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Computer-Aided Design AND APPLICATIONS

Research on Dance Art Teaching System Based on Data Mining and Machine Learning

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Abstract. In order to improve the scientificity of dance teaching system and the teaching effect, this paper creatively combines machine learning and data mining technology to build a dance teaching system based on the data mining and machine learning, which identifies and adjusts the moves according to the features so that the system is suitable for distance and local identification. The dance teaching system built on data mining and machine learning technology improves based on the traditional teaching mode. The data mining mainly deals with dance teaching resources, and the machine learning is to identify and collect dance move features. With the help of the algorithm put in this paper, the dance teaching effect will be improved accordingly. Tests and studies testifies that the teaching effect in the paper is reliable. Later the teaching quality can be continually improved in the practice by applying the system in the paper.

Keywords: Data Mining,,machine learning, dance teaching, system construction
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1 INTRODUCTION

The dance teaching management information system is a very important advance in the teaching work of the university.This system is Used to complete the management and circulation of dance resources on campus, and to complete the information exchange inside and outside campus.In online teaching, education of different majors and disciplines is provided students with a personalized and research-oriented external environment, so that students' knowledge is more extensive, and the main purpose of establishing a teaching management information system is to cultivate talents with high level of professionalism[5].At the same time, this system gives the majority of teachers committed to folk dance teaching a better teaching environment, make teaching methods more flexible and diverse, and improves the quality of dance teaching in colleges and universities.In the ordinary theoretical and practical learning of the majority of colleges and universities, the professionalism of teachers directly affects the quality of students' learning. Whatever the teacher

teaches, the students learn what they have, and there is no right to freely choose courses[13].In many cases, teachers are very authoritative, and often what they say is the truth. Therefore, many students blindly follow teachers and do not have the ability to learn actively. This traditional teaching method is not conducive to student's creativity and imagination. This is contrary to the concept of quality education that has been advocated by the country. In comparison with each other, the use of computer networks and advanced multimedia technologies can provide students with rich content on the basis of web pages easily and quickly. The dance resources on the Internet are not spatial and practical. Students can use the Internet to repeat the study according to their own conditions.At the same time, the combination of ordinary text, image, sound and video in the multimedia classroom, if some interesting scenes are added, can increase the students' enthusiasm for learning dance, thereby improving their learning quality [1].

The traditional teaching concept emphasizes "teaching", but modern educational technology emphasizes "learning". It can be seen that these two educational technology theories have completely different focuses, which fundamentally reflect the roles, teaching status and performance of teachers and students. The essential changes that have taken place in the role and so on. With the rapid development of computer network, communication and multimedia technology, classroom teaching has slowly bid farewell to tradition and transitioned to modern network teaching. The application of network platform teaching has become more and more widely used. Therefore, if dance can also be introduced into network platform teaching , Can reasonably improve the resources of dance teaching, and will also solve the communication restrictions of traditional dance teaching methods, and achieve a wider range of communication.

The development of science and technology is changing with each passing day. Computer communication and network technology can be used in many places in our lives. Application platforms designed with computer network technology are emerging one after another. Many colleges and universities have used multimedia technology to assist teaching, so countless new types have been built Teaching mode. These new teaching models have been unanimously welcomed by teachers and students because of their intuitive images, thus highlighting the important position of their teaching. It can be seen that multimedia technology and information technology as a platform for education and teaching will inevitably become the direction of the future development of educational technology. Therefore, the most important thing is to construct an open interactive and efficient network teaching system. The dance department of the Xihua University Art College has purchased a large number of computing hardware and created a good campus network to support dance online teaching, thereby providing a good development space for dance online teaching.

This article combines data mining and machine learning technology to construct a dance teaching system, and improves the traditional teaching mode to improve the effect of college dance teaching.

2 RELATED WORK

The traditional teaching concept emphasizes "teaching", but modern educational technology emphasizes "learning". It can be seen that these two educational technology theories have completely different focuses, which fundamentally reflect the roles, teaching status and performance of teachers and students and the essential changes that have taken place in the role and so on [16]. With the rapid development of computer networks, communications and multimedia technologies, classroom teaching has slowly bid farewell to tradition and transitioned to modern online teaching. The application of online platform teaching has become more and more widely used. Therefore, if Tibetan folk dances can also be introduced to online platform teaching in the future, it can reasonably improve the resources of dance teaching, and will also solve the communication restrictions of traditional dance teaching methods, and achieve a wider range of communication [7].Literature [2] studies the elements of traditional dance, and there are many dance scores that focus on the

characteristics of ballet, ballroom dance and modern dance.No matter what kind of dance, as long as you can use the computer to find suitable, recognizable, and analyzable programming, you can use multimedia technology to study and record. Our country's national dance has these characteristics, so it can be seen that the Chinese Digitalization of ethnic dance is feasible [10]. In recent years, many scholars have begun to study the evolution, culture and history of national dances in their own countries, and many valuable treatises have appeared, which have promoted the inheritance and development of national dances [3]. In many developing countries, traditional culture is very distinctive. Their ethnic dances represent their own culture, tradition and identity. Some ethnic dances learn to stand from this perspective and study how to maintain the diversity of the country's traditional culture and the setbacks and surprises encountered in development in the process of social development in western developed countries, I hope it can provide references for certain departments [6].For all the research institutions and research areas of the national dance major, there are more studies on the two folk dances that cherish the traditional art of the nation and the folk dance that is in danger of being lost, and they began to pay attention to the historical evolution of the folk dance of this nation and the authenticity of its culture so as to achieve the purpose of teaching and educating people[9], how to innovate on folk dance, how to realize the industrialization of folk dance, at this stage, many experts have begun to pay attention to how to inherit and how to develop lop folk dance and promote the national dance, how to develop the national song and dance tourism market, how to rebuild the national dance culture [20].In response to more and more researches on ethnic folk dances, dance colleges and related research institutions and organizations in various regions have begun to pay attention to and research at the same time, and they have begun to obtain relevant materials related to ethnic folk dances (including books, tapes, music scores, audio and video [8]) for rescue collection. Such as,video materials of many folk dance activities of various ethnic groups, historical cultural relics recorded the ethnic folk dances, stage photos of outstanding programs performed by dance art groups, books and literatures about Chinese folk dances from Hong Kong, Macao and Taiwan [14], as well as related books and literature on outstanding foreign folk dances in many excellent magazines abroad. as well as related books and literature on outstanding foreign language folk dances in action abroad. In addition, costumes, musical instruments, cultural relics, pictures, copy books and dance rubbings about folk dances are collected and stored. It is the organization of folk dances with the richest data preserved at this stage in our country..In addition, there is the library of Guangdong Dance School, which also stores nearly 10,000 boxes of very precious audio and video materials of folk dances[11].

3 FEATURE EXTRACTION OF DANCE ACTION

The corner points are the points high enough in all directions in the neighborhood; they are the points with the curvature maximum value on the image edge curve. The basic concept of the algorithm is using a fixed window to slide in random directions and then comparing the degree of pixel gray scale change in the window before and after the window is slid.

In this paper, horizontal and vertical difference operators are used to filter on each pixel of the image, so as to obtain the gray of image and the auto-correlation matrix M describing the degree change of regional local gray in the image, the matrix M is shown below[15].

$$M = \sum_{(x,y)} \omega(x,y) \begin{pmatrix} I_X^2 & I_X I_Y \\ I_X I_Y & I_Y^2 \end{pmatrix} = \begin{pmatrix} \sum_W I_X^2 & \sum_W I_X I_Y \\ \sum_W I_X I_Y & \sum_W I_Y^2 \end{pmatrix} \tag{1}$$

The DOG method of SIFT is not applied, but the image gray approximation is obtained through Hessian matrix, which is called DOH. In this way, the time complexity is reduced, the running speed of SURF is one tenth of that of SIFT. The matrix Hessian is shown as below[12]:

$$H = \begin{pmatrix} L_{XX} & L_{XY} \\ L_{XY} & L_{YY} \end{pmatrix} \Rightarrow drtH = L_{XX}L_{YY} - 0.9L_{XY}^2 \tag{2}$$

The Gaussian Smoothing is firstly performed and then the second derivative is calculated, which will form a single template in combination with the discrete pixel template.The size of image in SURF algorithm stays unchanged, by the size of Gaussian fuzzy template. The process mentioned above is with significance in the simulation of rendezvous and docking.

How can we determine a point p is a feature point in FAST feature extraction. Firstly, we choose a pixel point, mark it as p, take it as the center of the circle with a radius of 3 pixels, and draw a circle(as the figure shown below.), determine the continuous several pixels on the circumference, and if the gray scale value of the continuous several pixels is greater than the gray scale of p , or the gray scale value of the continuous several pixels are less than the gray scale of P, then the P is the feature point. In this experiment, we set n=12, firstly we detect the gray value in point 1,9,5,13, in order to reduces the computational time. If the gray value of three or more of the above four points are greater than p , or all less than p, then p may be a feature point, then we can carry on the algorithm, otherwise the point is directly excluded. This approach reduces the computational time for most of the pixels[4].

Figure 1: FAST Feature Extraction.

Next, use the ID3 algorithm to train a decision tree, 16 pixels are input into the decision tree, and the machine learning method is used to screen out the best FAST feature points. Next, the non-maximum suppression algorithm is used to solve the problem of feature point adhesion. In the comparison process, the point with the larger response value is retained, and other feature points in the neighborhood are deleted.

The above is the FAST extraction method. The FAST algorithm is a very fast method of extracting feature points, but for the subject, it lacks feature point direction and scale invariance. So imitate the SIFT algorithm to establish the pyramid scale space. The original image is reduced to n-layer image according to the scale factor.

The direction of the feature point can be describe as the intersection angle between the line connected the feature point and the center of mass and the x-axis ; in which the center of mass is within the circle that takes the feature point as the center and r as the radius[19].

$$C = \left(\frac{m_{10}}{m_{00}}, \frac{m_{01}}{m_{00}} \right) \tag{3}$$

Where $m_{pq} = \sum_{x,y \in r} x^p y^p I(x,y)$,I(x,y) is the grayscale expression. Therefor the direction of the feature point can be defined as:

$$\theta = \arctan\left(\frac{m_{10}}{m_{00}} / \frac{m_{01}}{m_{00}} \right) = \arctan\left(m_{01} / m_{10} \right) \tag{4}$$

(2) The feature description of rBRIEF:is based on the description of BRIEF, and rBRIEF adds Rotation factors. Within a neighborhood of a feature point, we can select the several pairs of pixel points piqi(i=1,2,…,n), and compare the gray value of each pair of the pixel points. If $I(p_i) > I(q_i)$,then output shall be 1 in the binary string, otherwise it shall be 0; and the comparison results generate a n-bit binary string.Gaussian smoothing processing is also carried to increase the noise resistance of the characteristic descriptor. In the figure where the rotation angle is relatively small, then BRIEF matches works well. When the rotation angle increases above 30, the matching rate drops to 0. If the rotation in-variance problem is solved, the real-time requirements can be met.

The steered BRIEF algorithm solves the problem of rotational in-variance, the original BRIEF algorithm is based on the several sets of points in the SxS neighborhood (Normally, S=31)

$$D = \begin{pmatrix} x_1, x_2, ..., x_n \\ y_1, y_2, ..., y_n \end{pmatrix}$$

After rotating the O angle, a binary descriptor is formed on the new point pair. The use of descriptors here needs to be converted to images of response scales, because in the oFast algorithm pyramid, feature points are extracted from images of different scales[17].

The steeredBRIEF algorithm solves the problem of rotation invariance, but the correlation of the descriptor becomes worse, which is not conducive to matching. On the test set of feature points, first perform smoothing, consider the 31x31 neighborhood of each point, and compare the values with the gray average of the 5×5 neighborhood instead of the points. In each large neighborhood, small neighborhoods are used for comparison. There are many ways to use them. Statistical methods are used to obtain 256 types with the least correlation.

As the ORB feature detection results are shown in FIG. 2, most of the feature points of the elevator plane can be detected, and it is not easy to detect the features caused by the texture, etc.

Figure 2: ORB Feature Detection Results.

The data extracted by SURF needs to be stored in the database; in the meantime it can be considered as input data for the neural network, so the diagonal data needs to be clustered. k-means clustering is used to cluster the corner point of each image in each training sets, and the results can be considered as the original data.

Figure 3: SURF Feature Detection Results.

The hough transformation of opencv is conducted to carry out the detection, the external profile and docking rod can be detected. They are classified by the slope and the average is calculated as the starting point of the docking rod.

In the European coordinate system, a straight line L can be represented as[20]:

$$y = mx + b \tag{5}$$

The straight line L is represented in polar coordinates as:

$$r = x\ cos(\theta)\ + y\ cos(\theta) \tag{6}$$

Under the European coordinate system, r is the distance from origin to line L, and 0 is the clip angle between line L and x axis, as shown in Figure 4.

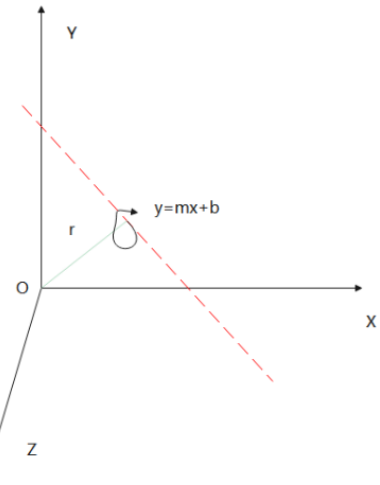

Figure 4: The Representation of the Straight Line L in Polar Coordinates.

In a r,θ two-dimensional space, the Hough transformation of a line on an arbitrary x,y plane is a point in the r,θ space, and a point on any x,y plane corresponds to a sinusoidal curve of the r,θ space. Each edge point on the line determined by the parameters ro andθ0shares a parameter of a line, and the corresponding sinusoidal curve in the r,θ space must correspond to the point (r0,θ0).

For a line represented as:

$$y\ = \alpha_1 x\ + \alpha_2 \tag{7}$$

Traditional Hough transformations convert a point (x1,y1) on a line to a line $\alpha_2 = y_1 - \alpha_1 x_1$ on the parameter space (a1,a2). However, if two points (x1,y1) and (x2,y2)are selected, you can use the following equations to map them to a point(a1,a2)1 on the parameter space (a1,a2).

$$\begin{cases} y_1\ = \alpha_1 x_1\ + \alpha_2 \\ y_2\ = \alpha_1 x_2\ + \alpha_2 \end{cases} \tag{8}$$

The basic idea of the probabilistic Hough transformation stems from this key point. First, put all the highlights in the binary image into the pixel dataset D. For each step of the process, two points

$d_1 = (x_1, y_1)$ are randomly selected in the data set D, and d1≠ d2, . In the process of selection, all points in the data set D have the same probability of being selected as d. Similarly, all points in D −{d1} have the same probability of being selected as d2. Afterwards, we use formula (8) to solve the parameter point $p_i = [a_i(i), a_2(i)]$ and save that point in the parameter space data set P. After making some selection of the points, it is not difficult to find that if the image space has a line with (a1,a2) as its parameters, then pi points shall have already been accumulated at the point (a1,a2). Finally, by finding the accumulated points in those data set P, all the lines contained in the image space can be detected.

In practice, the search for accumulation points can be realized in the following ways. Assume that each element in the parameter data set P consists of a parameter pair or parameter vector and a score. When taking out the point pi, we search and check whether there is an element in P that has the same parameter pair as pi. Finally, an element with a score greater than the threshold nt will be considered as a cell with a count.

At the same time, some methods that can improve performance can be added to these basic processes:

- The elements in P can be sorted by their a1 and a2 values, which can reduce the search time.
- Given a limit value δ, if the distance between the parameter vector of an element in P and pi is less than δ, then this element is considered the same as pi, and its score is increased by one.
- The detection and counting cells may be one by one. As long as there is an element p, and its score is greater than the threshold nt, all points di located on the straight line denoted as p are taken out from D, and the set P is made empty.

The general steps of probabilistic Hough transform are: first randomly extract a feature point from the image, that is, an edge point. If it is calibrated as a point on a certain straight line, it will be randomly selected from the set of edge points after subtracting this point. After that, the uncalibrated points found are subjected to Hough transform and cumulative sum calculation, and then the point with the largest score is selected. If the point is less than the minimum voting value, the random extraction of feature points is continued; otherwise, according to the maximum value obtained by the Hough transform, Starting from this point, move along the direction of the straight line to find the two end points of the straight line. Finally, the length of the straight line is calculated, and if it is greater than a certain threshold, it is regarded as the target straight line output. So until all the edge points are extracted.

Probabilistic Hough Transform is a random method in mathematics, it still retains some characteristics of traditional Hough Transform.

When the probabilistic Hough transformation is carried out, and the spacecraft docking plane had never occupied the entire image in the stage of target detection and tracking. It is easy to find out that the length of the line in the video is not that long, so the minimum voting value is 30, the minimum line length is 30, and the extracted linear features are shown in figure 5 a). After the docking plane begins to occupy the entire image, the desired extracted straight feature which is the straight length of the straight feature at the docking bar become larger, when the minimum voting value is 80, the minimum line length is 60, and the extracted line features are shown in figure. 5 b).

(a) Long-distance straight line feature

(b) Short-distance straight line feature

Figure 5: The Schematic Diagram of Linear Features.

Just as what is shown in the figure above,the linear features extracted by applying the transformation of probabilistic Hough can basically fully express the main structure of the target spacecraft, but many other non-characteristic linear interference still exists.

4 DANCING TEACHING SYSTEM BASED ON DATA MINING AND MACHINE LEARNING

The dance learners have to use the mobile device to view and search the resources, and the resources on the mobile device come from the server. In order to realize the interchangeability, JSON is needed to store the information. To improve the performance of the platform and maintainability, MVC framework technology is applied in the development process. The framework is shown in the Picture 6.

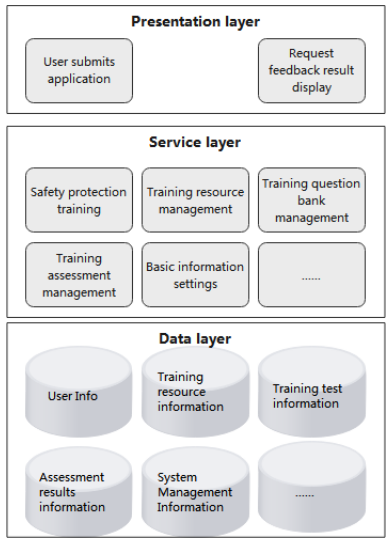

Figure 6: Dance Teaching System.

The mobile device is to provide convenience in learning dance for learners. For the resources supporting online learning, learners can ask questions at the same time, the function is shown in Picture 7.

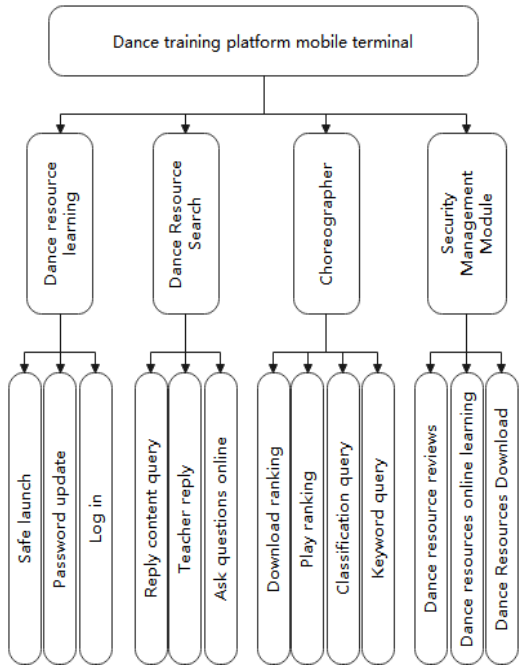

Figure 7: Framework of Mobile Device.

The data flowchart tells how to deal with the users according to the type. If the user is new, the profile will be stored in the register list after registration, then the user can enter different modules based on his own need. The administrator can login and manage the data. The data process is shown in the following picture.

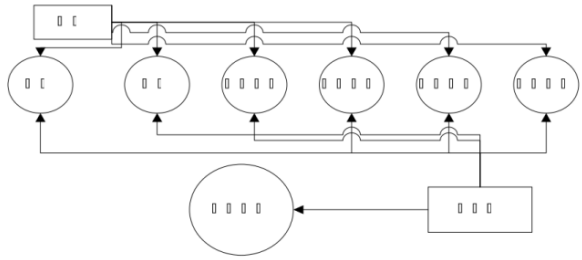

Figure 8: Data Flowchart of the System.

For construction of digital management platform in dance colleges and universities, the core is to solve the vast types of digital resources of dance colleges and universities and different classification standards. After understanding the classification of teaching resources by the Ministry of Education, the paper divides the digital resources in dance colleges and universities into 9 types according to the file type. The main three resource types are text, media and file. The specific classifications are shown in Picture 9:

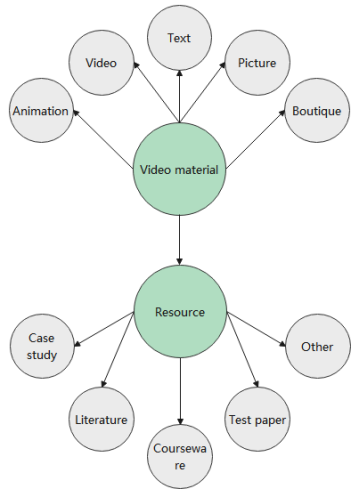

Figure 9: Classification of Resources.

From above mentioned dance teaching system based on the data mining and machine learning, the data mining mainly deals with the dance teaching resources, and the machine learning is to identify and collect the dance move features. The algorithm put in the paper helps improve the dance teaching effect. Two tests are designed in the paper to testify the performance of the system and respectively test the dance resource mining and dance move features. The results are shown in table 1 and table 2 respectively.

Number	Dance mining	Number	Dance mining	Number	Dance mining
1	92.25	25	93.19	49	92.20
2	89.70	26	90.91	50	89.00
3	90.52	27	91.70	51	95.85
4	90.74	28	88.44	52	95.60
5	96.33	29	92.53	53	95.63
6	96.85	30	88.89	54	97.00
7	90.15	31	95.77	55	93.62
8	89.87	32	93.51	56	92.42
9	90.60	33	94.50	57	89.82
10	93.26	34	90.11	58	90.83
11	88.64	35	88.02	59	88.51
12	92.82	36	93.35	60	94.32
13	94.06	37	92.12	61	96.01
14	96.51	38	88.37	62	95.46
15	91.61	39	94.41	63	88.96
16	92.03	40	95.19	64	96.33
17	93.07	41	91.83	65	95.82
18	89.59	42	91.43	66	95.24
19	89.40	43	96.64	67	95.99
20	91.54	44	95.12	68	94.95
21	92.28	45	96.67	69	96.41
22	92.18	46	93.28	70	89.64
23	96.24	47	88.59	71	94.91
24	90.36	48	90.42	72	96.24

Table 1: Dance Teaching Resource Mining Effect.

Number	Action recognition	Number	Action recognition	Number	Action recognition
1	78.47	25	83.30	49	80.33
2	90.37	26	79.02	50	91.57
3	82.51	27	85.35	51	79.40
4	90.76	28	83.48	52	89.96
5	78.41	29	88.86	53	79.90
6	80.96	30	83.87	54	87.92
7	82.79	31	84.17	55	90.12
8	87.90	32	83.81	56	80.08
9	86.71	33	80.10	57	88.16
10	85.19	34	88.38	58	78.78

11	*91.01*	*35*	*83.25*	*59*	*88.69*
12	*82.67*	*36*	*82.79*	*60*	*80.76*
13	*81.95*	*37*	*91.19*	*61*	*84.45*
14	*89.53*	*38*	*86.39*	*62*	*82.99*
15	*78.39*	*39*	*83.06*	*63*	*80.04*
16	*78.29*	*40*	*89.94*	*64*	*79.83*
17	*78.30*	*41*	*84.62*	*65*	*89.04*
18	*79.24*	*42*	*90.83*	*66*	*87.08*
19	*79.88*	*43*	*81.98*	*67*	*80.62*
20	*81.35*	*44*	*78.75*	*68*	*79.94*
21	*79.07*	*45*	*90.69*	*69*	*81.62*
22	*79.70*	*46*	*81.75*	*70*	*81.25*
23	*78.19*	*47*	*86.49*	*71*	*90.34*
24	*81.41*	*48*	*83.05*	*72*	*82.83*

Table 2: Dance Move Feature Identification Effect.

Above tests suggest that the dance teaching system built in the paper based on the data mining and machine learning has better teaching effects. Practice teaching can continually testify the system in the paper later on.

5 CONCLUSION

Information technology has been widely used in all fields and the principle is high efficiency but low cost. At present each field tries to change the current mode through information technology, and the dance industry is included. Currently the training in the dance field is the mode of on-field teaching and learning. Thus the learners can not arrange their time to learn, and there is no inactive platform between the instructor and the learner, which is not good for dance improvement. Based on above reasons, dance train platform becomes a trend in the future. The paper combines machine learning and data mining technology to build a dance teaching system based on the data mining and machine learning, which identifies and adjusts the moves according to the features so that the system is suitable for distance and local identification. The dance teaching system built on data mining and machine learning technology improves based on the traditional teaching mode. The data mining mainly deals with dance teaching resources, and the machine learning is to identify and collect dance move features. With the help of the algorithm put in this paper, the dance teaching effect will be improved accordingly. Tests and studies testifies the reliability of teaching effect put in the paper.

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REFERENCES

[1] Aizad, H.; Chen, Z.; Kassim, S.: Physical Dance Teaching Based On Virtual Environment, Malaysian Sports Journal, 1(1), 2019, 01-03. https://doi.org/10.26480/msj.01.2019.01.03

[2] Ancillao, A.; Savastano, B.; Galli, M.: et al. Three dimensional motion capture applied to violin playing, A study on feasibility and characterization of the motor strategy, Computer Methods & Programs in Biomedicine, 149(2), 2017, 19-27 https://doi.org/10.1016/j.cmpb.2017.07.005
[3] Fátima Sá.; António Marques.; Rocha, N. B. F.: et al. Kinematic parameters of throwing performance in patients with schizophrenia using a markerless motion capture system, Somatosensory Research, 2015, 32(2), 2015, 77-86. https://doi.org/10.3109/08990220.2014.969838
[4] Giannetti, R.; Petrella, A.; Bach, J.: et al. In vivo Bone Position Measurement Using High-Frequency Ultrasound Validated with 3-D Optical Motion Capture Systems: A Feasibility Study, Journal of Medical & Biological Engineering, 37(7), 2017, 1-8. https://doi.org/10.1007/s40846-017-0273-x
[5] Granados, D. F. P.; Yamamoto, B. A.; Kamide, H.:et al. Dance teaching by a robot, Combining cognitive and physical human–robot interaction for supporting the skill learning process, IEEE Robotics and Automation Letters, 2(3), 2017, 1452-1459. https://doi.org/10.1109/LRA.2017.2671428
[6] Juan Pablo ngel-López.; Nelson Arzola de la Peña.: Kinematic Hand Analysis Using Motion Capture Technology, IFMBE proceedings, 49(6), 2015, 257-260.https://doi.org/10.1007/978-3-319-13117-7_67
[7] Katelyn Cahill-Rowley.; Jessica Rose.: Temporal-spatial reach parameters derived from inertial sensors: comparison to 3D marker-based motion capture, Journal of Biomechanics, 52(1), 2017, 11-16.DOI: https://doi.org/10.1016/j.jbiomech.2016.10.031
[8] Khan, M. A.: Multiresolution coding of motion capture data for real-time multimedia applications, Multimedia Tools & Applications, 76(15), 2016, 1-16. https://doi.org/10.1007/s11042-016-3944-7
[9] Kim, M. K.; Kim, T. Y.; Lyou, J.: Performance Improvement of an AHRS for Motion Capture, Journal of Institute of Control, 21(12), 2015, 1167-1172. https://doi.org/10.5302/J.ICROS.2015.15.0116
[10] Komisar, V.; Novak, A. C.; Haycock, B.: A novel method for synchronizing motion capture with other data sources for millisecond-level precision, Gait & Posture, 51(3), 2016, 125-131https://doi.org/10.1016/j.gaitpost.2016.10.002
[11] Lee, Y.; Yoo, H.: Low-Cost 3D Motion Capture System Using Passive Optical Markers and Monocular Vision, Optik International Journal for Light & Electron Optics, 130(2), 2016, 1397-1407. https://doi.org/10.1016/j.ijleo.2016.11.174
[12] Park, S. W.; Park, H. S.; Kim, J. H.: et al. 3D displacement measurement model for health monitoring of structures using a motion capture system, Measurement, 59(5), 2015, 352–362. https://doi.org/10.1016/j.measurement.2014.09.063
[13] Portnova, T. V.: The formation of research skills of the master's degree students of choreographic art field of study within the framework of the study of philosophy of dance program, Journal for Educators, Teachers and Trainers, 12(1), 2021, 61-66. https://doi.org/10.47750/jett.2021.12.01.009
[14] Puupponen, A.; Wainio, T.; Burger, B.: et al. Head movements in Finnish Sign Language on the basis of Motion Capture data: A study of the form and function of nods, nodding, head thrusts, and head pulls, Sign Language & Linguistics, 18(1), 2015, 41-89. https://doi.org/10.1075/sll.18.1.02puu
[15] Rahman, M. M .: Analysis of Finger Movements of a Pianist Using Magnetic Motion Capture System with Six Dimensional Position Sensors, Transactions of the Virtual Reality Society of Japan, 15(3), 2017, 243-250.
[16] Srinin, W.; Lamnaokrut, T.; Retnowati, T.H.: An Introduction of Developing Technology of Basic Thai Classical Dance based on Android Smartphones, Solid State Technology, 2020, 63(1), 2020, 1180-1194.

[17] Wang, C. S.; Wang, L. H.; Kuo, L. C .: et al. Comparison of breast motion at different levels of support during physical activity, Journal of Human Sport and Exercise, 12(4), 2017, 1256-1264. https://doi.org/10.14198/jhse.2017.124.12

[18] Yang, Y.; Zhan, Y.; Wang, X.: A two-phase low-level motion data segmentation method based on relative position, Jiangsu Daxue Xuebao (Ziran Kexue Ban) / Journal of Jiangsu University Natural Science Edition, 38(2), 2017, 186-191.

[19] Zhang, H., Wang, L.; Chu, S.: et al. Application of Optical Motion Capture Technology in Power Safety Entitative Simulation Training System, Optics & Photonics Journal, 06(8), 2016, 155-163 https://doi.org/10.4236/opj.2016.68B026

[20] Zhao, H.; Liu, Z.; Yao, X.; Yang, Q.: A machine learning-based sentiment analysis of online product reviews with a novel term weighting and feature selection approach, Information Processing & Management, 58(5), 2021, 102656. https://doi.org/10.1016/j.ipm.2021.102656