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Feature Reduction of Wayang Golek Dance Data Using Principal Component Analysis (Pca)

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Abstract: One of the internally acknowledged Indonesian Culture inheritance is the Wayang Golek Menak Yogyakarta, which is usually performed with wood doll characters. The objective of the study is to apply motion capture (mocap) technique with Kinect Sensor to capture the Wayang Golek Menak dance movements and apply the Principal Component Analysis (PCA) to identify the specific patterns of the data and express them so that their similarities and differences can be seen. This method is useful as well to compress the data without losing the important information. The resulting BioVision Hierarchy (BVH) motion of this Kinect sensor is to simulate the wayang Golek Menak dance of sizes 149x54 and 151x54 dimension cartesius (*x, y, z*). Then these tensor cartesius data are converted into spherical frame of $h\theta, h\varphi, hr$. Reduction of matrix dimension is to ease the process in next stage. The results show a truly acceptable wayang golek performance.

Keywords: Feature, Reduction, Kinect, PCA

1. Introduction

Wayang Golek is an internationally acknowledged Indonesian culture inheritance reflecting social, politic, economic, religious, linguistic and human relation life aspects. Wayang Golek researched in this study is Wayang Golek Menak Yogyakarta. Motion capture of Wayang Golek Menak Yogyakarta dance used motion capture (mocap) method and Kinect as input device to detect motion. Kinect has higher performance than other device, namely, it is able to capture and trace motion or action of 3D objects (human and animal), non-intrusive and work with less lighting. However, system of Kinect motion capture (mocap) needs calibration of appropriate object capture space[1][2].

Biovision Hierarchy (BVH) data processing used Principal component Analysis (PCA) methods reducing of data matrix. Objective of PCA methods is to process computation into easier way to make further processing unmeet significant constraints. The method Principal Component Analysis (PCA) to reduce the dimension of the input image for face recognition and percentage of success of face recognition process in this study was 82.81%[3].

2. Literature Review

2.1 Motion Capture (mocap) Technique

Motion capture (mocap) is digital recording technique in motion of real objects such as human or animal that can be illustrated in animation computer character[4]. Procedure of motion capture is to extract motion of an object in real world in computer using a set of input devices, furthermore actor or performer does motion with a set of input devices with motion model where pattern has been determined according to story. Strengths of motion capture are that generated images are more complex with shorter production time and lower significant production process cost because time is minimized and process is more effective, generated motion is more natural and accurate, pursuant to natural motion of taken objects. Weaknesses of motion capture are that it needs specific hardware and software, price and application of input devices becoming constraints for small industries; and it needs accuracy in synchronizing character motion when taking motion. A motion capture of data is a representation of digital data from the motion capture technique actor or character. Digital data

obtained in the data format of motion or motion in the form of a position or orientation coordinates (points) position gestures at a certain time[4]. The data format mocap consists of the skeleton which is a representation of the movement of the character as a whole, bone as the basic entity of the skeleton that became the subject of transformation, Channel or Degree Of Freedom (DOF) as a parameter for transformation of bone (translation, rotation, orientation movement) and the frame as a collection of information channels / DOF for each bone in a pose[5].

2.2 Sensor Kinect

Sensor Kinect is a control technology in game introduced by Microsoft in November 2010. Kinect develops continuously for not only games but also robotic applications, virtual reality, health and various pattern identifications without requiring additional devices. Sensor Kinect was developed by software technology from Microsoft Game Studios and camera technology from Prime Sense. Camera technology of Kinect has performance to interpret body motion or gesture movement specifically without requiring control using hands-free, utilizing infrared projector, RGB camera and microchip to trace motion of objects in 3D format. Kinect has RGB camera and depth sensor facilities. Application of motion capture technique is to use results of Sensor Kinect capture generating motion data consistent with each motion of Wayang Golek Menak dancer in motion data formats such as Biovision Hierarchy (BVH). BVH is used as motion capture data format generated by Kinect, because it has support of compatible data format to be exported and imported in some 3D software applications[6]. BVH data format consists of two parts, information on hierarchical structure of bone and information on parameters of each channel.

2.3 Principal component Analysis (PCA)

Principal component Analysis (PCA) is a way to identify patterns of data and express them so that their similarities and differences can be seen. These patterns are useful to compress data, namely, to reduce size or dimension of data without losing many kinds of information[7].

PCA is statistic technique which can be used to explain structures of variances in a group of variables through some new variables where these new variables are mutually independent, and these are linear combinations of origin variables. Furthermore, the new variables are named PCA. Generally, the objective of PCA is to reduce dimension of data and to fulfill need of interpretation.

In each multiple-variant measurement (observation), principal component is linear combination of initial variables. Main objective of PCA is to reduce dimension of changes which are interrelated and have sufficient quantity of variables so that it is easier to interpret data[8].

Mathematically, PCA as orthogonal linear transforms data into new coordinate system so that biggest variance of any data projection will exist in first coordinate, the second biggest variance exists in second coordinate, and so on[9].

PCA is one way to identify patterns in the data and express it in a way that can be seen similarities and differences. This pattern is useful to compress data, which reduces the size or dimension of data without losing much of the information contained[7]. If it be defined a matrix A, with x an eigenvector and λ is the eigenvalue, then to get the eigenvector and eigenvalue can use any general equations of PCA :

$$Ax = \lambda x \quad (1)$$

$$(A - \lambda I)x = 0 \quad (2)$$

The principal components analysis would reduce the observational data into multiple sets of data so that information from all the data we can absorb optimally. Thus the principal component analysis can be viewed as the transformation of $X_1, X_2, \ldots X_p$. For example $X_1, X_2, \ldots X_p$ has a variance-covariance matrix $\Sigma = (\sigma^2 ij)$, $i = 1,2\ldots p$; $j = 1,2,\ldots p$ and the Σ has eigenvalues $\lambda_1 \geq \lambda_2 \geq \ldots \geq \lambda_p \geq 0$. The first Principal Component expressed by PC_1 contains the greatest amount of total variation of the data. PC_1 as linear combinations of the variables X_i. ; $i = 1,2 \ldots p$

$$PC_1 = a_{11}X_1 + a_{12}X_{12} + \cdots + a_{1p}X_p \quad (3)$$

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Where a_{1i} chosen, so as to maximize the ratio of variance PC_1 to the total variance, with a barrier that$\Sigma {a_{1i}}^2 = 1$. The principal component regression formation through principal component analysis, there are two ways.First, the establishment of the main components based on the covariance matrix. Secondly, the formation of the main components is based on the correlation matrix.

2.3.1. The Principal Component Analysis Based Formed Covariance Matrix

Through the data source to be searched X_{nxp} variance covariance matrix Σ where elements are :

$$S_{jk} = \frac{1}{n-1}\sum_{j=1}^{p}(X_{ij} - X_j)(X_{ik} - X_k) \quad (4)$$

Then from the variance covariance matrix of the sought eigenvalues λ_i with $i = 1,2, \ldots p$, obtained from the determinant equation form :

$$\left|S - \lambda_i I\right| = 0 \quad (5)$$

eigenvalues of the vector-eigenvectors calculated by an equation $S_{ei} = \lambda_i ei, i = 1,2, \ldots p$.

2.3.2. The Principal Component Analysis Based Formed Correlation Matrix

The main components of the i-th; W_i formed by variables that have been standardized$Z' = (Z_1, Z_2, \ldots, Z_p)$ with $cov(Z) = \rho$defined as follows:

$$W_i = e_{i1}Z_1 + e_{i2}Z_2 + \cdots + e_{ip}Z_p \qquad i = 1, 2, \ldots, p \quad (6)$$

2.4 Wayang Golek Menak Yogyakarta

Wayang Golek Menak show in Yogyakarta and surrounding reached glory in approximately 1950s, pioneered by Ki Widiprayitna[10]. Ki Widiprayitna was Dalang Wayang Golek and he was also known as wayang kulit maker. Wayang Golek show currently becomes media to present various moral messages, entertainments, advices, and announcements for people. Wayang Golek Menak has given economic, spiritual and social-political contributions to the people. As appreciation of Wayang Golek Menak story attraction, Sultan Hamengku Buwana IX as Yogyakarta Sultanate King immortalized story plots of Wayang Golek Menak in a set of drama art motions or ballets known as beksa golek Menak or golek Menak dance. Distinctive-typical characteristic of beksa golek Menak is lied in strength of dance motion including elements of self-defense, fingered hand palm, and firm dance motion. Ballet beksa Golek Menak a transformation of the story puppet show Menak into works of art and culture that has a value system of motion, meaning and philosophy are high. In terms of movement on the motion basically imitating the pupper Golek menak dance. Benchmark standard of Golek Menak dance referring to the Javanese dance style of Yogyakarta, which is modified with emphasis on the hull base motion, motion tolehan head, hands and feet[11]. Puppet Golek Menak dance is a form of transformation of the storyline puppet Golek Menak show. This dance is the creation Sultan Hamengku Buwono IX combining puppet Golek performances with classical Javanese dance which was then named Beksa Golek Menak[12]. Wayang Golek Menak motion of dance includes series of Sabetan (Tangkep Asta, Tancep, Jogetan Bapang Menak), Nyrimpet Maju, Ulap–ulap, Muryani Busana (Atrap jamang, Usap Rawis, Ngingset Udet), Lampah Sekar, Pencak Silat Gaya Minang and Peperangan[11].

3. Material & Method

3.1. Data

Motion capture (mocap) of Sensor Kinect are motion data of Biovision Hierarchy (BVH) of Wayang Golek Menak Yogyakarta dancers. Motion data of Biovision Hierarchy (BVH) generate data of motion tensor data cartesius (x, y, z) and then converted into sphere $(h\theta, h\varphi, hr)$.

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3.2. Method

This study observed and interviewed directly with experts of Wayang Golek Menak dancers for basic motions of the Wayang Golek Menak dance. The following is process of motion data processing of Wayang Golek Menak Yogyakarta dance:

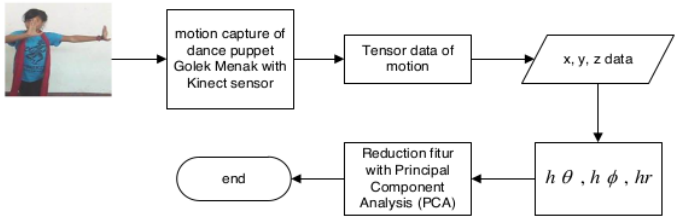

Figure 1. Flowchart of Research

4. Results and Discussion

The results of motion capture (mocap) of Sensor Kinect are motion data of Biovision Hierarchy (BVH) of Wayang Golek Menak Yogyakarta dancers.

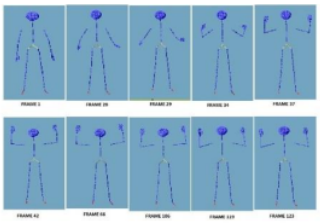

Figure 2. Frame of Body Motion Position

Wayang Golek Menak dance consists of 61 joint but just taken a major parts are 18 joint, time to capture dance ± 4 second, and count of frames between 140 – 180. The dance data consists of a skeleton name, nestdepth, parent, offset, Nchannel, order, Dxyz, Rxyz, and trans.

Table1. Tensor Data Motion X, Y, Z of Wayang Golek Menak Dance

Frame	1 HIPS X	2 HIPS Y	3 HIPS Z	4 LEFT HIP X	....	54 HEAD Z
Data *x, y, z*of Wayang Golek Menak Dance – Jogetan (149x54)						
1	-139,144	49,1302	-653,392	-132,824	.....	-655,168
2	-139,144	49,1302	-653,392	-132,824	.....	-655,168
3	-138,808	48,9704	-653,233	-132,524	.....	-654,472
4	-138,775	48,9436	-653,22	-132,496	.....	-654,41
.....up to 149 frames.....						
Data *x, y, z*of Wayang Golek Menak Dance – Sabetan (151x54)						
1	-132,285	67,4904	-688,208	-124,79	.....	-691,588
2	-132,332	67,3781	-688,121	-124,864	.....	-691,159
3	-132,332	67,3781	-688,121	-124,864	.....	-691,159
4	-132,339	67,3713	-688,113	-124,878	.....	-691,021

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.....up to 151 frames.....

Motion data of BVH generate data of motion tensor data cartesius (x, y, z) and then converted into sphere $(h\theta, h\varphi, hr)$.

$$\theta = tan^{-1}(y, x) \quad (7)$$

$$\varphi = tan^{-1}(z, \sqrt{x^2 + y^2} \quad (8)$$

$$r = \sqrt{x^2 + y^2 + z^2} \quad (9)$$

Table 2. Tensor Data Motion $h\theta, h\varphi, hr$of Wayang Golek Menak Dance

Frame	1 HIPSθ	2 HIPS φ	3 HIPS r	4 LEFT HIPθ	....	54 HEAD r
Data positions $hr, h\varphi, h\theta$of Wayang Golek Menak Dance – Jogetan (149x54)						
1	2,802168	-1,34868	669,8477	2,802168	.....	669,8477
2	2,802168	-1,34868	669,8477	2,802168	.....	669,8477
3	2,802433	-1,34917	669,6112	2,802433	.....	669,6112
4	2,80253	-1,34922	669,5897	2,80253	.....	669,6112
.....up to 149 frames.....						
Data positions $hr, h\varphi, h\theta$of Wayang Golek Menak Dance – Sabetan (151x54)						
1	2,669826	-1,35827	704,0486	2,669826	.....	704,0486
2	2,670643	-1,35825	703,9616	2,670643	.....	703,9616
3	2,670643	-1,35825	703,9616	2,670643	.....	703,9616
4	2,670707	-1,35825	703,9616	2,670707	.....	703,9546
.....up to 151 frames.....						

Tensor data shpere$(h\theta, h\varphi, hr)$of dance motion of Wayang Golek Menak have big matrix dimension so that tensor data of dance motion are reduced. Objective of this tensor data reduction is to make computation process become simple. Method used to reduce tensor data is PCA. The result gave eigenvalue, because main objective of PCA is to obtain eigenvalue.

Table 3. Dance Motion Tensor Data Reduction Method Results PCA

Frame	Jogetan	Sabetan
1	4,011922	1,187172
2	4,011922	1,136066
3	3,674163	1,136066
4	3,54979	1,12832
5	3,54979	1,132112
6	3,54979	1,132112
7	3,54979	1,132112
8	3,54979	1,132112
9	3,54979	1,138808
10	3,54979	1,138808
.....up to 149 data.....		
149	2,51913	2,297637

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Dimension matrix of tensor data motion after reduction used PCA method from matrix dimension 149x54 and 151x54 become 149x1 matrix dimension for each one of dance data.

5. Conclusion

a. Motion capture of Wayang Golek Menak Yogyakarta dance generates motion data withBiovision Hierarchy(BVH) format compatible to be imported and exported in some 3D software forms.
b. BVH motion data are motion position matrix with 149x54 and 151x54 dimension, furthermore the matrix is reduced by Principal component Analysis (PCA) into matrix with 149x1dimension for each one of dance data.
c. Reduction of matrix dimension is to ease process of computer-based computation in next stage.
d. The results of the PCA reduction feature can be used to process motion classification.

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