Thai Dance Knowledge Archive Framework Based on Labanotation Represented in 3D Animation

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***Abstract*—Southeast Asia is one of the most rapidly growing regions in the world with natural and cultural resources. It is important to pass on the cultural knowledge to the next generation. Intangible Cultural Heritage like traditional dances, or folk dance is a valuable cultural knowledge to be maintained and passed on by transferring tacit knowledge, and even explicit knowledge such as books, or video presentations. Issues of passing on the knowledge can be the loss of knowledge from time to time by the reduction of the number of dance masters, unreliable sources, and low quality. To retrieve such valuable knowledge, there is a widely-used tool in Europe, in the United States, Asia and Southeast Asia, called "Labanotation" which is about recording and analyzing the dance movement. This paper focuses on proposing 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. The framework assists dancers, notators, knowledge engineers, software engineers to successfully communicate with each other.**

Keywords— Intangible Cultural Heritage; Labanotation; Knowledge Archive; Thai Dance; Knowledge Engineering; Notation Score; Transletion; 3D Animation

I. INTRODUCTION

It is difficult to identify the exact year when dance history became part of our human culture. Unlike, the evident as the physical artifact in last over millennia. For example, stone tools, or cave paintings. However, dance as a form of entertainment is an important part of our culture for a long time. The 30,000-year-old Bhimbetka rock shelter painting was found in India since and, the painted image of dancing figures from 3300 BC was found in an Egyptian tomb [22]. Natya Shastra, which was found between 200 BC and 200 CE, is an early manuscript describing performing arts like the classical Indian dance in a Sanskrit Hindu text [6][7]. Thencient Chinese also have a very long history of recoding dance in ancient texts related to shamanic rituals. Folk dances were a primary basis for development for the Chinese court dances. For the Zhou dynasty of the first millennium BC, the ceremonial yayue was an important dance of their early period [21]. In the 18th century, the royal court dance as ballet appeared in the Paris Opera and during this century in Europe, the development of ballet influenced a large field of entertainment through the spectacle show of the moving image of ballet [22].

In Thailand, there is a written evidence of a ceremony including singing and dancing on the main inscription of King Ramkhamhaeng under the Sukhothai dynasty from 1780 B.E. and folk dance was mentioned in the book called "Trai Bhum Pra Ruang", a Thai Buddhist cosmology composed around 1888 B.E. The impact of Indian Dance was the first influence of ancient Thai dance during the Sukhothai dynasty. An Indian Dance manuscript with image explanations for each movement was the earliest text book which contributed to this era and it was a good example for the archiving of the ancient Thai dance in the Rattanakosin dynasty in 2325 B.E. [13][15]. In 2310 B.E., King Rama II developed the gestures of performing arts and archived the Thai dance based on drawings of the human figure on paper to be passed on from generation to generation. Unfortunately, it was lost during the World War I. A few hundred years later, during King Rama VI, his Majesty wanted to bring the Thai dances to a new level by establishing the Theatre Department to maintain dances like Khon, theater, music, and gamelan art. Correspondingly, his Majesty ordered the production of a Thai dance manuscript by taking photos of the dancer in full dress illustrating more than sixty-eight gestures to be distributed for teaching and learning in the School of Dramatic Arts under the Theatre Department [14].

In the present, maintaining the intangible cultural properties like the traditional dance, or folk dance is very difficult. The new generations have various fields of education offering good career opportunities. Nevertheless, the Thai dance as intangible cultural heritage must be forwarded to the next generation as an important part of learning about the possessed historical culture. Therefore, archiving the Thai dance gestures is important as well as the final outcome to represent the Thai dance knowledge in the form of drawings

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of the human figure, photographs or video representation. Unfortunately, these representations can be damaged, they don't last long and can get lost from time to time [13][14][15].

Hence, there is a method of sustainable recoding and restoring the dance knowledge and it has been used widely in Europe, America and even in Asia. Thai dance as intangible cultural property can be recorded by notation scores based on labanotation created by Rudolf von Laban [5][18]. Labanotation is a significant method to recode and analyze any human movement. In Asia, labanotation has been widely used to recode Asian dances (Indian dance, Malaysian dance, Vietnamese dance, Japanese dance, Korean dance, Taiwanese dance) [2][3][8] because of the similarity of dance gestures. For example: slowly moving arms in front of the expressing the emotion of the character. From the late 19th to the 20th century, many scholars from Japan were working on the translation of notation scores to be displayed in 3D animation [9][11]. They were successful in some level of the Japanese dance and they keep developing it even in the present day.

As seen in the above example of Asian dances, labanotation wasn't only used to recode the dance in Europe and in the United States. It spread into Asia, into China, India, Japan and Korea as well as into Southeast Asia, into such countries as Vietnam, Malaysia where the style of the dance movement is similar to Thai dance movements. Therefore, intangible cultural properties like the Thai dance point towards the direction of the labanotation method to recode and analyze the Thai dance movement in the near future. Thus, this paper focuses on proposing a framework for a traditional Thai dance knowledge archive creating an ontology using knowledge engineering based on the labanotation method.

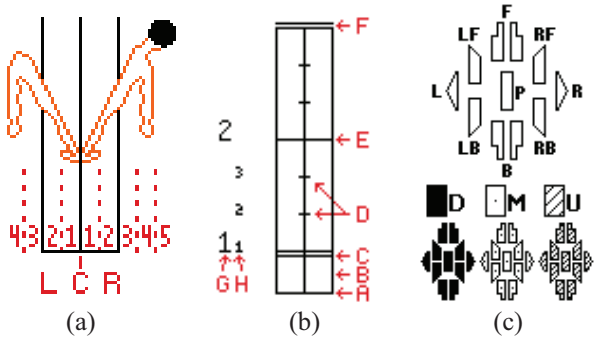
II. Literature Review

A. Intangible Cultural Heritage

Intangible cultural heritage is defined as the practice, representations, expressions, knowledge and skills and also called "living cultural heritage" by UNESCO covering performing arts, oral traditions, social practices, rituals, festive events [17]. The definition of culture by Sir Edward Burnett Tylor is "*that complex whole which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by man as a member of society*" [16]. Therefore, dance is one form of the intangible cultural heritage that is learned and developed by the members of the society until it becomes the cultural knowledge. In Asia, several classes of traditional dances exist and the cultural roots of these dances are coming from the peoples' culture traditions. Also, each country has own culture, beliefs and customs being passed from generation to generation including performing arts or dance. Besides, people have their own techniques for their traditional dance knowledge to be passed on.

B. Labanotation

Labanotation is a system to record human movement that was invented by a group of people leaded by Rudolf von Laban. He first published "Kinetographie" in the first issue of "Schrifttanz" in 1928 [8][9]. Rudolf von Laban studied architecture and was interested in the visual arts. However, his interest shifted to the dance and movement. Rudolf von Laban referred to "Kinetography" in the name of "Labanotation" but he could not claim the system as fully his own. It was a group effort. Rudolf von Laban worked on the lanbanotation fundamentals and was assisted by his colleagues, Sigurd Leeder, Kurt Jooss, Dussia Bereska, Albrecht Knust, Fritze Klingenbeck and Gertrud Snell [8]. Rudolf von Laban focused on analyzing and recording any human movement, and also the European modern dance. Therefore, a notation system has been developed to describe the movement in terms of spatial models and concepts in which temporal patterns, actions, floor plans, body parts, and the three-dimensional use of space is precisely and accurately portrayed. Figure 1. shows the examples of the labanotation system and notation scores as follows: (a) the column: each column indicates a part of the body, for example the left leg is positioned on the column no. 2 on the left side; (b) structure: the staff refers to time, each line shows a space similar to the bar lines in music notes; (c) the direction symbols: each symbol indicates the direction of the movement. Figure 2 is an explanation of the basic notation scores [9].



(a) (b) (c)

Fig. 1. Example of the Labanotation System (a) the column, (b) structure of the staff, (c) the direction symbol

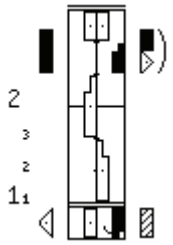


Fig. 2. Example of the basic notation score discribing the score: the beginning at the bottom is the starting position. The person is standing on the left leg, the right leg is directed diagonally low to the back (the small hook on the sign modifies the direction in the way that the toe has contact to the ground - the sign is placed in the gesture column therefore no weight is on that leg). The right arm is directed straight up, the left arm is directed to the left side. The double line separates the starting position from the movement sequence.

The labanotation system provides the notation score as an explicit knowledge, only notators who learn how to read the Laban notation score, can read the symbol. Not too many people take serious studies on the Labanotation symbols.

Hence the idea to translate the Laban notation scores to be represented in a multimedia visualization system like 3D animation. Due to the technology advancement, many scholars from Japan had made significant efforts to create a tool to encode the LabanWriter File and display it in 3D animation. For example: LabanEditor. Not long ago in 2002, LabanEditor was created by a group of Japanese scholars to translate the notation scores to be displayed in 3D animation. Therefore, intangible cultural properties like dance can be the subject of digital archiving. The LabanEditor helped the scholars as the user can upload and edit any dance movement and demonstration in 3D graphics as a human body model [9]. Another example: In 2012, a group of Japanese scholars developed an easy-to-use authoring system on Noh dance -a Japanese traditional theater, a kind of musical drama- to solve existing problems of animation systems. A Noh animation system is based on labanotation and is a method for describing the movement of each part of the body during dancing [11]. In Thailand, a scholar named Chommanad Kijkhun worked on the development of the Thai dance vocabulary notation with labanotation. She used the labanotation method to produce a standard vocabulary of Thai dance and generated dance notation scores, then he used LabanEditor to represent the Thai dance in 3D animation allowing intangible cultural knowledge to be assed on in the university [4]. Several years later, her publication was used for teaching using a learning tool for Thai dance and a collection of new symbols for describing the Thai notation for hand gesture was generated [19].

C. Archiving Issues Considering Thai Dance

The knowledge can be transferred by teaching from the dance master to the dance student. The knowledge can also be extracted into an explicit knowledge such as a text book but in this case error might occur and also issues of storage and maintenance [13][15]. Such problems can have an impact on the dance students, dance teachers, scholars or researchers when working with this valuable knowledge making it difficult to maintain the intangible cultural heritage for the next generation.

There are four issues considered in this paper related to dancers, knowledge engineers, notators and software engineers. These problems relate to the following phases: creating dance ontology between dancers and knowledge engineers, writing notation scores between dancers and notators and translating the 3D animation between notators and software engineers.

First, there are no tools to collect knowledge on dance ontology. When extracting the knowledge from an expert, the knowledge engineers must have a tool to help themselves to precisely gather all the information without missing any point. For this reason, it helps the knowledge engineers save time and gather all the information needed. The knowledge engineering method is one of the good tools to gather information form experts in systematic architecture including building, maintaining and using knowledge-based systems.

Second, there is an unsustainable tradition of storing the knowledge in traditional forms representation like drawings of the human figure, photographs or text books or even very low quality video representations [13][14][15]. This generates a problem for the dance learners or scholars when studying such a valuable intangible cultural heritage knowledge. Labanotation system assists notators to recode the dance systematically and store on cloud computing systems where it is available for everyone and can be kept for a long time.

Third, there is no standard of translating notation scores to 3D animation. A standard is necessary for the communication between the notators and software engineers to assist both parties in achieving the goal of creating the notation score translation for the in-3D animation representation.

Fourth, there is no software available for representing the dance in 3D animation based on labanotation at the present time. Before, some software were developed such as LabanDancer, LabanEditor, GenLaban and LabanAssist [9][10][20]. Some of the software isn't supported by the new operating systems, some of them cannot display images of high resolution. There is an important task of 3D animation to represent intangible cultural heritage for teaching and learning purposes.

Therefore, the main focus of this paper is to propose a framework for a traditional Thai dance knowledge archive creating an ontology using a knowledge engineering tool based on the labanotation method.

III. Framework

According to the four issues mentioned, to Thai dance knowledge archive using this framework supports dancers, knowledge engineers, notators and software engineers to create ontology on Thai Dance, dance notation score and 3D animation representation. Figure 3 illustrates the framework of the Thai dance knowledge archive of dance ontology based on the labanotation method for 3D animation representation.

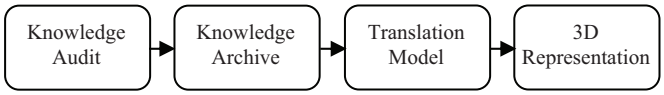


Fig. 3. *Framework of the Thai dance knowledge archive creating a dance ontology based on labanotation method to be represented in 3D animation*

A. Knowledge Audit

In terms of business, knowledge audit is an effort of knowledge engineers to understand the organization structure, duty of each department and knowledge assets. As Ann Hylton said "*A Knowledge audit should be the first step in any Knowledge Management initiative. Properly done, it would provide accurate identification, quantification, measurement and assessment of the sum total of tacit and explicit knowledge in the organization*" [1]. To understand all the knowledge assets, there is a mothed called "Knowledge Engineering" of gathering information from the expert based on systematic architecture including building, maintaining and using knowledge-based systems. In the creation of an ontology for Thai dance, using a knowledge engineering tool can support knowledge engineers to have a clear understanding and to work step by step without omitting essential tasks. Knowledge

engineering tool assists knowledge engineers in creating a cluster, in understanding the link between each cluster and in comprehending the relationship between them. The tool classifies the steps of the dance gestures, identifies the connection of each dance movement and realizes the dance requirements for the teaching and learning process. This will solve the problem of unplanned structures, lacking information and time consuming workflow.

B. Knowledge Archive

There is a knowledge achieve of dancing in Thailand for teaching and learning passed through generations in the form of explicit knowledge such as a book or video presentation. However, the books or video presentation can be lost and videos are of low quality/resolution. Also, when dance students learn the moves, there isn't an explanation for every detail of the moves. Therefore, every time they learn, the teacher must emphasize every small detail of information. Then, the old knowledge archive is not very successful in transferring valuable knowledge. The labanotation system is very widely used in Europe (England, France,) America, Asia (China, India, Japan, and Korea) and even in Southeast Asia (Vietnam and Malaysia). This fact ensures that using the labanotation system to archive the Thai dance knowledge would require the same standards as the other systems and the system is very reliable in recoding and analyzing the dance movement. The system has been established to define and describe the dance movement in terms of spatial models and to accurately portray temporal patterns, actions, floor plans, body parts, and a three-dimensional use of space. Nowadays, the internet is becoming a part of our life. Storing the notation score in a cloud computing system is an easy and convenient way for the people to reach the information on Thai dance notation scores.

C. Translation Model

The translation model is designed to convert LabanWriter files to be displayed as a 3D animation and to give an understanding to both notators and software engineers on the translation of the Laban notation scores. The model is from Michael C. and his colleagues [12] and they were working on a tool for translating dance notation to animation. Therefore, the following six steps are applied to translate Thai notation scores to be displayed in 3D animation.

1) Parse the LabanWriter file: Parsing the LabanWriter file is the first step to identify the column, and the start-end time for each symbol. It provides a channel for each body segment showing all support change and gesture of the body segment with the start times and duration of the movement.

2) Create Laban sentences: Each labanotation symbol has its own meaning; still, all the Laban symbols are considered as sentences if they pertain to a single motion. Hence, to identify sentences or symbols referring to a single motion, they need to be related to symbols that are connected to others.

3) Normalize Laban sentences: Normalizing Laban sentences is to reduce representation to a simple form workable for the computer. It affects the translation, the encode assumption of limb positions and transitions.

4) Use a rule base to interpret Laban sentences: After the sentence is ready in the simple form, placing rule on each sentence or symbol is the next step. Thus, it creates a condition on each sentence to limit the movement.

5) Generate keyframes: To animate the 3D model, the generation of the keyframe is done according to the rule.. Each sentence must be matched with each part of the model body to generate to movement by rendering the keyframe.

6) Check generated keyframes for correctness: Finally, checking the translation is the last step for the correctness of the notation score and animation. The notators must verify each movement corresponding to the Laban symbol.

D. 3D Representation

3D representation for the Labanotation system is a successful idea to make sure the notation score is correctly written. In the past, such software were developed as LabanDancer, LabanEditor, GenLaban and LabanAssist [9][10][20] which provided an effective visualization to correct the Laban notation score. In addition, they were made for repositioning the 3D model dancers to recreate a better form of dance movement. There are several advantages of 3D representation.

- Serve notators to effectively correct the dance notation score by viewing the 3D display.
- The ability to create renderings and animations to see all the angles, positions.
- Gain more precision and control. For example: to stop and play the 3D representation when the dance is very complex.
- Support dance teachers to effectively communicate with dance students by visualizing 3D display
- Create a new dance and see the flow of the movement.

IV. Conclusion

In conclusion, intangible cultural properties like the traditional Thai dance are appropriate to be recorded and analyzed by the labanotation method. Archiving the knowledge of Thai dance is difficult without using a tool or system to gather information from the dance master experts in systematic architecture including building, maintaining and using knowledge-based systems. This proposed framework aims to assist on how to archive the Thai dance knowledge based on Labanotation system and how to transfer the notation scores to be represented in 3D animation. By the following framework and knowledge audit, a Thai dance ontology can be created using a knowledge engineering tool. A knowledge archive can be established using the labanotation system to record and analyze Thai dance. The translation model translates the Laban notation scores to be display in 3-dimensional animation. 3D Representation can effectively represent the Thai dance knowledge in a multimedia visualization system.

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