Flexibility Optimization Analysis of Dance Movements in Body Aesthetics

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Abstract: As a relatively long history of art, dance can give the audience better art experience. It is very necessary to study the dance moves because it is very intuitive and cordial. This paper has done the optimization analysis on dance movements’ flexibility in dance training through the mathematical geometric principles, and has completed the optimization analysis on dance movements’ flexibility in dance training. The method this paper has used is relatively rare in domestic about the optimization problems in dance training. Such methods are equally applicable in the optimization analysis of the other movements about limb aesthetics, and provide some reference for such movements optimization studies.

1. Introduction

In 21st century, people began to chase the construction of spiritual civilization as well as the pursuit of art. With the improvement of people's spiritual realm, whose requirements on the reflects of aesthetic aspects of dance is also gradually improved. This paper optimizes dance moves’s flexibility in dance training from a limb aesthetics perspective, in order to improve the flexible beauty in dance performances process. Firstly, the term of the limb aesthetics are explained in this paper, and do some simple discussion on the current status and development trend of current limb aesthetics. Then began to optimize the analysis of dance moves’s flexibility in dance training using mathematical geometric principles, after complete this optimization we began to integrate the limb aesthetics of dance moves in dance training to complete the core reserch of this paper. The study of this peper in the domestic dance realm is relatively less, and the method is relatively unique. The method which the same paper used is equally applicable to other optimization studies of limb aesthetics, it is able to provide reference for similar studies.

2. Limb aesthetics

2.1 The brief introduction of limb aesthetics

It was first proposed in the thesis “Lin Hwai-min's context and Oriental limb aesthetics” about limb aesthetics, it is mainly about interpreting the dance moves into a kind of distinctive movement language. It is understood from an aesthetic perspective. In this article we research the scope of body movements’beauty and ugliness as well as the aesthetic consciousness of people to dance ,from the dance aesthetic point, as dance moves is the main object of study (Figure 1). It studies the essence and significance of limb beauty. It makes the dance itself has the elaboration of aesthetic aspects, mainly by the dance moves themselves and the compeletion of these moves. It has gradually attracted people's attention on the interpretation of limb aesthetics in dance moves. People began to optimize the dance moves based on the aesthetics, in order to perfectly elaborate the ideas which expressed by the body language of dance moves.
2.2 The status and development of limb aesthetics

It has been extended to a certain extent about the range of the limb aesthetics study today, as well as the theoretical level has been improved to some extent, as Figure 2. The current research achievement on limb aesthetics has studied it from different perspectives. It reveals the beauty of body language as a discipline, so that people can understand, appreciate and create the beauty of body language. It directs against the secular utilitarian of society today, improves the aesthetic level of people. It reflects the ultimate concern and pursuit of people to body language. Likewise, it also allows people to transcend the mundane mediocrity, then “look at the body language from an aesthetic perspective,”. It is great quantity and mostly diverse that the methods of body aesthetics research. We can learn from the research methods related to other disciplines to study limb aesthetics. Finally complete the perfect embodiment of the limb aesthetics in the limb training of domestic dance moves.

3. The optimization analysis of dance moves’ flexibility

The paper analyzes the geometric relationship of spinal joints in dance training through studying the spinal joints and vertebrae joints of human, we get a linear relationship between the flexible neck column’s bending angle $\theta$ of human spinal joints and the mobile angle $\alpha$ of cervical vertebrae:

$$\theta = 2n\alpha$$

In which, the flexible neck column’s bending radius $R$ is changed with the cervical vertebrae mobile angle $\alpha$ in the dance movement.

At the same time, dispose the cervical vertebrae’s sliding radius is $r$, thereby obtain the formula of the flexible neck column’s bending radius $R$ as following:

$$R = [r - (r - W) \cos \alpha] / \sin \alpha$$

$$L_\alpha = 2n[r - (r - W) \cos \alpha]$$

(2)
In which, \( W \) is the distance between the cervical vertebrae; \( La \) stand for the length of the flexible vertebrae.

According to the above formulas, it can be seen approximately that the length and bending radius of the flexible neck column is changed with the the cervical vertebrae’s mobile angle in dance training.

Then, this paper adopts the base coordinate of the end point of human single cervical vertebrae to analyze the flexibility of dance training movements, we can obtain the following formula:

\[
\begin{align*}
x_p &= R(1 - \cos 2\alpha) \cos \beta \\
y_p &= R(1 - \cos 2\alpha) \cos \beta \\
z_p &= R \sin 2\alpha
\end{align*}
\]

Then combining the above formulas, and calculating the coordinate when the movement angle of the cervical vertebrae is 0. At the time we can obtain the mathematical model of dance training movements at the end point of neck column:

\[
\begin{cases}
x = \frac{r - (r - W) \cos \alpha}{\sin \alpha} (1 - \cos 2\alpha) \cos \beta & (\alpha \neq 0) \\
y = \frac{r - (r - W) \cos \alpha}{\sin \alpha} (1 - \cos 2\alpha) \cos \beta & (\alpha \neq 0) \\
z = \frac{r - (r - W) \cos \alpha}{\sin \alpha} \sin 2\alpha & (\alpha \neq 0)
\end{cases}
\]

\[
\begin{cases}
x = 0 & \alpha = 0 \\
y = 0 & \alpha = 0 \\
z = 2W & \alpha = 0
\end{cases}
\]

The coordinates of the end vertebrae of the flexible neck column in dance training, which move from the origin \( O \) to the end point \( P (P_x, P_y, P_z) \) of the cervical vertebrae, and then rotate angle \( \alpha \) around the line \( e \). Its unit vector as follows:

\[
e = \{e_x, e_y, e_z\} = \{-\sin \beta, \cos \beta, 0\}
\]

In accordance with the general rotation transformation formula, its homogeneous transformation is obtained as follows:

\[
T = \begin{bmatrix}
  n_x & o_x & \alpha_x & p_x \\
  n_y & o_y & \alpha_y & p_y \\
  n_z & o_z & \alpha_z & p_z \\
  0 & 0 & 0 & 1
\end{bmatrix}
\]

So the gesture of the coordinates of the end of flexible neck column of the action in the dance training with the unit vector in the following:

\[
\begin{align*}
n_x &= s\beta \text{Vers}\alpha + c\alpha & o_x &= -s\beta c\alpha \text{Vers}\alpha & a_x &= c\beta s\alpha \\
n_y &= -s\beta c\beta \text{Vers}\alpha & o_y &= c\beta \text{Vers}\alpha + c\alpha & a_y &= s\beta s\alpha \\
n_z &= -s\alpha c\beta & o_z &= -s\beta s\alpha & a_z &= c\alpha
\end{align*}
\]

In which, \( \text{sina, cosa} \) for cos\( \alpha \), and \( \text{Vers}\theta = 1 - \cos \theta \),
\[ p_x = \frac{r - (r - W) \cos \alpha}{\sin \alpha} (1 - \cos 2\alpha) \cos \beta \]
\[ p_y = \frac{r - (r - W) \cos \alpha}{\sin \alpha} (1 - \cos 2\alpha) \cos \beta \]
\[ p_z = \frac{r - (r - W) \cos \alpha}{\sin \alpha} \sin 2\alpha - 2W \]  
(9)

As human’s neck column is consist of n sections cervical vertebraes, and each section of the cervical vertebraes has the above movement of a single cervical vertebrae when performing dance training, so you can get the transformation matrix \( T_i \) reasoned by each section cervical bone, as follows:

\[ T_i = T_1 T_2 \ldots T_i \]  
(10)

The transformation matrix \( T \) of the n sections which the whole neck column have is shown below:

\[ T = T_1 T_2 \ldots T_{n-1} T_n \]  
(11)

From the above formulas, according to the geometric principle on flexible movement of human’s neck column, training the flexibility of dance moves. Drawing up a reasonable flexibility training plan according to the actual situation of each dancer, to complete the optimization of dance moves’ flexibility during the process of dance training.

4. The optimization of movement flexibility based on limb aesthetic

4.1 Limb aesthetic drives the optimization of dance moves’ flexibility.

As the dance itself belongs to a class of body language, in order to combine the limb aesthetic with the moves’ flexibility, we usually optimize the dance moves’ flexibility for a certain extent as well as the body dancing speed of dancer must reach a certain level, and only so can we do better that dance moves have perfect manifestation in limb aesthetics.

Firstly, determine the relationship between the bending speed and moving speed of the human cervical vertebraes during the process of dance movement, as follows:

\[ \theta = 2n\omega \]  
(12)

Then through the above formulas, we can derivethe relationship between the pulling speed \( V_{cd} \) and the twisting speed \( \omega_a \) of body as follows:

\[ \begin{cases} V_{cd1,2} = \mp 2nH\omega_a \cos \alpha \cos \beta \\ V_{cd3,4} = \mp \mu 2nH\omega_a \cos \alpha \cos \beta \end{cases} \]  
(13)

During the process of actual dance training, the pulling speed of the human body depends on its physical fitness parameters \( n \). Accordance with the above; we can get the following formula:

\[ V_{cd} = \frac{\pi Dinz}{60} \]  
(14)

Then through the above formulas establish the equation, we can obtain the relationship between physical quality parameters \( n \) and the down bending speed \( \theta \) and the down bending azimuth speed \( \beta \) of human flexible cervical vertebraes as follows:
\[
\begin{align*}
\phi + \theta \pi &= 60H\cos \beta \theta \cos \left( \frac{\theta}{2m} + \varphi_{0\theta} \right) \\
\beta &= 60H\sin \beta \theta \cos \left( \frac{\theta}{2m} + \varphi_{0\beta} \right)
\end{align*}
\]
\[(15)\]
\[
\begin{align*}
\phi + \beta \pi &= \frac{120mH\cos \alpha}{\pi D_i} \beta \sin (\beta_i + \varphi_{0\beta}) \\
\beta &= \frac{120mH\sin \alpha}{\pi D_i} \beta \sin (\beta_i + \varphi_{0\beta})
\end{align*}
\]
\[(16)\]

In the above formulas, \(n_{x\theta}, n_{y\theta}, n_{x\beta}, n_{y\beta}\) respectively stand for the torsion speed of body in the two coordinate directions, \(\varphi_{0\theta}\) and \(\varphi_{0\beta}\) represents the beginning bending angle and azimuth of the flexible cervical vertebrae of human body dance moves.

According to the above formulas, it can be seen that the dancer can more perfectly complete dance moves in the process of dancing by using the above bending speed, the angle of bending and bending azimuth.

4.2 Discussion and Suggestion.

Dance moves are not only as the above onto in dance training process, should also join the dancers emotions to dance in dance performances processes. Only join individual emotion to dance into dance moves can it provide a better interpretation on dancing beauty to the audience when dance performs in the late stage. Second, it should be noted that the lessons of other domestic and foreign various styles of dance movements when we integrate limb aesthetics into dance training. After perfectly absorb the essence of a variety of dance then blooming in dancers’ individual performances which can give the audience some of the unique interpretation of dancing beauty and make the dance itself no longer monotonous. Finally it should also strengthen the exercise of the basic skills of the variety of dance when in dance movements’ flexibility training. Only when it has been trained properly, can we complete the interpretations of the other actions out of the dance moves. At the last of this paper, three points are given, combining with the above optimization analysis on movements’ flexibility, we can make a more detailed interpretation of the optimization problems of movements’ flexibility in the current dance training to a certain extent. And provide certain technical reference for the dance moves perfect embodiment of limb aesthetic in the current dance training.

5. Conclusion

With the improvement of the quality of life, people start to pursue after some artistic beauty of spiritual level. It is particularly hot to manifest body language in the aesthetics. As an art form of body language, we focus on this form of limb aestheticst, and dance is still rare both at home and abroad. Some standardized regulations of dance moves are investigated in the current dance training, which is demanded in the world of dance very urgently. This paper researches on the real problem that dance moves’ flexibility in dance training through the mathematical geometric principles. We hope this research will make the dance moves in dance training more in line with the current limb aesthetics, and perfect the blank of this field in domestic. Meanwhile, we hope that this research method can provide some reference for the other domestic aesthetic research on body language, and make some contribution to the development of the domestic arts.

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