Chapter 5
The Positive Exertion of "Fuzzy Control" in Art Appreciation Class

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Abstract In order to improve the teaching effect of art appreciation class and promote the development of students' creative thinking, based on ASIFT (Affine Scale-Invariant Feature Transform) algorithm, this paper uses Nelder-Mead method as an optimization tool, introduces fuzzy control according to the characteristics of ASIFT sampling space to realize the self-adaptive adjustment of simplex parameters, and makes the sampling points converge towards the optimal matching direction. Moreover, this paper puts forward that in the process of art appreciation, it is necessary to combine fuzzy control method for image intelligent control, and resample the image by setting discrete sampling points to simulate the deformation caused by visual angle transformation. In addition, this paper gives a teaching model of art appreciation class combined with fuzzy control, demonstrates the display effect of fuzzy control art works through cases, and evaluates the teaching effect of this method combined with teaching evaluation. From the evaluation results, it can be seen that the fuzzy control method proposed in this paper can play an important role in art appreciation class.

5.1 Introduction

Art is a kind of spiritual product created by human beings, which is different from music of auditory art and literature of language art. It is a kind of space art with modeling, visibility, static, and materiality. Because of the above basic characteristics, art works should first be a spatial form that can be perceived by people, which can arouse people's visual perception; Secondly, it shows people a relatively ideal objective world in a static state through its material media, and then triggers people to create specific emotions for the second time.

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In terms of art appreciation teaching, art is a comprehensive art that combines emotional, formative, visual, static, and material characteristics. These characteristics make its teaching methods correspondingly diverse and flexible. The ways and methods of appreciating art works of different schools and styles also vary. When students first come into contact with a piece of art, their appreciation experience exists in a scattered, free, and uncertain form, a completely subjective appreciation and imagination of the individual. The appreciation process will go through three stages, from "initial perception" to "emotional experience" and finally to "understanding improvement" [1]. Teachers should give students enough tolerance in this process, allowing them to self improve their understanding of themselves and emphasize the psychological process of the subject's emotional experience [2]. Fuzzy teaching method can fully leverage its uncertain advantages and stimulate students' subjective initiative. Fuzzy teaching breaks away from the traditional thinking pattern of "either this or that" binary logic in teaching, and is more conducive to cultivating students' creative thinking [3].

From a psychological perspective, there is a type of thinking that lacks rigorous logical reasoning in its judgments. Instead, the brain constantly experiences conceptual leaps and intersections of light and dark, demonstrating the situation of the problem in an unconscious process [4]. Therefore, psychologists refer to it as fuzzy thinking. Due to the different life experiences of students, it is impossible to have identical experiences with the same artwork. If the teacher only gives one appreciation result, students will not be able to stimulate emotional resonance with the work [5].

Art works, as a bridge between painters and viewers, have an indirect nature. Information can only be obtained visually, and this information is inevitably indirect. The painter's inner emotional world is expressed through external images, and external images only appear meaningful when expressing a person's inner emotions [6]. Therefore, art works serve to express the emotional world of painters. Art mainly appeals to emotions, and the stimulation of emotions inevitably carries a strong personal color. The blurriness of emotions displayed on the screen may attract the viewer in a broader field, causing them to experience the beauty of blurriness and melting their own experience into the blurriness of the work [7].

The application of fuzzy teaching method in art appreciation teaching is determined by the characteristics of art and the existence of students' fuzzy thinking ability. Art appreciation is an aesthetic activity that takes art works as objects and experiences and comprehends the true essence of art through observation and other auxiliary means, thereby obtaining spiritual pleasure. Appreciation teaching holds a significant proportion and holds a significant position in art classes. It not only enriches students' associative and aesthetic abilities, but also enhances their emotional experience and intuition abilities, thereby cultivating students' interest in art, expanding their artistic horizons, and enriching the emotional world [8].

Relatively speaking, students lack rich life experience, lack rigorous logical thinking, and exhibit active and jumping characteristics. However, their ability to think vaguely is quite strong. Their unique and profound perception and understanding of art works can sometimes be surprising. Therefore, in art appreciation

classes, teachers should not accurately explain and depict the "unique" context of the picture, but should broaden the space for art thinking, so that students can have multiple ways of understanding the language, emotional, and meaning levels [9].

Cloud class is a platform for teacher-student communication and learning based on the development of digital technology. Teachers and students can communicate and learn in cloud class, and even complete classroom teaching. Through cloud based classes, teachers can create classes and courses, push teaching materials such as courseware, videos, images, and text to students, and students can also respond in cloud based classes. The launch of this modern interactive teaching platform has brought more possibilities for art teaching. In the process of practice and exploration in the use of cloud classes, teachers have changed the teaching state, no longer instilling knowledge into students, but teaching students how to use modern technology to obtain real and effective information, how to improve the interaction of learning in the process of learning, and how to conduct active inquiry learning methods [10]. How to make this technological means play a significant advantage in art classroom and extracurricular teaching and learning, making the use of mobile devices such as mobile phones in students' hands undergo powerful changes, turning them into powerful learning tools, and stimulating students' interest in using mobile phones for self-directed learning. Making these tools better serve art appreciation teaching is worth exploring and researching strategies for teachers and students to interact in real-time using mobile phones [11].

By using this interactive platform in autonomous learning, students can choose learning content according to their own needs, the depth of learning content according to their own ability, and the learning content according to their own needs, whether in class or at any free time after class. Teachers can track and feedback students' learning situation in time, so as to achieve effective learning. The appropriate combination of the positive role of fuzzy control can effectively improve the teaching effect of art appreciation.

5.2 Sampling Point Optimization Strategy Based on Fuzzy Control

In the process of art appreciation, it is necessary to combine fuzzy control method to control the image intelligently, and resample the image by setting discrete sampling points to simulate the deformation caused by the transformation of viewing angle. Because discrete sampling cannot guarantee the optimal matching of the sampled image, this paper uses Nelder-Mead method [12] as an optimization tool based on ASIFT algorithm, and introduces fuzzy control according to the characteristics of ASIFT sampling space to realize the adaptive adjustment of simplex parameters, in order to make the sampling points converge towards the optimal matching direction.

5.2.1 *Affine Imaging Model*

ASIFT algorithm simulates the deformation of target in different angles by means of affine image sampling. Through Singular Value Decomposition (SVD), the algorithm verifies that any positive definite affine transformation A can be decomposed into:

$$A = \lambda R_{\psi} \begin{pmatrix} t & 0 \\ 0 & 1 \end{pmatrix} R_{\phi} = \lambda \begin{pmatrix} \cos\psi & -\sin\psi \\ \sin\psi & \cos\psi \end{pmatrix} \begin{pmatrix} t & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} \cos\phi & -\sin\phi \\ \sin\phi & \cos\phi \end{pmatrix} \tag{5.1}$$

Among them, $\lambda > 0$, $\varphi \in [0, 180]$, $t \geq 1$, R_{ψ} and R_{φ} are rotation matrices corresponding to camera orientations. Figure 5.1 depicts the geometric meaning of λ, ψ, φ in Eq. (5.1). Among them, λ represents the scale change, $\varphi = \arccos\left(\frac{1}{t}\right)$, and ψ is the camera rotation angle. In the sampling process, the image to be matched is placed in the center of XOY plane, and the transformed image can be resampled according to the camera orientation and angle.

Because SIFT (Scale-Invariant Feature Transform) operator is invariant to rotation and scale, ASIFT only samples t and l in Eq. (5.1). The sampled image can be obtained by the following transformation matrix, see Eq. (5.2):

$$I_{t,\phi} = \begin{pmatrix} t & 0 \\ 0 & 1 \end{pmatrix} R_{\phi}(I) \tag{5.2}$$

Figure 5.1 depicts the ASIFT sampling point setting with respect to t and φ, where the black dots indicate where the camera is placed.

After the sampled images are generated, all images are extracted and matched by SIFT features. In order to speed up the algorithm, ASIFT adopts dual-resolution strategy. In the first stage of the algorithm, the image to be matched is sampled by 3 $\times$ 3 to reduce the resolution of the image, so as to speed up SIFT feature extraction and matching, and save the five transformation models with the most matching. Re-transform and SIFT feature extraction in high-resolution images to improve the robustness of the algorithm to affine transformation.

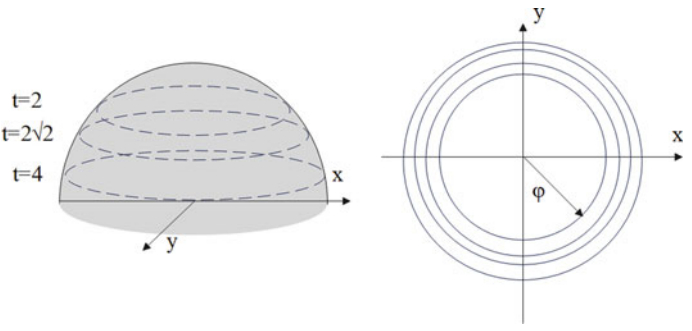


Fig. 5.1 Sampling point settings of t and φ

Although ASIFT algorithm has strong robustness to the change of viewing angle, the sampling points of ASIFT algorithm are discrete, which cannot guarantee the maximum matching of the obtained images in continuous space. As shown in Fig. 5.2a, b, there is deformation between the two images. By affine sampling of two images and calculating SIFT feature matching number, the matching point function corresponding to rotation angle is shown in Fig. 5.2c. It can be seen that the matching feature is a multimodal problem. Obviously, the matching number obtained by ASIFT finite discrete sampling points cannot guarantee global optimality. Because the sampling points of ASIFT algorithm are dense and the optimal matching is generally not far from the global optimum, this paper introduces Nelder-Mead algorithm, which takes the approximate optimal transformation model found by ASIFT algorithm as the initial point, and uses Nelder-Mead algorithm's ability to climb mountains quickly to find the optimal transformation model. In addition, according to the characteristics of image sampling set, this paper also introduces fuzzy control strategy to realize the adaptive adjustment of simplex parameters, so that simplex algorithm can better converge to the extreme point of matching function.

5.2.2 Fuzzy Control Strategy with Pure Shape Parameters

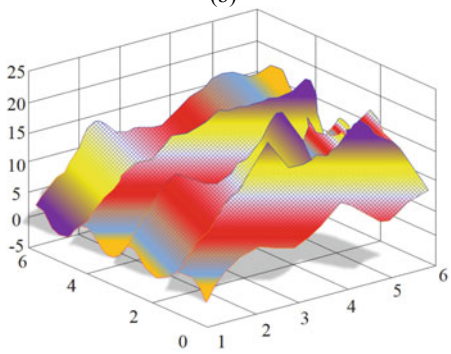
In Nelder-Mead method, γ, β and ρ are the key parameters, which determine the search range and convergence rate of simplex. Generally, we take $\gamma = 1$, $\beta = 0.5$, and $\rho = 0.5$. In the observation of ASIFT, we find that its parameter space and objective function have the following characteristics (see Fig. 5.3).

(1) The objective function changes little (flat) near the peak value. This is because the traditional SIFT algorithm itself has a certain view invariance, and changing the sampling parameters in a small range will not affect the SIFT matching value. Therefore, even if the search range is enlarged near the optimal value, the convergence property of the algorithm is generally not affected;
(2) The objective function shows a step in the non-peak region. Especially, in the process of climbing to the "peak", the objective function changes dramatically, so the search range should be reduced to ensure the convergence stability of the algorithm.

In view of the above characteristics, this paper introduces fuzzy control strategy into Nelder-Mead simplex method. The purpose is to make the optimization algorithm adaptively adjust the parameters according to the current matching value, so as to improve the search efficiency. Because ASIFT only samples two rotation angles, simplex consists of three vectors in two-dimensional parameter space. If the three vectors are assumed to be a_0, a_1 and a_2 respectively, the difference between the three vectors can be expressed by the following Eq. (5.3):

(a)

(b)



(c)

Fig. 5.2 Image deformation and multimodal cost function

$$E = \frac{1}{3N} \sum_{i=0}^{2} E(a_i) \tag{5.3}$$

$$\text{Var} = \frac{1}{3N} \sum_{i=0}^{2} (E(a_i) - E(\overline{a}))^2 \tag{5.4}$$

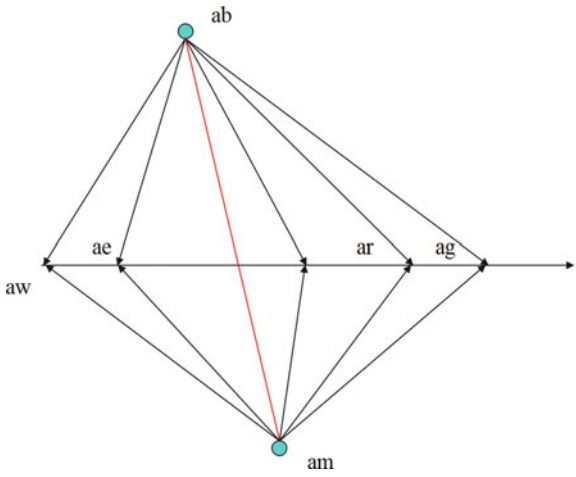


Fig. 5.3 Basic operation of Nelder-Mead algorithm

Among them, $\overline{a}$ represents the mean of three vectors, $E(a_i)$ represents the number of matches corresponding to the i-th vector, and N represents the number of feature matches of the optimal vector.

5.2.3 Fuzzy Control Model of Art Appreciation Class

Combined with fuzzy control algorithm, this paper puts forward the idea of using paintings to improve visual literacy, analyzes paintings and students as the main factors affecting the improvement of visual literacy, and puts forward specific improvement methods. Finally, the solutions are applied to specific teaching practices. Moreover, this paper gets teaching feedback from students' classroom participation and homework completion, and explores effective resources suitable for improving students' visual literacy, as shown in Fig. 5.4.

Under the background of computational thinking teaching, based on the virtual teaching model of "input-virtualization-output", this study recombs the relationship between users and systems in virtualization from the perspective of embodied cognition, that is, the relationship between students, learning tools, and teachers. Specifically, students form a perceptual motor cycle by controlling the feedback of learning tools and perceptual learning tools, while teachers need to support students' interaction with tools (as shown in Fig. 5.5). The introduction of cognitive perspective enables this model to explain more deeply how students learn computational thinking in the interaction between body and environment, and the role played by teachers in it.

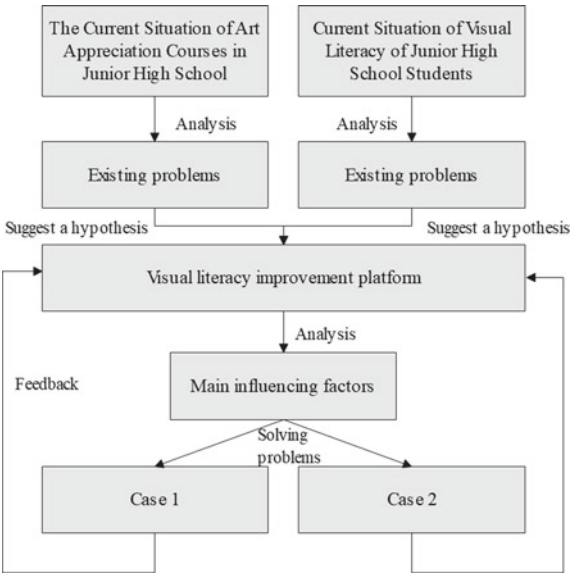


Fig. 5.4 Teaching modulus of art appreciation class combined with fuzzy control algorithm

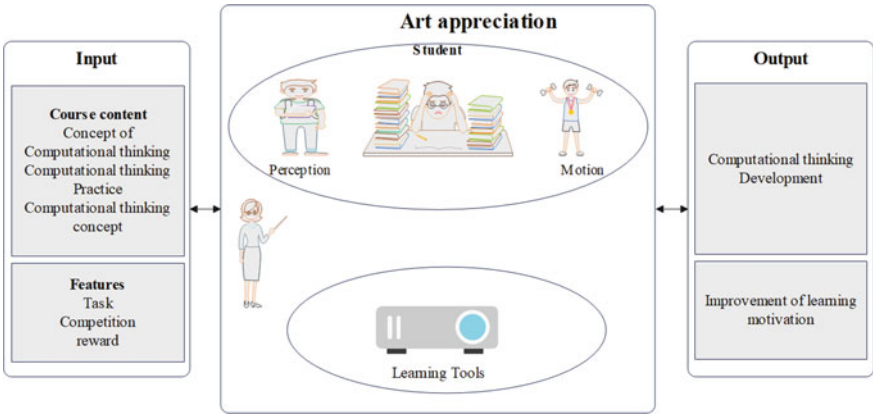


Fig. 5.5 Virtual teaching model of computational thinking in art appreciation class

5.3 Verification of the Function of "Fuzzy Control" in Art Appreciation

The "fuzziness" in painting creation does not mean the real confusion or pure fuzziness in its connotation. It is relative to the clear concept of rational abstraction, relative to the accuracy of science and relative to the essential law of abstraction. It refers to the richness, polysemy and uncertainty of sensibility, which has no strict scientific logic, but has a moving emotional rationality with strong subjective color.

Moreover, emotional factors undoubtedly run through the whole process of painting creation, and it is the rich emotional experience that urges painters to pick up brushes. The artist's inspiration imagination is the irresistible passion of emotion, and it is the strong artistic impulse of not spitting out unhappiness that has the motive force of continuous innovation and development of painting art. There is no doubt that finding our attitude towards life-unique emotional experience is the first step into creation.

Art works have the basic characteristics of modeling, visibility, static, and materiality. Therefore, art image has naturally become an ideal terminal form for artists to realize in art works. The purpose of a work of art is to express basic or remarkable features, which are more complete and clearer than physical objects. Artists first form a concept of basic features, and then change physical objects according to the concept. After such changes, the objects are "consistent with the artist's concept", that is to say, they become "ideal". Although it also belongs to objective existence, it is different from the objective reality in our lives. The so-called "art originates from life and is higher than life". This shows that the concepts instilled by artists in their works also have "undetermined" "fuzzy levels".

In art appreciation, students often play a "rational" bystander and an object of appreciation, describing artistic emotions in a stylized way, such as "embodying the wisdom and strength of the working people", "expressing the lofty ideals of the author", "reflecting the darkness and cruelty of feudal society", etc., without their own true emotional imagination at all, they are completely passive in appreciation.

Constructivism theory holds that learning is a process in which learners actively construct knowledge, rather than a process in which textbooks and teachers' knowledge are simply loaded into students' minds. Art appreciation can't be a process in which teachers instill a single certain related knowledge into students, and students can't be bystanders and recipients of appreciation.

Based on the "fuzzy level" of art works, we should create a certain situation, encourage students to boldly imagine emotions and feel artistic images from multiple angles, and don't let teachers' aesthetic expression become the only aesthetic standard.

The "fuzzy level" in art works leaves readers with broad thinking space and room for emotional association, and each reader's personality is different. Teachers can make full use of this, explore each student's perception potential, and give students more opportunities to take the initiative to participate, which is very beneficial to the development of students' aesthetic personality.

Build a simulation experimental environment by combining hardware and software environments. The hardware environment is divided into five parts, namely: output device, input device, central processing unit, motherboard, and memory. The specific hardware device environment settings are shown in Table 5.1

Under the guidance of the above ideas, this paper verifies the effect of fuzzy control algorithm in art appreciation.

Figure 5.6 shows an appreciation case of hazy art works. In this paper, the fuzzy control algorithm proposed in this paper is used to analyze art works in a variety of ways, so as to improve the diversity of art works and facilitate students to appreciate

Table 5.1 Simulation experimental environment

Type	Model
Display	DELL Ultra Sharp3008 WFP
Central processing unit	Intel Core i9 -3970X
Memory storage	ADATA XPG DDR3-1600 4 GB*4GIGABYTE GA-X79-UD7
Motherboard	Cinema series
Scanner	Guide 600/i700 Series

Fig. 5.6 A case of fuzzy appreciation of art works

art works from multiple angles. On this basis, we verify the effect of art appreciation system based on fuzzy control, count the practical effect of this model in art appreciation class, and get the verification results shown in Table 5.2 and Fig. 5.7.

As shown in Table 5.2 and Fig. 5.7, the fuzzy control model proposed in this paper has good performance in art appreciation, with evaluation scores distributed directly in [77,87]. Based on this, the method proposed in this paper is compared with the fuzzy control method proposed in Ref. [12] to analyze its effectiveness in art appreciation. Reference [12] developed an optimized driven deep learning technique for image forgery detection. Local GaborXOR patterns and Texton features were extracted from the partition, and deep neural fuzzy networks were used to detect forgery. Similarly, a scoring method is used for comparison, and the results shown in Table 5.3 are obtained.

From the above analysis, it can be seen that the fuzzy control method proposed in this article has good effects on art appreciation and has certain advantages compared to traditional algorithms.

From the above research results, we can see that the fuzzy control algorithm proposed in this paper can effectively improve the appreciation effect of art works, facilitate the development of students' creative thinking, and contribute to the innovation and improvement of the follow-up art appreciation course.

Table 5.2 Effect evaluation of art appreciation system based on fuzzy control

Number	Fuzzy control evaluation	Number	Fuzzy control evaluation	Number	Fuzzy control evaluation
1	79.83	13	83.61	25	78.36
2	77.29	14	78.96	26	83.70
3	80.18	15	80.17	27	83.89
4	77.66	16	79.63	28	80.18
5	83.79	17	80.47	29	80.04
6	82.46	18	83.48	30	79.15
7	80.18	19	82.55	31	83.96
8	83.43	20	79.30	32	79.72
9	84.06	21	83.21	33	84.19
10	85.02	22	85.69	34	78.12
11	81.72	23	78.06	35	78.71
12	84.95	24	85.99	36	80.12

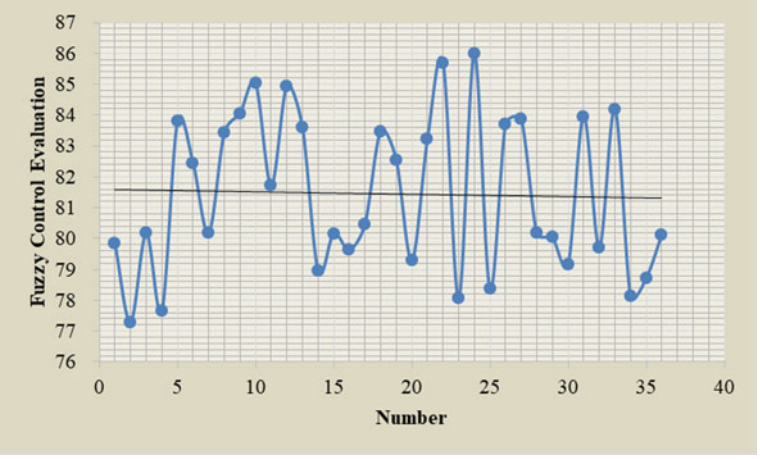


Fig. 5.7 Statistical diagram of system evaluation data

Table 5.3 Comparison test results

	Method of this article	Method of Ref. [12]
1	85.23	79.52
2	84.32	78.24
3	84.63	80.11
4	84.35	79.32
5	85.21	79.56
6	85.33	80.11

5.4 Conclusion

Today's education is vigorously advocating the cultivation of students' innovative thinking and practical ability. The art discipline aims at cultivating students' aesthetic ability and aesthetic quality, which can only be reflected in real life. "Lifelong education" has been deeply rooted in people's hearts, and art education is not the accumulation of art works, but the comprehension of the inner meaning of artistic images, so as to hone their thinking habits and emotional imagination.

In the process of art appreciation, we need to combine fuzzy control method to control the image intelligently, and resample the image by setting discrete sampling points to simulate the deformation caused by the transformation of visual angle. This paper gives a teaching model of art appreciation course combined with fuzzy control, and verifies the effect of the teaching model by combining cases with teaching evaluation. The research shows that the fuzzy control algorithm proposed in this paper can effectively improve the appreciation effect of art works, facilitate the development of students' creative thinking, and contribute to the innovation and improvement of the follow-up art appreciation course.

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