by the Ministry of Education enforced Thai performing arts to the basic education core curriculum A.D. 2008 [8]. Thai dance is a challenging movement to learn and perform on stage. The textbook had been written in text with pictures and describing roughly how-to-perform movement of the body parts with no rhythm and beat. Teacher demonstrates, and student follow the dances. To record the movement, dance notation systems were created, and many dance notation systems created for certain dance movement. In 1928, Rudolf von Laban introduced Kinetography or Labanotation system to record the human movement using abstract symbols to represent the human movement [6]. The symbols for human body and specifically symbols for the direction, position and degrees which the notators can write it down on the columns.
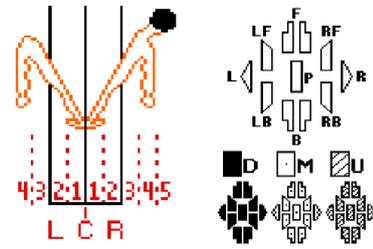

Fig 1. The columns of the parts of body and horizontal direction symbols

In Thailand, Labanotation system was introduced Dr. Chommanard who had been training Thai dance since she was young, having a wide amount of experience in teaching and learning Thai performing arts. Dr. Chommanard had got a scholarship for training Labanotation system. Her research is focusing on using Labanotation to teach and learn Thai dance. In 2013, Labanotation was used by Dr. Chommanard to record Thai dance movement and she created new symbols for describing Thai dance movement specially on hand and finger movements [9].
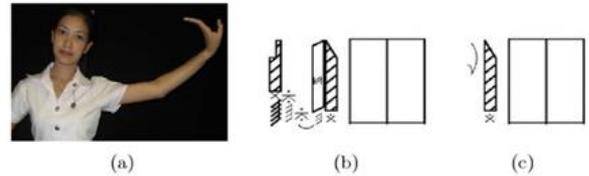

Fig 2. Thai notation hand gesture that created by Dr Chommanard (a) hand gesture named "Wong" (b) Standard labanotation (c) Thai labanotation

In addition, using Labanotation as a tool to teach Thai dance students from Thai dance schools and college in the central and the northern of Thailand. The result, the tool is very difficult to understand the notions and it will be a barrier for learning. The suggestion is to investigate a computer-aided tools such as LabanEditor as an interactive system for input of the Thai dance scores and display it into 3D animation together with notation scores. In the meantime, she recorded Thai dance movement in Labanotation by the movement of actor character.
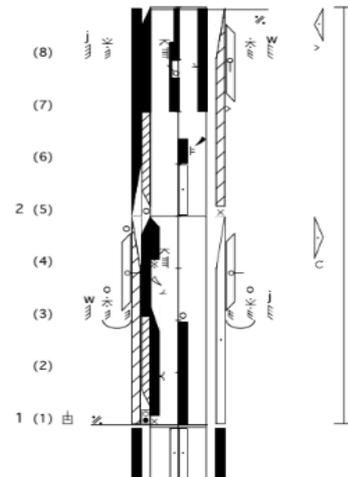
In 2016, Dr. Darakorn Chanasaro researched on using Labanotation system to record dance movement [7]. Dr. Darakorn focused on recording dance movement using dance notation system which is Labanotation system. Recording movement is sharing of dance knowledge. However, different notators uses different techniques, different symbols to record movement. Thus, recording using abstract symbols depends on the experience of the notators. If the notators have a long experience on writing the score, he or she might be used to the advance abstract symbols to notate the movement. His researches proved that Thai dance can be recorded by Labanotation system as shown in figure 3.

B. XML

In 2006, Nakamura and Hachimura provided a crossover between Labanotation and Motion Capture. The objective of Nakamura is to provide a well-formed Labanotation description of motion capture data in XML, called LabanXML by using Document Type Definition (DTD). The result, LabanXML offers direct translation from handwritten Labanotation directly into XML [10]. Later, in 2013, Chommanard Kijkhun have presented about the program LabanDancer that is used for translating tool for displaying the 3D animation of the Labanotation score, but now it has ceased to develop [9]. Bashar Altakrouri and Andreas Schrader used Labanotation XML scheme to standardize the description of movements in motion gestures. The project aims to utilize most of the infrastructure elements from labanotation. They have found that Labanotation is flexible and extensible movement data system can describe the movements aspects of gestural interactions in 2014 [11]. In 2015, Matevž Baloh, Ciril Bohak and Matija Marolt used the labanotation symbols to define formats, platforms and software that can help in the transcription, analysis and production of dance tracks, presenting Labanotation in the digital format that is called StreamingLaban [12]. StreamingLaban is a text-based file format that uses parameters from LabanXML. In 2016, Yootthapong proposed a framework for a traditional Thai dance knowledge archive creating an ontology using knowledge engineering based on Labanotation by transferring notation scores to represent the dance in 3D Animation [13]. The consequence is communication with each other. From the above mentioned, to interpret human readable information like Thai dance notation scores to machine readable information by using Extensible Markup Language or XML.

C. Representing 3D animation using Unity 3D program

Kojima Kazuya, Hachimura Kozaburo and Nakamura Minako have researched the Graphical Editor for Dance Notation in 2002. Intangible cultural properties like dancing are targets for digital data storage [14]. They have developed a system for processing input, describe, record, search, and display human body movements. The Labanotation data format is used to record human movements using the graphic symbol format. LabanEditor, a program for writing and editing Labanotation scores [14]. By using LabanEditor, input and modification of body movements of the dance can be done using graphic symbols of Labanotation. The paper was concluded when the Labanotation system and the dance score correction system was developed. The body movement was displayed through a 3D model, although it was more accessible to input, edit, and display motion, it does not support all the functions of LabanEditor. However, the problem has been resolved even though LabanEditor has many functions. They modified it by adding an extension function. It can explain other movement information. At present, the relationship between the body and the environment is not being used. For a more natural motion, dynamic simulation is required, which is currently under development.

In 2004, the Dance Notation Bureau and the Ohio State University sponsored a workshop for experts. Labanotation, dance, human movement, and technology, to discuss adding, editing and animating of Labanotation [15]. LabanDancer is a program that was developed to convert Labanotation scores from LabanWriter to Animation [15]. LabanDancer converts the symbol into a gesture. The first step in translating a LabanWriter file is to convert the graphic symbol data into a meaningful data system of Labanotation and make the data structure match the Labanotation score. Labanotation relies on knowledge from both the notators and dancers to get feedback on movement problems of animation and solve the problems. The first LabanDancer prototype has been introduced with Windows and Mac OSX [15]. The most important feature is the display graphic with the original Labanotation on the left side of the screen.

In 2007, Tom Calvert researched on animating dance, and he found Composite scores containing maps of the animation channel [15]. Each channel is associated with arms, legs or other support. Composite scores are split into three categories. The first one is to interpret the gesture of a movement and it does not depend on the weight of the body part. The second section describes the support changes that include movement of gesture, and the third is another component, such as repeating the direction in the map and others. For generating the movement, animators and notators have taken parallel steps to develop keyframe animation and notation scores. They use their knowledge to analyze motion to components, to decide between keyframes or notation symbols which should be used in more representations. Motion Capture System describes the motion data but not analysis of each movement. However, it is difficult to correct Mocap data, editing or integrating with other parts of the movement. There is research on the process and dynamic approaches that use basic knowledge to calculate motion patterns. These techniques can be advantageous and especially useful for repetitive movements such as locomotion or manipulation. Therefore, the LabanDancer program is ideal for translating Laban notation score into animations, representing the power of these methods. LabanDancer is a software where converting the dance notation score and representing into 3D animation. However, the software stopped developing for some reason.

Accordingly, this paper proposes to translate ThaiDanceXML to represent the dance movement into 3D animation. Labanotation was written to recode the movement information, nevertheless there are no programs to translate and display the Labanotation score into Three-Dimensional Vision.

III. TRANSLATING THAIDANCEXML TO 3D ANIMATION PROCESS

In regard to ThaiDanceXML standard, translating the XML file to represent Thai dance movement in 3D animation according to the translation process assists to preserve Thai intangible culture heritage and provide the platform to implement learning and teaching application in the future. Four processes have been completed, creating an animation from ThaiDanceXML file into Unity 3D, Model preparation, 3D character transformation and 3D animation presentation as following figure.
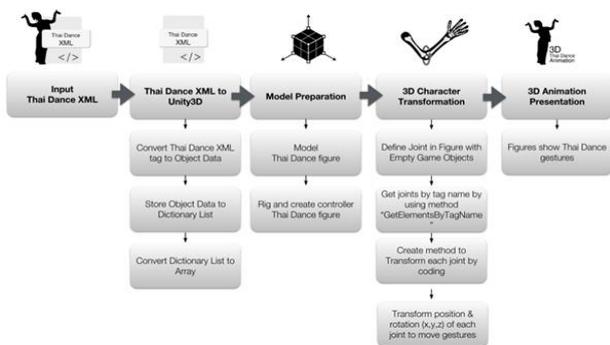

Fig 4. Translating Process from ThaiDanceXML to 3D Animation

A. ThaiDanceXML

To interpret Thai Dance notation scores into ThaiDanceXML. XML and Thai Dance Techniques have been adopted to generate a ThaiDanceXML Standard, for extending more information on Thai Dance Terminologies focusing on hand and finger movement. According to Prof. Dr Chommanard, her research focused on creating a set of new graphical symbols for representing most common hand and finger poses on Thai dance terminologies such as Jeeb, Wong etc. [9].

```xml
<laban>
    <measure num="1">
      <body part="arm_left">
        <direction>forward</direction>
        <level>high</level>
      </body>

      <body part="arm_right">
        <direction>forward</direction>
        <level>low</level>
      </body>

      <body part="leg_right">
        <direction>backward</direction>
        <level>low</level>
      </body>

      <body part="knee_right">
        <direction>backward</direction>
        <level>high</level>
      </body>
    </measure>
</laban>
```

Fig 5. Sample of ThaiDanceXML

Labanotation and XML are the languages used to convey meaning, using the symbolic form that is human-readable. When ThaiDanceXML was written, it can be used with the process of translating Thai Dance movement to represent it into 3D animation on Thai Dance gestures with the critical step accordingly on ThaiDanceXML standard as shown in figure 5.

B. ThaiDanceXML to Unity3D

Loading the XML file into Unity 3D program using C# language to connect the data. The program must be able to assign the data into a List from the XML file. First, XMLReader class is the way to avoid access to the file in advance and spend the lowest performance. Second, XMLDocument class which not many people use it. Third, which is the most effective is XMLSerializer. Next step, Reading XML in Unity 3D is done when an XML file was created and place the file in a folder named Resources in the project. For example, assets/resources/ThaiDanceXML. The following step is to create a scene to load the XML file containing the object. It will be used to load, read the file and assign data. The last step is to write code to support reading the XML file, then run the program to recheck the correct data. However, these steps can process only on XML standard.

For ThaiDanceXML, the individual step must be considered due to the standard of how to read the ThaiDanceXML which mainly focus on storing a representation of the Laban Notation System. The method requires additional functionality to read ThaiDanceXML structures on advance hierarchy. ThaiDanceXML involved tags to indicate the direction, size, location, body parts, and stroke. These tags will be called from the method to compare them with the object data stored in the form of List and collected into arrays. Since, the object defines the tag, using Element and Attribute to store the parameter for the direction, size, location, body parts, and stroke. The difference between Element and Attribute, Element is a tag that we define from terminology, such as <notation> tag whatever that element

contains the data texts between the <notation> and </notation> tags. The attribute is the variable which defines the element, for example, <beat measure = "1">, "measure" is an attribute of the "beat" element.

C. Model Preparation

Preparing 3D character model is based on a 3D mesh clothing referencing to the 3D model using Autodesk Maya. The polygon mesh of the character must be cleaned and even. Character rigging is the process of creating a skeleton of joints and binding it to the model, to control the movements of the model. The joint hierarchy should define the structure of the human body and assign a name that corresponds to the actual parts of the body, as defined in ThaiDanceXML. In Unity 3D program, model is prepared as an essential step to set up the skeleton which requires naming and tagging each part of the joint similar to the input data from ThaiDanceXML. For example; "RightArm", "LeftUpperArm".

D. 3D Character Transformation

To make 3D transformations using three-dimensional characters. Absolutely, it is essential to focus on the joints of the character. Each joint is binding to a specific part of the model to control the body movement and named it differently according to the body parts. For example, to move the character's arm, three joints must be moved, shoulder, elbow and hand joint. The transformation on each joint is associated with joint's coordinate which is X, Y and Z-axis.
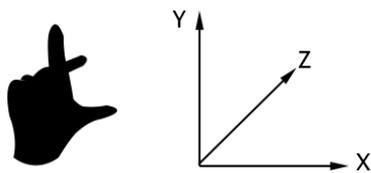

Fig 6. Left-handed coordinate

The two systems of transformation have been used which is world coordinate system and the local coordinate system. In addition, both system of transformation provides two coordinate systems which is Left and Right-Handed coordinate. For example, Left-handed, Direct X is where the positive X-axis points to the right, the Y-axis indicates upwards, and the Z-axis is pointed towards the screen. On this research, the world coordinate has been used for defining a variable, set the motion and optimize for proper movement. Then, define the transformation of each joint to shift into the same direction as the world coordinate. Using Vector3 function in the Unity 3D program is to represent the 3D vector point, which is the position and the direction of x-axis, y-axis, z-axis. Labanotation has three kinds of shadings to show the vertical dimension which is high, middle and low. For instance, rotate to high level by defining the vector3.x to 120.0f and 90.0f for the middle. Then, prepare to store another vocabulary by pulling out the tag data from XML which named as the body parts and direction of tag; forward, backward, left, right. If there is no rhythm, it will represent an incomplete movement. From the figure 5, num is an attribute that indicate the motion of the character movement. For instance, <measure num= "1"> means movement in measure

1. It is very significant because it should depict when the dance move should be executed at specific part of the song.

E. 3D Animation Presentation

When Unity 3D program is reading and storing the data from the ThaiDanceXML file, the system defines the tag corresponding to the body part based on the XML naming data. To create the same name tag, using inspector panel to create the name tag to match with elements or attributes data as shown in figure 7.
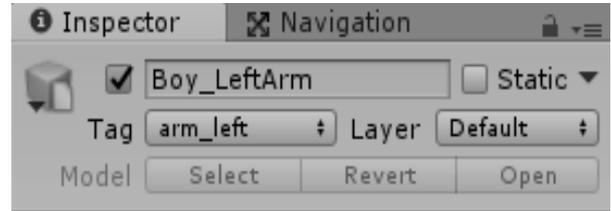

Fig 7. Create a name tag that matches the body part in XML.

Thus, an attribute in the XML file, called "part" that calls specific part of the character body that is tagged in Unity 3D. Assigning a tag to the joint used in the movement will allow the script to call the animation that has been written. For example, the "arm_left" part will rotate when the XML "forward" direction function and XML "high" level is called, so the script will search for the gameobject that is tagged "arm_left" and will rotate the left arm joint in the forward direction and set the height of the joint as high in Unity 3D as shown in figure 8.
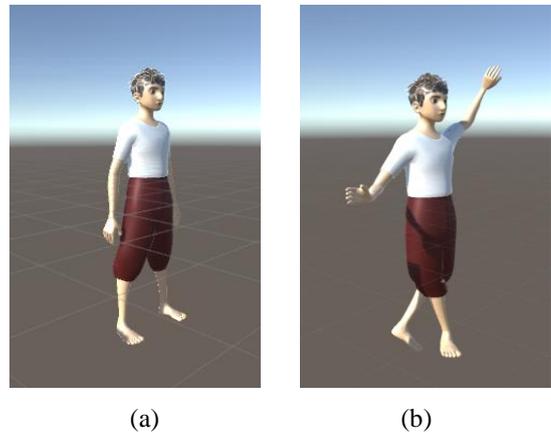

(a)   (b)

Fig 8. Default post (a) The character can move by XML (b)

IV. CONCLUSION

The research on this paper is the beginning of AniAge project. The purpose is to preserve the intangible culture heritage of Southeast Asia using archive technology and transferring the knowledge which focuses on reducing production costs. Thai dance is challenging to preserve and record in digital format due to its delicate and complicate movement especially the hand and fingers movement. In addition, it is very challenging to keep up with a rhythmic motion in harmony and archive the accurate movements with the song. Fortunately, dance notation system such as Labanotation, it is possible to record such complex movement

in very little detail like fingers movement. Therefore, to represent the dance movement in 3D animation is complicated. In this case study, ThaiDanceXML had been created to interpret human readable information to machine readable information mainly to display Thai dance movement by using Unity 3D program. Unity 3D works well with animating the 3D character using game objects and it contains the outsource files as C# script to command the character to move.

The translation process had been done to represent the Thai dance movement from the ThaiDanceXML into Unity 3D program using several techniques to read the ThaiDanceXML data, storing the data in Unity 3D and represent the movement in the 3D environment. Still, issues are rising such as controlling the coordinate system, coordinating hand and fingers movements. For our future work, improving the process of demonstration Thai dance in more complex movement according to the Thai dance terminologies and create the function for non-programmer user.

REFERENCES

[1] M. Oshita, R. Yamanaka, M. Iwatsuki, Y. Nakatsuka, T. Seki. "Development of Easy-To-Use Authoring System for Noh (Japanese Traditional) Dance Animation". Retrieved 2012. https://ieeexplore.ieee.org/document/6337399/

[2] Keith Howard, "How did North Korean dance notation make its way to South Korea's bastion of traditional arts, the National Gugak Center?", Retrieved 2015, https://www.soas.ac.uk/japankorea/research/soas-aks-papers/

[3] Annemette P. Karpen. "Labanotation for Indian Dance In Particular Bharata Natyam".11Th European Conference On Modern South Asian Studies Amsterdam, 1990.

[4] Beck J. "The Dancing History Collection Cultural Dances Part 1 Chapter 2 Vietnam Harvest Dance". Retrieved January 28, 2016. http://escholarship.org/uc/item/0g5802j8

[5] Ann H. "A KM Initiative is Unlikely to Succeed Without a Knowledge Audit". Retrieved December 10, 2016. http://www.providersedge.com/docs/km_articles/KM_Initiative_Unlikely_to_Succeed_Without_a_K_Audit.pdf

[6] Christian G., Frankfurt M. "Introduction to Labanotation". Retrieved May 25, 2016. http://user.uni-frankfurt.de/~griesbec/LABANE.HTML

[7] Dharakorn Chandnasaro. "Labanotation: The Development of Western Dance Notation by Using Symbol", Retrieved November 15, 2016.

[8] The Ministry of Education Thailand. "The Basic Education Core Curriculum B.E. 2551 (A.D. 2008)" www.act.ac.th/document/1741.pdf

[9] Worawat C. Kingkarn S. Chommanad K. Kozaburo H. "Desirability of a Teaching and Learning Tool for Thai Dance Body Motion". Retrieved January 8, 2016. http://link.springer.com/chapter/10.1007/978-3-642-39241-2_20

[10] M. Nakamura, K. Hachimura . "AN XML REPRESENTATION OF LABANOTATION,LabanXML, AND ITS IMPLEMENTATION ON THE NOTATION EDITOR LabanEditor2", 2006, Преглед НЦД

[11] Bashar Altakrouri, Andreas Schrader, "Describing movements for motion gestures" , in 2014. https://www.ceur-ws.org/Vol-1190/paper1.pdf

[12] Matevž Baloh, Ciril Bohak, Matija Marolt. "StreamingLaban – Low bandwidth format for dance encoding with Labanotation" in 2015, Retrieved June 10, 2015, https://www.researchgate.net/publication/308652271_StreamingLaban_-_Low_bandwidth_format_for_dance_encoding_with_Labanotation

[13] Yootthapong Tongpaeng. "Thai Dance Knowledge Archive Framework Based on Labanotation Represented in 3D Animation". Retrieved 2016. http://ieeexplore.ieee.org/document/7904936/?reload=true

[14] K. Kazuya, H. Kozaburo and N. Minako. "LabanEditor : Graphical Editor for Dance Notation". Retrieved 2002,. http://www.ieeexplore.ieee.org/document/1045598/

[15] Tom Calvert, "Animating Dance", Proceedings of Graphics Interface 2007: Montréal, Québec, Canada, 28 - 30 May , 2007. http://graphicsinterface.org/proceedings/gi2007/gi2007-1/