On the detection of video's Ethnic Vietnamese Thai Dance Movements

Tung Pham Thanh*, Salem Benferhat †, Ma Thi Chau*, Truong-Thanh Ma†, Karim Tabia† and Ha Le Thanh*

†CRIL - UMR 8188 CNRS/Université d'Artois
Faculté des Sciences Jean Perrin
Rue Jean Souvraz SP 18
62307 Lens Cedex - France

* HMI Lab, University of Engineering and Technology
Vietnam National University Hanoi, Vietnam

***Abstract*—The problem addressed in this paper is the one of classifying Vietnamese dances' videos. In particular, we focus on an automatic detection of movements in the Ethnic Vietnamese Thai dances (ETVD). We first propose an ontology-based description of ETVD movements in terms of main movements' steps. We then associate with each movement step a profile containing typical features that characterize a movement step. The automatic detection of ETVD movements is based on a correlation method that matches movements' steps profiles with concepts present in frames of dances' videos. The last part of the paper contain experimental studies that show the good classification rate of our ETVD movement detection method.**

***Index Terms*—Basic movement, Ethnic Vietnamese Thai dance, Vietnamese folk dance, pose detection, dance detection.**

I. Introduction

Vietnamese traditional dances have a long and rich history of development. The dances with cultural identity are closely associated with historical traditions, customs and daily labor activities [1]. Recently, there have been several research works for collecting, preserving and promoting traditional dances [2].

The Laban Movement Analysis and the Labanotation system [3] are frameworks for analysing and annotating movements [4] [5] [6]. In [7], [8], [4] the authors propose approaches for the representation of the body human movements in the videos. Other attempts focus on image and video processing system for automating concepts' classifiers. In a similar direction, Piana et al.[9] propose computational models and software libraries to measure automatically expressive qualities and emotions from individual and group movements.

Within Aniage project[1], there are already some researches on building and modeling some Asian dances [10][11][12] including Vietnamese traditional dances. Vietnam is known by its diversity and abundance of traditional dances issued from 54 ethnic groups. In this paper, we focus on developing an automatic method that applies to the detection Ethnic Vietnamese Thai dances' movements.

Recently, a new method has been proposed to perform videos' content-based analysis performed on each frame [13]. This method have shown good results but require a huge data for training purposes. Such data is not always available. In order to overcome this limitation, we propose a process for an automatic movement detection based on the notion of a reference model. Three issues need to be addressed:

1. How to take into account the variations of the dances that depends on the region and choreographer's style?

2. The dance descriptions in existing books and documents may be different. How to establish the posture profile for each dance step that cover different description of dances?

3. The automatic detection of body part pose using machine learning is not always satisfactory due to the low video quality and to the fact that some body parts are hidden. How to deal with such imperfection?

To deal with problems 1 and 2, we propose a knowledge-based model that intends to describe basic dancing movements using based on dancing steps. Our knowledge-based model, not only describes steps' typical characteristics but it also ensures the variations in each basic movement. For problem 3, we design a simple interpolation operator to estimate missing body postures. All of these contribute to make a complete dance structure-based process of detecting and classifying steps and basic movements.

The rest of this paper is organized as follows: Section II and Section III briefly describe Vietnamese dances and Ethnic Vietnamese Thai dances. In Section IV, the ETVD movements' step detection is proposed. Section V presents our experimental studies.

II. Vietnamese dance in general

Through ETVD dances, people express 3 kinds of messages: (i) daily life activities, (ii) festival activities and, (iii) human spirituality. A Vietnamese folk dance includes basic movements. There are two types of movements in ETVD dances: (i) Body movements, making the position of the whole body of dancer moving in space and (ii) Body part movements, making the position of different parts of dancer's bodies changing. For body movements, dancers move on stage. On the other hand, dancers change their position on a plane. Along with

[1]https://www.euh2020aniage.org

978-1-7281-5686-6/19/$31.00 ©2019 IEEE
DOI 10.1109/SITIS.2019.00064

the implementation of the body phrases, dancers perform body part movements. A dance posture, a particular position of dancer' body, is made from basic body part postures, such as, basic head poses, basic hand poses, basic arm poses, basic leg poses and basic combined arm-leg poses. An important factor to make a basic body part posture is orientation of the body part. Orientation of a body part is defined as angles between limb inside the body part and the torso to describe basic body part posture. In Vietnam folk dances, there are eight orientations, simply denoted by Orientation1 to Orientation 8.

III. Modelling Ethnic Vietnamese Thai Dance

In Ethnic Vietnamese Thai dances (ETVD), most of the gestures and movements are intimately related to the processing of manual labor as well as the life activities in ethnic community. Each dance performance session lasts from 4 minutes to 10 minutes [15]. Based on props, the Thai dance is divided into 6 main types which include few basic movements like the ones given on Figure 1.

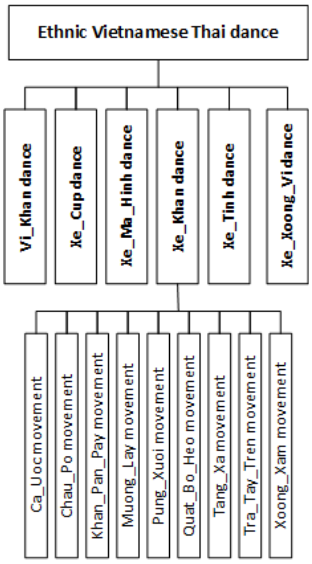


Fig. 1: Main types of Ethnic Vietnamese Thai dance

Dancers are often characterize by their basic movements and by the used props. Props are in the form of shapes, colors and materials, which can be viewed as good criteria to recognize dances. In order to identify dance types, one needs to automatically detect their basic movements. For example, in Xe_Khan dance, a dance type with scarfs, consists of 9 basic movements: Ca_Uoc, Chau_Po, Khan_Phan_Pay, Muong_Lay, Pung_Xuoi, Quat_Bo_Heo, Tang_Xa, Tra_Tay_Tren and Xoong_Xam. The Ca_Uoc basic movement is very popular in Vietnamese Thai dances and hence it will be used as a case study in this paper. Each basic movement has its own meaning to convey messages to the audience. In Vietnamese, Uoc means "desire" and people perform the Ca_Uoc basic movements with the hope that good things will happen to every one. Another example is Mo_Moi. Moi means "invitation". Mo_Moi, a familiar basic movement of Vietnamese group, shows invitations for people to join a dance.

To determine the movements of a dance, the dancer as well as his/her body parts has eight orientations depending on the angle between the dancer/the body part and the horizontal line. Dances in different regions have their own characteristics because they are made up of separate postures when dancers perform dances. In Ethnic Vietnamese Thai dance, there are 15 basic postures including 5 leg postures, 5 arm postures, 2 sitting postures and 3 standing postures (Figure 2). Dancers' body movements change from one specific posture to another according to certain trajectories and rules that constitute the basic movements. Based on regional characteristic and posture/movement analysis, we built a dance ontology for Ethnic Vietnamese Thai dances (EVTD) to widely store and share the meaning of dances. Figure 3 presents a taxonomy of body parts, body part orientations and body part postures in Ethnic Vietnamese Thai dances. For more details see [10].

IV. Methodology

We focus on studying three main issues: (i) estimating the similarity of the orientations of the body parts of the dancer; (ii) estimating the posture step profile to identify video segments containing specific steps of a Ca_Uoc basic movement and (iii) detecting Ca_Uoc movements. But first let us describe the used data and knowledge.

A. The used features

1) Features and their representations: In a dance, when analyzing movements, we need to consider different body parts' postures and motions. We consider 13 main body parts: Right_Shoulder, Left_Shoulder, Right_Upper_Arm, Right_Fore_Arm, Left_Upper_Arm, Left_Fore_Arm, Right_Hip, Right_Thigh, Right_Shin, Left_Hip, Left_Thigh, Left_Shin, and Head. In addition to body part postures, we also have 4 additional posture features: arm, leg, standing, sitting. So we have 17 basic features, each of them is associated with one of the eight orientations (Figure **??**).

For each ETVD video and for each of its frame we developed an automatic tool that detects these 17 main features and their orientations based on TF - Openpose framework [14]. The orientations of Right_Shoulder, Left_Shoulder, Right_Upper_Arm, Right_Fore_Arm, Left_Upper_Arm and Left_Fore_Arm are used to detect arm posture. For each video we obtained a two-dimensions matrix $P_{I \times B}$, where I is the number of frames in a video and B = 17 is the number of body parts and body part postures (leg postures, arm postures, siting postures and standing postures).

2) Step posture profiles of a Ca_Uoc movement: The Ca_Uoc basic movement contains 9 steps numbered from 0 to 8. Step_0 and step_8 are identical (Figure 4). In a segment of a dance that has more than one successive Ca_Uoc basic movements, the step_8 of the current movement is also step_0 of the following movement. These steps are called ***preparing***

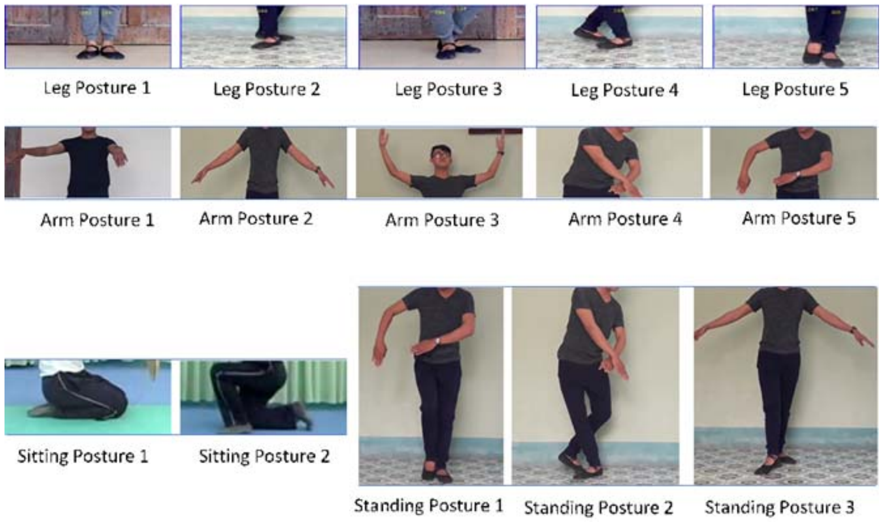


Fig. 2: Basic postures in Ethnic Vietnamese Thai Dances

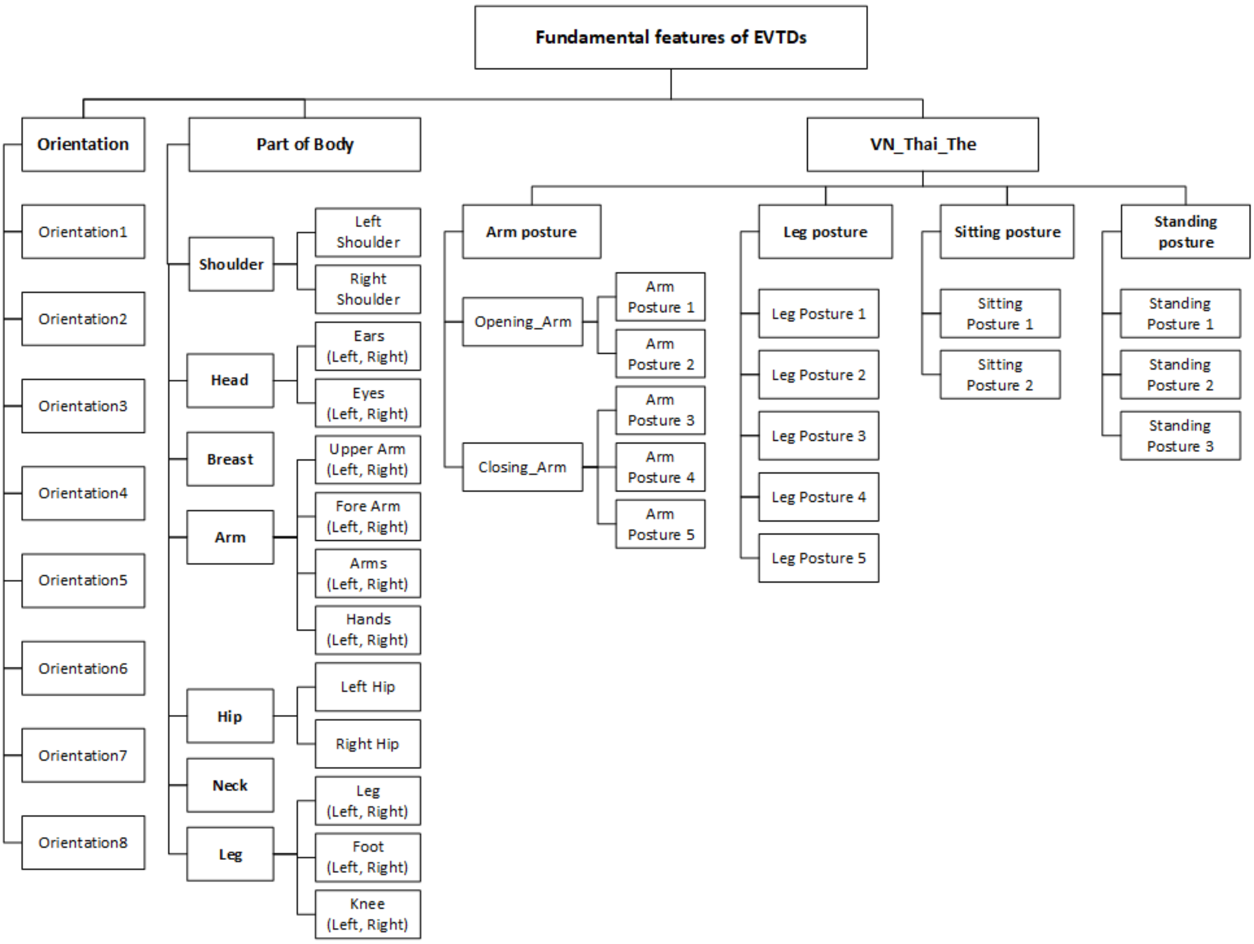


Fig. 3: Ontology of an Ethnic Vietnamese Thai Dance

(a) Step_0 (b) Step_1 (c) Step_2 (d) Step_3 (e) Step_4 (f) Step_5 (g) Step_6 (h) Step_7 (i) Step_8

Fig. 4: Steps in Ca_Uoc movement

steps. Step_4 has the same motion as step_8 but it is played in an opposite side.

Each step has its own ***step posture profile*** representing the maximum variation in the step dancer movement. Steps' posture profiles are represented by a three-dimensional matrix $S_{K\times B\times O}$, where:

K = 9: number of steps in a Ca_Uoc basic movement;

B = 17: number of body part postures and basic postures;

O = 8: number of Orientations.

Table I and table II show step_0 and step_4 posture profiles. If a step_k posture profile has body part b in orientation o, S[k,b,o] is assigned the value at 1. Otherwise, S[k,b,o] is set to 0. However, the body parts cannot always have an exact step standard poses. So in addition to the the binary degrees 0 and 1, we may also have the value 0.5 for each orientation and for each a body part.

TABLE I: Step_0/step_8 posture profile of Ca_Uoc

Body parts	O1	O2	O3	O4	O5	O6	O7	O8
Right_Shoulder	0	0.5	1	1	0.5	0	0	0
Left_Shoulder	0.5	0	0	0	0	0.5	1	1
Right_Upper_Arm	1	0.5	0.5	1	0	0	0	0
Right_Fore_Arm	0.5	0	0	0	0	0.5	1	1
Left_Upper_Arm	1	0.5	0	0	0	0	0.5	1
Left_Fore_Arm	1	0.5	0	0	0	0	0.5	1
Right_Hip	1	1	0.5	0	0	0	0	0.5
Right_Thigh	1	0.5	0	0	0	0	0	0.5
Right_Shin	1	0.5	0	0	0	0	0	0.5
Left_Hip	1	0.5	0	0	0	0	0	0.5
Left_Thigh	1	0.5	0	0	0	0	0	0.5
Left_Shin	1	1	0.5	0	0	0	0	0.5
Head	0	0	0	0	0.5	1	0.5	0
Arm	0	0	0	0	0	0	0	0
Leg	0	0	1	0	0	0	0	0
Standing	0	0	0	0	0	0	0	0
Sitting	0	0	0	0	0	0	0	0

3) Weighting body parts features: features do not play the same role in the detection of steps. The body part postures are in a definite position, but the levels of importance in each part position are not the same. For example, in step_4, the posture of the Leg and $Right\_Fore\_Arm$ are very important. Therefore, we define a weight matrix, $C_{K\times B}$ (Table III), that stores weights for each body part in each step.

B. From ETVD videos to annotated frames

We now propose a method, illustrated by Figure 5, to automatically detect Ca_Uoc basic movements in ETVD videos.

TABLE II: Step_4 posture profile of Ca_Uoc

Body parts	O1	O2	O3	O4	O5	O6	O7	O8
Right_Shoulder	0.5	1	1	0.5	0	0	0	0
Left_Shoulder	0	0	0	0	0.5	1	1	0.5
Right_Upper_Arm	1	1	0.5	0	0	0	0	0.5
Right_Fore_Arm	1	1	0.5	0	0	0	0	0.5
Left_Upper_Arm	0.5	1	0	0	0	0	1	0.5
Left_Fore_Arm	0.5	1	1	0.5	0	0	0	0
Right_Hip	1	0.5	0	0	0	0	0	0.5
Right_Thigh	1	0.5	0	0	0	0	0	0.5
Right_Shin	1	0.5	0	0	0	0	0	0.5
Left_Hip	1	0.5	0	0	0	0	0.5	1
Left_Thigh	1	0.5	0	0	0	0	0	0.5
Left_Shin	1	0.5	0	0	0	0	0	0.5
Head	0	0	0.5	1	0.5	0	0	0
Arm	0	0	0	0	0	0	0	0
Leg	0	0	1	0	0	0	0	0
Standing	0	0	0	0	0	0	0	0
Sitting	0	0	0	0	0	0	0	0

Recall that there are 9 steps in a Ca_Uoc basic movement that are played in a sequence. The first step step_0 and the last step step_8 have the same description. In Ca_Uoc basic movements, step_0, step_4 and step_8 are more important than others and have distinct body part posture in their step posture profile. They represent the starting, end and middle step in Ca_Uoc. In fact, step_0, step_4 and step_8 are enough to determine a Ca_Uoc basic movement. The structure of Ca_Uoc can be approximated as a basic movement which has 3 mains steps (step_0, step_4, and step_0 - start, middle, and stop, respectively). In the structure, the time difference (in $frames$) d_1 from the starting step to middle step and the time difference d_2 from the middle step to stop step are stable and are nearly equal to each other. The proposed method normalizes similar measures between videos data with posture profile in form of a signal. This process of signal filtering is obtained according to the structure of dance movements.

1) Fixing body posture: Due to video quality, occlusions, dancer's positions and postures, and props' the position of some body parts could be missed when we perform body posture detection frame by frame. The body and body part postures of a dancer change slightly in consecutive frames of a video (Figure 6). The missing body part in a frame is estimated based on the same body part orientation in previous and next frames. In our method, the mean of orientations in n previous frames and n next frames are used to estimate a missing body part b in a frame i according to the formula:

TABLE III: Weights of body parts

Body part	Step_0	Step_1	Step_2	Step_3	Step_4	Step_5	Step_6	Step_7	Step_8
Right_Shoulder	2	2	2	2	2	2	2	2	2
Left_Shoulder	1	2	2	2	1	2	2	2	1
Right_Upper_Arm	2	2	1	2	2	2	1	2	2
Right_Fore_Arm	3	2	2	2	3	2	2	2	3
Left_Upper_Arm	1	2	1	2	1	2	1	2	1
Left_Fore_Arm	1	2	2	2	1	2	2	2	1
Right_Hip	1	1	1	1	1	1	1	1	1
Right_Thigh	1	1	1	1	1	1	1	1	1
Right_Shin	1	1	1	1	1	1	1	1	1
Left_Hip	1	1	1	1	1	1	1	1	1
Left_Thigh	1	1	1	1	1	1	1	1	1
Left_Shin	1	1	1	1	1	1	1	1	1
Head	2	1	1	1	2	1	1	1	2
Arm	1	2	1	2	1	2	1	2	1
Leg	3	1	3	1	3	1	3	1	3
Standing	1	1	1	1	1	1	1	1	1
Sitting	1	1	1	1	1	1	1	1	1

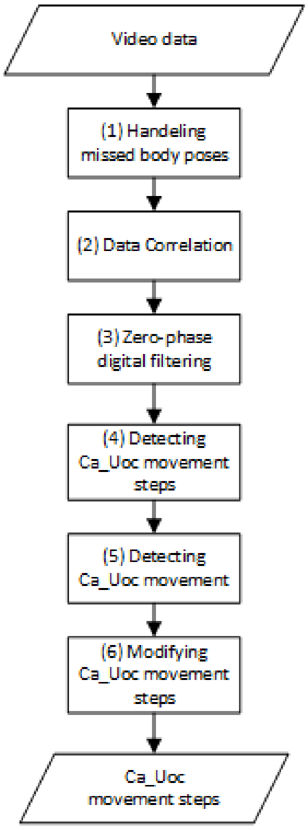


Fig. 5: Major steps for Ca_Uoc basic movements

$$P(i,b) = \frac{1}{2*n}\Sigma_{j=-n,j\neq i}^{n} P(i+j,b), \qquad (1)$$

where $P[i,b]$ is orientation of body part b in frame i.

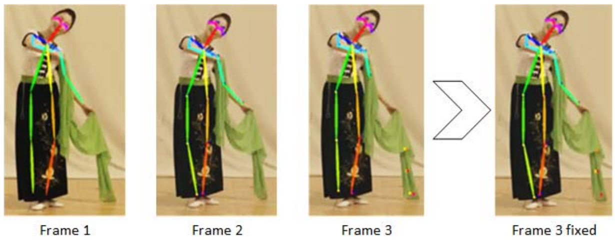


Fig. 6: Motion of dancer's body postures

2) Determining step postures in each frame: After detecting dancer postures frame by frame, we define a similarity measure of the dancer's posture in each frame with respect to the step posture profile. This is done in order to determine which step the dancer is performing in each frame. The similarity measure between a dancer pose in frame i and a step posture profile k, called $M(i,k)$, is obtained using the equation:

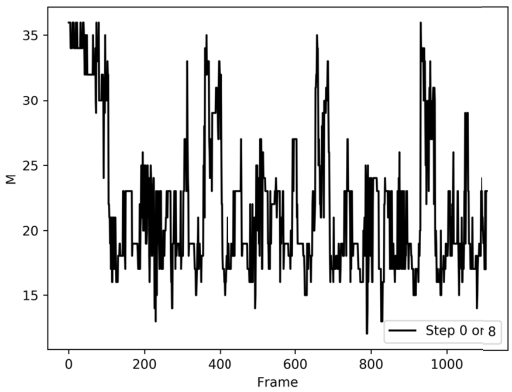
$$M(i,k) = \sum_{b=1}^{B} C(k,b) * S(k,b,o), \qquad (2)$$

where:

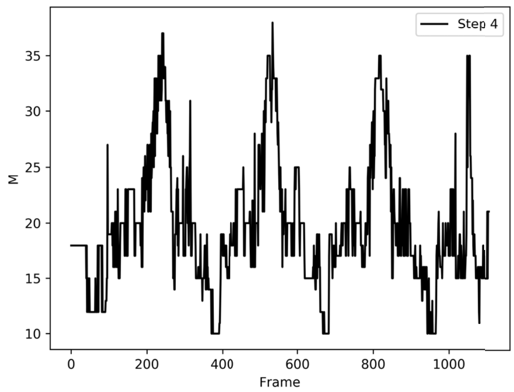
- i : index of frame;
- k : index of step;
- B : number of body part;
- b : index of body part;
- o : orientation of body part b in frame $i, o = P[i,b]$.

Formula (2) is applied for all frames i and to all step posture profiles k. The result of the similarity measures can be represented in a form of signals as shown in Figure 7. For each step k, the higher the similarity measure is, the more matching the dancer's performance with a predefined step is.

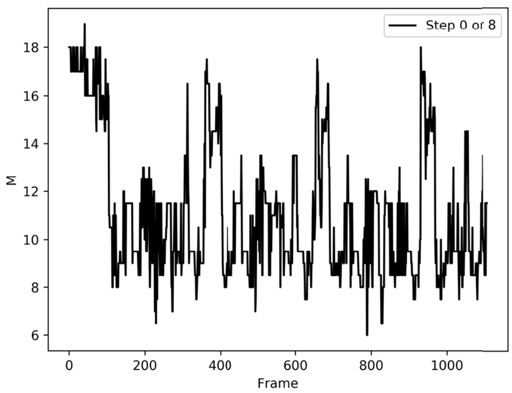
Zero-phase digital filtering In case where the signals, denoted by M, is of low quality because of low detecting



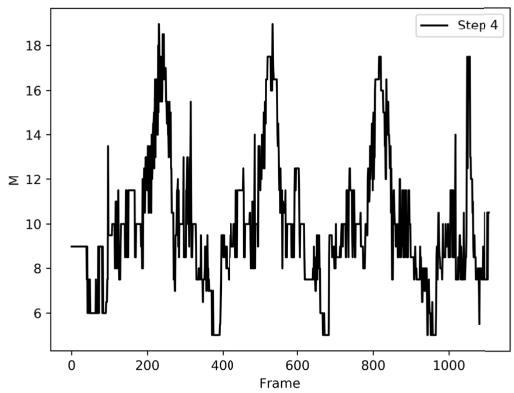
(a) Step_0 before missing pose fixing



(b) Step_4 before missing pose fixing



(c) Step_0 after missing pose fixing



(d) Step_4 after missing pose fixing

Fig. 7: Similarity measures between dancer movements and step_0 (step_4) posture profile

body pose, a filter is applied to improve its quality. This filter applies a linear digital filter twice, once forward and the other backward [16]. The combined filter has zero phase. The filter provides options for handling the edges of the signal. The transfer function coefficients of an n-order lowpass digital Butterworth filter with normalized cutoff frequency Wn is $[b, a] = butter(n, Wn)$, where n is the minimum of frames in a step; a and b are coefficient vectors in size N. The formula of zero-phase digital filtering for each step k is:

$$MF(i) = \sum_{j=0}^{N} b(j+1)M(i-j,k) - \sum_{j=1}^{N} a(j+1)M(i-j,k), \quad (3)$$

where:

- i : index of frame;
- a : The denominator coefficient vector of the filter;
- b : The numerator coefficient vector of the filter;
- N: Size of a, b;

After filtering, the edges and noise of the signal are removed. Figure 8 shows the resulting signals for which each step, identified is having local extreme values.

3) Detecting Ca_Uoc's steps: In the following, the parameter θ is called the minimum adaptive of the similarity measure in steps. θ is a deviation that ensures the flexibility of main body part orientations of dancer in comparison with those in the step posture profile. We use θ to discrete signal MF for each step k using the following formula:

$$MQ^{(k)}(i) = \begin{cases} 1 & \text{if} \quad MF^{(k)}(i) >= \theta \\ -1 & otherwise \end{cases} \quad (4)$$

$MQ^{(k)}(i) = 1$ means that in the frame i the dancer performs a posture that belongs to the step k. Given body part

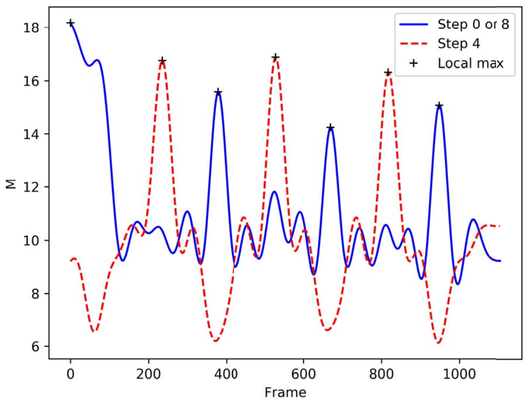


Fig. 8: Noises and edges of the similarity measure Signal are removed after using zero-phase digital filtering

coefficients and values of step posture profile orientation, the correlation value oscillates in $(1, 24)$. Namely, $1 <= \theta <= 24$.

Let us denote by t the minimum duration time, in seconds, for a step. So, the minimum number of frames per step is: $n_{min} = t * \delta$, where, δ is the frame rate of the video. $S^{(k)}_{(a)(b)}$, a segment in dance video, associated to step k, starts and ends at frames a, b respectively. For $\forall k$, $S^{(k)}_{(a)(b)}$ is a segment of at least n_{min} frames and consists of consecutive frames such that $MQ^{(k)}(i) == 1$ with $a << i << b$.

To exclude the possibility that the same segment in the video contains different steps of the Ca_Uoc basic movements, we divide the video into spans which contain one step in Ca_Uoc basic movement or undefined step[2]. Spans in the video are non-overlap consecutive segments. $F = \{f_0 = 0, f_1, ..., f_M\}$ is set of ascending frames to determine the spans. F consists of all ascending indexes of frames of $S^{(k)}_{(a)(b)}$ with $k = \overline{0, 8}$.

The measure, denoted by MS a combination of all signals $MQ^{(k)}$, is calculated on each span of the video. MS shows Ca_Uoc's steps on each span of the video. The value of the signal MS is the step index of Ca_Uoc. If span contains undefined step, the value of the signal $MS(i)$ on that span receives value -1. For each span from f_i to f_{j+1}, MS is calculated as follow:

$$MS_{(f_j),(f_{j+1})} = \begin{cases} k & \text{if} \quad S^{(k)}_{(f_j)(f_{j+1})} = 1 \\ & \quad\; and \quad S^{(m \neq k)}_{(f_j)(f_{j+1})} = -1 \\ & \text{or} \quad S^{(k)}_{(f_j)(f_{j+1})} = S^{(m)}_{(f_j)(f_{j+1})} = 1 \\ & \quad\; and \quad S^{(k)}_{(f_{j-1})(f_j)} = 1 \\ -1 & \text{if} \quad S^{(k)}_{(f_j)(f_{j+1})} = -1 \quad \forall k \end{cases} \tag{6}$$

[2]undefined step does not belong to set of Ca_Uoc's steps

Formula (6) is applied to automatically annotate spans in video with name of steps in Ca_Uoc basic movement. Figure 9 shows all frames in step_0 (or step_8) and all frames in step_4. There are 4 sets of frames in step_0 (step_8) and 3 sets of frames in step_4 after detecting Ca_Uoc's steps.

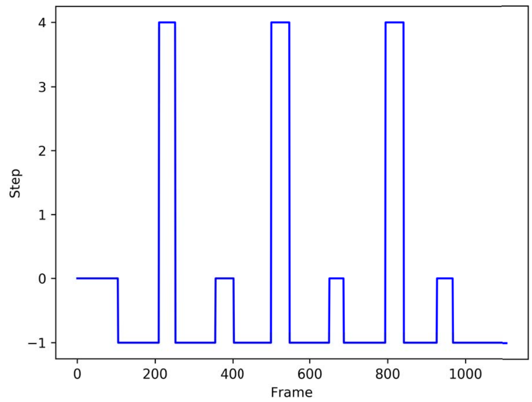


Fig. 9: Classified frames after detecting Ca_Uoc's steps

4) Detecting Ca_Uoc basic movements: As mentioned above, steps 0, 4, and 8 are very important and are used to recognize Ca_Uoc movements. Ca_Uoc basic movement is detected in a video by finding sequences in the frames where $MS_{(i_1),(j_1)} = 0$, $MS_{(i_2),(j_2)} = 4$, $MS_{(i_3),(j_3)} = 8$ and where the following conditions: $|d_1 - d_2| < \Theta$ and $\Delta_1 <= d_1, d_2 <= \Delta_2$, $d_1 = i_2 - j_1$, $d_2 = i_3 - j_2$. The deviation of d_1 and d_2 should not exceed a quarter length of step_4, so, $\Theta = (j_2 - i_2)/4$. As mention in section III, n_{min} is the minimum number of frames of a step, then, $d_1 = 3 * n_{min}$ and $d_2 = 3 * n_{min}$

Figure 10 shows that there are three Ca_Uoc basic movements in a video. Each movement has 9 steps from step_0 to step_8. However, due to the fact that the movements are continuous, step_8 of movement 1, 2 is step_0 movement 2, 3. The final frames of last step_4 in video are not classified in Ca_Uoc basic movements.

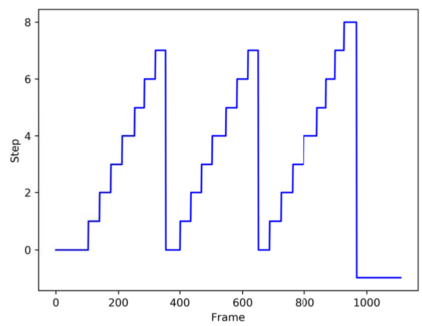


Fig. 10: Output results per frames for each step in video

V. Experiments and Evaluations

We evaluated our method for detecting the Ca_Uoc basic movements using 40 videos. The first 20 videos contain at least one or several Ca_Uoc basic movement with a total of 176 Ca_Uoc basic movements. The last 20 videos, which are not Ca_Uoc movements, were randomly selected. Our method detects and classifies videos into steps and movements. In order to evaluate our method, we also manually annotated the videos. A manual segment experiment is realized with same videos for a validate purpose. Table IV shows the evaluation of our method.

TABLE IV: Statistical results

Object determine	Manual	Proposed	Standard deviation(%)
Movement	176	172	1.18
Step	1467	1439	10.54
Step_8	200	200	6.16
Step_4	181	177	8.56

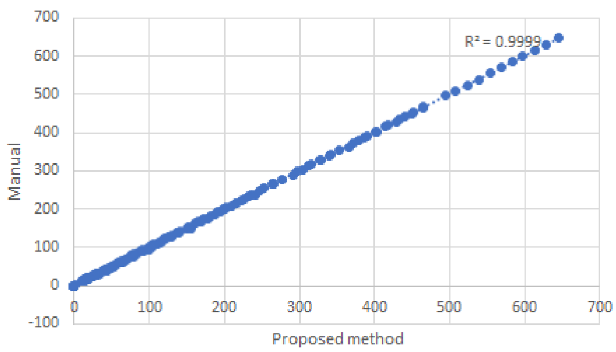


Fig. 11: Start timeline of Ca_Uoc basic movement correlation

Table IV shows that the correct classification of Ca_Uoc basic movements is high despite the fact that it is only based on important steps. Our method only misses 4 movements. Standard deviation of movement start time between proposed method and manual segment is 0.179 second (4.29 frames with rate 24 frames per second) which ensures the correct movement detection. The correlation between their timeline is almost equal to 1 indicating the good matching result (Figure 11).

VI. Conclusion

This paper proposed a method to classify Vietnamese traditional dance movements in videos by detecting their steps using the concept of step posture profiles. This study was applied the Ethnic Vietnamese Thai dance named Ca_Uoc basic movement. Experimental results show that our detection method is good with a percentage of correct classification higher than 97%.

VII. Acknowledgements

This work has received support from the European Project H2020 Marie Sklodowska-Curie Actions (MSCA), Research and Innovation Staff Exchange (RISE): Aniage project (High Dimensional Heterogeneous Data based Animation Techniques for Southeast Asian ICH Digital Content), No: 691215.

References

[1] Le Thi Minh Nguyet. The formation and development of traditional Vietnamese dance. Hanoi: Vietnam Literaturepublisher, 2018.

[2] Truong Van Son, Dieu Thuy Hoan and Nguyen Thi Mai Huong.Folk dance of some ethnic groups in the Northwest. Hanoi: Publisher of National Culture, 2018.

[3] Guest, A. H.(2005). Labanotation: the system of analyzing and recording movement. Psychology Press.

[4] El Raheb, K. and Ioannidis, Y. "A labanotation based ontology for representing dance movement." International Gesture Workshop. Springer Berlin Heidelberg, 2011.

[5] Hatol, Jonathan. MOVEMENTXML: A representation of semantics of human movement based on Labanotation. Diss. School of Interactive Arts and Technology-Simon Fraser University, 2006

[6] Nakamura, Minako, and Kozaburo Hachimura. An xml representation of labanotation, labanxml, and its implementation on the notation editor labaneditor2. Review of the National Center for Digitization 9, 2006, 47-51.

[7] Calvert, Tom. "Approaches to the Representation of Human Movement: Notation, Animation and Motion Capture." Dance Notations and Robot Motion. Springer, 2016. 49-68.

[8] Ceusters, W., and Barry S. "Switching Partners: Dancing with the Ontological Engineers." Switching Codes. Thinking through Digital Technology in the Humanities and the Arts (2011): 103-124.

[9] Piana, S., Staglianò, A., Odone, F., and Camurri, A. (2016). Adaptive body gesture representation for automatic emotion recognition. ACM Transactions on Interactive Intelligent Systems (TiiS), 6(1), 6.

[10] Truong-Thanh Ma, Salem Benferhat, Zied Bouraoui, Karim Tabia, Thanh-Nghi Do and Huu-Hoa Nguyen. An Ontology-Based Modelling of Vietnamese Traditional Dances. International Conference on Software Engineering and Knowledge Engineering, 2018

[11] Truong-Thanh Ma, Salem Benferhat, Zied Bouraoui, Thanh-Nghi Do, Huu-Hoa Nguyen. Developing Application Based Upon An Ontology-Based Modelling of Vietnamese Traditional Dances. 3rd International conference on Digital Heritage, 2018

[12] Ma Thi Chau, Nathalie Chetcuti-Sperandio, Sylvain Lagrue, Thuy Nguyen Thanh and Bui The Duy. Towards an Ontology for Vietnamese Water Puppetry in 2nd International Conference on Digital Arts, Media and Technology (ICDAMT'17), 2017.

[13] Hossein Hosseini, Baicen Xiao, Andrew Clark and Radha Poovendran. Attacking Automatic Video Analysis Algorithms: A Case Study of Google Cloud Video Intelligence API. arXiv preprint, 2017.

[14] Zhe Cao, Gines Hidalgo, Tomas Simon, ShihEn Wei and Yaser Sheikh. OpenPose: Realtime Multi-Person 2D Pose Estimation using Part Affinity. arXiv preprint, 2018.

[15] L.N.Canh. General dance, in Culture and information publishing house, 2003.

[16] S.H.Chung and R.A.Kennedy. Forward-backward non-linear filtering technique for extracting small biological signals from noise. Journal of Neuroscience Methods Vol. 40, Issue 1, 1991, Pages 71-86