

Retraction

Retracted: An Improved Particle Swarm Optimization-Powered Adaptive Classification and Migration Visualization for Music Style

Complexity

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] X. Liu, "An Improved Particle Swarm Optimization-Powered Adaptive Classification and Migration Visualization for Music Style," *Complexity*, vol. 2021, Article ID 5515095, 10 pages, 2021.

Research Article

An Improved Particle Swarm Optimization-Powered Adaptive Classification and Migration Visualization for Music Style

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Based on the adaptive particle swarm algorithm and error backpropagation neural network, this paper proposes methods for different styles of music classification and migration visualization. This method has the advantages of simple structure, mature algorithm, and accurate optimization. It can find better network weights and thresholds so that particles can jump out of the local optimal solutions previously searched and search in a larger space. The global search uses the gradient method to accelerate the optimization and control the real-time generation effect of the music style transfer, thereby improving the learning performance and convergence performance of the entire network, ultimately improving the recognition rate of the entire system, and visualizing the musical perception. This kind of real-time information visualization is an artistic expression form, in which artificial intelligence imitates human synesthesia, and it is also a kind of performance art. Combining traditional music visualization and image style transfer adds specific content expression to music visualization and time sequence expression to image style transfer. This visual effect can help users generate unique and personalized portraits with music; it can also be widely used by artists to express the relationship between music and vision. The simulation results show that the method has better classification performance and has certain practical significance and reference value.

1. Introduction

Through colour brightness, purity, hue, and the visual colour elements correspond, and the point, line, and surface composition of the image correspond to the basic unit line style of data visualization, and the design is expressed through information visualization. Music visualization is one of the expressions of music iconography, which mainly focuses on music feature extraction, motion detection, image processing, etc. [1]. Visualization is a form of data expression and transmission, like the way computers simulate people's emotions that can be seen through facial expressions, body movements, etc. Music visualization focuses on the interaction, transformation, and expression of hearing and vision. In the process of visual design, there are a variety of mapping modes and media that are used to convey ideas that may be stimulated by thoughts and actions or express feelings. Therefore, the expression of visual works today is usually subject to the strong subjective influence of creators

[2], which plays a role like emotional communication in other aesthetic creations [3]. Some studies have found that if visual aids can be provided, while music is being played, it can better help listeners recognize the emotions expressed by music and help make listeners deepen their understanding of music through visual effects. Nowadays, increased computer scholars and designers are beginning to pay attention to the relationship between music and colour, image, semantics, and emotion [4].

The particle swarm algorithm simulates birds in a flock of birds by designing a massless particle. The particle has only two attributes: speed and position. Speed represents the speed of movement, and position represents the direction of movement. Each particle searches for the optimal solution individually in the search space, records it as the current individual extreme value, shares the individual extreme value with other particles in the entire particle swarm, and finds the optimal individual extreme value as the entire particle. As today's society moves increasingly in the

direction of intelligence, interactive forms of sound visualization will have a lot of room for development in future practical applications. Interactive sound visualization emphasizes the process of interactive communication with the audience, so it is necessary to explore the visual representation of sound from the audience's perspective [5]. Regarding the current global optimal solution of the swarm, all particles in the particle swarm adjust their speed and position according to the current individual extreme value they find and the current global optimal solution shared by the entire particle swarm.

The research in this paper provides theoretical guidance on the design of visual representation for the practical application of interactive sound visualization in human work and life in the future so that it can better meet the application needs of people. The research in this paper incorporates modern high technology and is more in line with the development and application practices of modern society in terms of visual expression.

2. Related Work

Music visualization combines hearing and vision to enhance the comprehensibility and emotional resonance of music. As far as music visualization is concerned, there have been a lot of results in the research between music and images for reference [6]. The current research can be summarized into two research directions.

Vedachalam et al. calculated the conversion relationship between tones and light waves by introducing a coefficient based on Newton's theory of colour and light to produce a conversion between music and colour [7]. With the development of visualization and feature extraction analysis techniques, the current research on music visualization focuses on the conversion relationship between music and visual representation and the theoretical study of related implementation techniques [8]. Tamura et al. added abstract geometric shapes to electronic music scores to generate a visual understanding of the musical structure to generate a more recognizable musical map [9]. Zhang et al. proposed to present music derivatives in the form of abstract graphics in the web interface according to the content and structure of music to interact with users and increase their pleasure of listening to music [10]. Hejna et al. visualized music according to the structure of classical music [11]. Liu et al. point out that music emotions can correspond to visual representations of figurative characters, such as happy expressions for cheerful melodies and sad states for low melodies [12].

With the advancement of technology and different application needs, forms of interaction between humans and machines and systems are used in various fields, and interaction-based sound visualization has evolved from a purely artistic field to a more practical direction, such as aiding in medical, entertainment, and teaching applications [1]. In music teaching, interactive sound visualization can be used to show students the visual structure of the music, which is easy for them to operate and learn according to their learning situation. Interactive sound visualization can

play an active role in speech recognition, music performance, and other aspects.

Matching and applying their respective tags, this theory proposes a system that combines audio and physiology to generate a music visualization system that can respond to music and listeners' wake-up responses in real-time and provide the music and auditory experience obtained in the sound and physiology fields Artistic visual representation [3]. The label matching method can effectively and accurately match music files or image files with the same label. The content of these labels is usually based on the designer's empirical understanding or experimental conclusions to compare the original music file or image file. The style is described semantically to help other viewers understand through semantics.

Create new images or music by combining computer-recognizable parameters in music or images, combined with the parameters prebuilt by the designer to express content. For example, to directly associate visual attributes with musical attributes, users can create a new musical melody by drawing on a virtual canvas and combine expression clues with emotional colour clues through structures such as rhythm, loudness, and time, according to the defined association, convert it into an emotional state, and then determine facial emotions and actions to create visual effects [5]. This method provides freedom of expression for music visualization, but it still requires designers to set a fixed expression paradigm. Music file generation screen or image file generation sound only allows one-sided data to have a higher degree of freedom, so, to a certain extent, the free interaction between music and images still cannot be satisfied [6]. The above two kinds of music visualization research are based on people labeling music or images, or the unilateral transformation effect of algorithm application, and, to a certain extent, realize the highly subjective creative expression in the field of art but miss the music creation and image shooter. By extracting the essential information of music or image transmission, the subjective label of the creator is no longer added, but the computer is allowed to complete the two links of identification and output of the original music and image files, which can not only retain the information in the original file to the maximum extent.

3. Particle Swarm Optimization Algorithms

3.1. Algorithm Initialization. The adaptive variable particle subgroup algorithm optimizes the BP neural network and is divided into three parts: BP neural network structure determination, adaptive variable particle subgroup algorithm optimization, and BP neural network prediction. Among them, the BP nerve network structure determination part is to determine the BP nerve network structure according to the number of input and output parameters of the application and then determine the length of the individual particle group algorithm. Take the initial population N as 50, the number of iterations is 100, and of course, the spatial dimension d is also 1 [13]. The initialization of position and speed is to randomly generate a matrix within the position and speed limit. For this problem, the position initialization

is to randomly generate a data matrix within 0–20, but for speed, there is no need to consider constraints. Generate a data matrix randomly within 0–1 directly. The position constraint here can also be understood as the position limit, and the speed limit is to ensure that the particle step length does not exceed the limit. Generally, the speed limit is set to $[-1, 1]$. The adaptive mutation particle swarm algorithm optimizes the weights and thresholds of the BP neural network. Everyone in the population contains a network ownership value and threshold. The individual calculates the individual fitness value through the fitness function and then updates the individual extreme value and the group extreme value to find the optimal fitness value corresponding to the individual.

3.2. Finding the Optimal Solution. Another feature of particle swarm is to record the historical optimal of each individual and the historical optimal of the population [14]. Therefore, the corresponding optimal positions and optimal values of the two also need to be initialized. The historical optimal position of everyone can be initialized to the current position first, and the historical optimal position of the population can be initialized to the origin. For the optimal value, if the maximum value is obtained, it is initialized to negative infinity and conversely initialized to positive infinity. Each search needs to compare the current fitness and optimal solution with the historical record value. If it exceeds the historical optimal value, update the historical optimal position and optimal solution of the individual and the population. BP neural network prediction uses its technology and method to adapt to the optimal individual obtained by the variable particle subgroup algorithm to assign initial weights and thresholds to the network and predict the results after the network meridian training.

3.3. Particle Swarm Algorithm Optimizes Neural Network

3.3.1. Errors Are Transmitted back to the Nerve Network (BP Nerve Network) Part. Error backpropagation neural network is referred to as BP neural network. It is a one-way propagation multilayer forward network. In addition to input and output nodes, there are one or more hidden layer nodes in the network [15]. The input signal passes from the input layer node through the hidden layer nodes one by one, and then to the output layer node. The output of each layer node only affects the output of the next layer node.

The heuristic particle swarm optimization (HPSO) algorithm used for constrained optimization problems is mainly heuristic, while the GAPSO algorithm is a MATLAB program that combines genetic algorithm and particle swarm optimization algorithm. The optimization efficiency is greatly improved and will not fall into the local optimum.

The main feature of this network is the forward transmission of signals and the backward propagation of errors. In the forward pass, the input signal is processed layer by layer from the input layer through the hidden layer to the output layer. The neuron state of each layer only affects the state of the next layer of neurons. If the output layer cannot

get the expected output, it will switch to backpropagation and adjust the network weights and thresholds according to the prediction error, so that the BP neural network's predicted output will continuously approach the expected output. The BP neural network can be regarded as a non-linear function. The value and predicted value are the independent and dependent variables of the function, respectively.

Figure 1 shows a two-layer BP neural network structure, and the network has only one hidden layer.

$$W_{R \times S} = \begin{bmatrix} W_{0,0} & W_{0,1} & \cdots & W_{0,S-1} \\ W_{1,0} & W_{1,1} & \cdots & W_{1,S-1} \\ \vdots & \vdots & \vdots & \vdots \\ W_{R-1} & W_{R-1} & \cdots & W_{R-1,S-1} \end{bmatrix}, \quad (1)$$

$$V_{S \times N} = \begin{bmatrix} V_{0,0} & V_{0,1} & \cdots & V_{0,S-1} \\ V_{1,0} & V_{1,1} & \cdots & V_{1,S-1} \\ \vdots & \vdots & \vdots & \vdots \\ V_{R-1} & V_{R-1} & \cdots & V_{R-1,S-1} \end{bmatrix}. \quad (2)$$

The matrix W is the connection weight matrix between the input layer and the hidden layer, and the matrix V is the connection weight matrix between the hidden layer and the output layer.

Assume that the neuronal thresholds of the hidden layer and the output layer are, respectively,

$$\alpha = \{\alpha_0, \dots, \alpha_{S-1}\}, \quad (3)$$

$$\beta = \{\beta_0, \dots, \beta_{S-1}\}. \quad (4)$$

The corresponding expected output value is

$$O = \{o_0, o_1, \dots, o_{N-1}\}. \quad (5)$$

3.3.2. Adaptive Mutation Particle Swarm Algorithm Part. It searches for the optimal example in the solution space by the particles in the swarm [16]. Research and practice have shown that PSO has the advantages of fast convergence speed, high quality of noninferior solutions, and good robustness in multidimensional spatial function optimization and dynamic objective optimization. It is especially suitable for engineering applications. But at the same time, PSO also has the disadvantages of premature collection, low search accuracy, and low efficiency of later iterations.

The speed and position update formula of particles is as follows:

$$v_{ij}^{k+1} = \omega \times v_{ij}^k + c1 \times r1(pbest_{ij}^k - x_{ij}^k) + c2 \times r2(gbest_{ij}^k - x_{ij}^k), \quad (6)$$

$$x_{ij}^{k+1} = x_{ij}^k + v_{ij}^{k+1}. \quad (7)$$

This article borrows from the inheritance algorithm's variation idea and proposes an adaptive variation particle

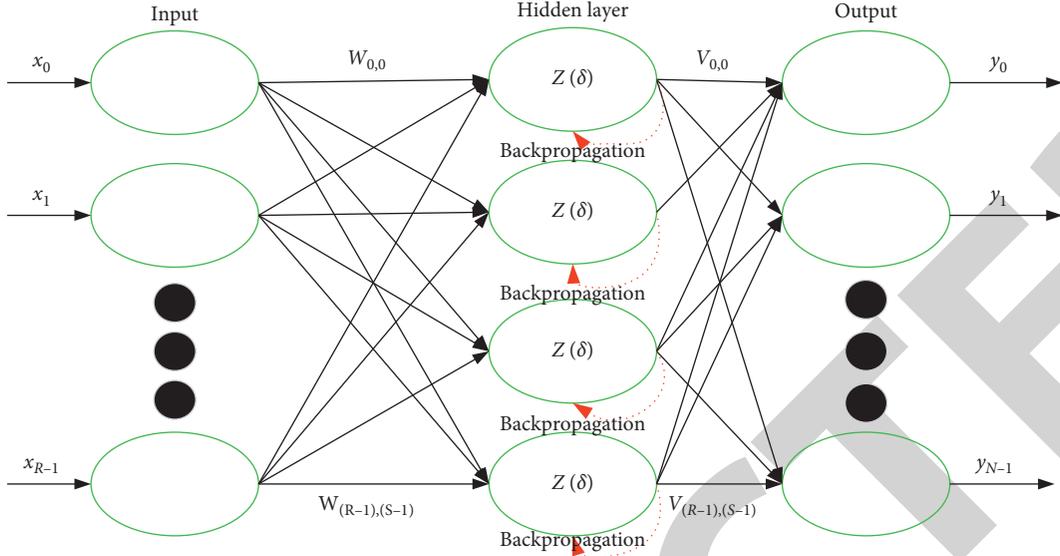


FIGURE 1: The topological structure of the BP neural network.

subgroup algorithm based on the inheritance crossover operator. The main method is to generate a population representing a new solution set by using a crossover operator. The crossover method is as follows. In each iteration, the first half of the particles with good fitness after sorting are taken directly into the next generation, and the second half are put into the particle selection pair in pairs in the pool, generate a random crossover position for genetic selection and crossover operations, generate the same number of offspring as the parent, then compare with the parent, and choose half of the good fitness to enter the next generation to maintain the population of particles. In this way, the crossover can not only increase the diversity of particles and jump out of the best position, but also speed up the convergence rate.

Suppose that a and b , respectively, represent the pointers of two-parent individuals selected for genetic selection and crossover operations, and then the specific calculation formula for this operation is as follows:

$$x_a^{k+1} = r_1 x_a^k + (1.0 - r_1) x_b^k, \quad (8)$$

$$x_b^{k+1} = r_1 x_b^k + (1.0 - r_1) x_a^k, \quad (9)$$

$$v_a^{t+1} = \frac{v_a^t + v_b^t}{\Pi v_a^t + v_b^t} \Pi v_a^t, \quad (10)$$

$$v_b^{t+1} = \frac{v_a^t + v_b^t}{\Pi v_a^t + v_b^t} \Pi v_b^t. \quad (11)$$

After the above calculations, two new positions are randomly generated in the hypercube formed by the parent granules, in which the sum of the velocities of the two-parent individuals is standardized at the intersection of the velocities. Therefore, only the direction of the particles is affected, but the number does not change.

3.3.3. Optimization of Adaptive Mutation Particle Swarm.

The adaptive mutation particle swarm algorithm optimizes the weights and thresholds of the BP neural network. Everyone in the population contains a network ownership value and threshold [17]. The individual calculates the individual fitness value through the fitness function and then updates the individual extreme value and the group extreme value to find the optimal fitness value corresponding to the individual. BP neural network prediction uses the adaptive variable particle group algorithm to obtain the optimal individual to assign initial weights and thresholds to the network and predict the results after network meridian training.

Figure 2 shows the process of optimizing the BP neural network algorithm by the adaptive variable particle group algorithm.

3.4. Music Style Adaptive Classification and Migration Visualization.

This design uses the scheme of mapping volume to circle radius and pitch to colour saturation as an example. Under this mapping scheme, the higher the volume, the larger the circle in the screen, the higher the pitch, and the higher the colour saturation [18]. If the treble is sung at a higher volume, a large circle with high saturation is obtained on the screen, a smaller circle with high saturation is obtained when the treble is sung at a lower volume, a larger circle with low saturation is obtained when the bass is sung at a higher volume, and a smaller circle with low saturation is obtained when the bass is sung at a lower volume.

Figure 3 shows the presentation in both views, where the white circle in the overlapping view shows the reference audio, and the blue circle with some transparency shows the user singing in real-time, with the singer's pitch getting progressively higher and louder from left to right. The overlapping view allows the singer to see more directly how their volume compares to the reference audio. The contrasting view is divided into two areas: the left area shows the

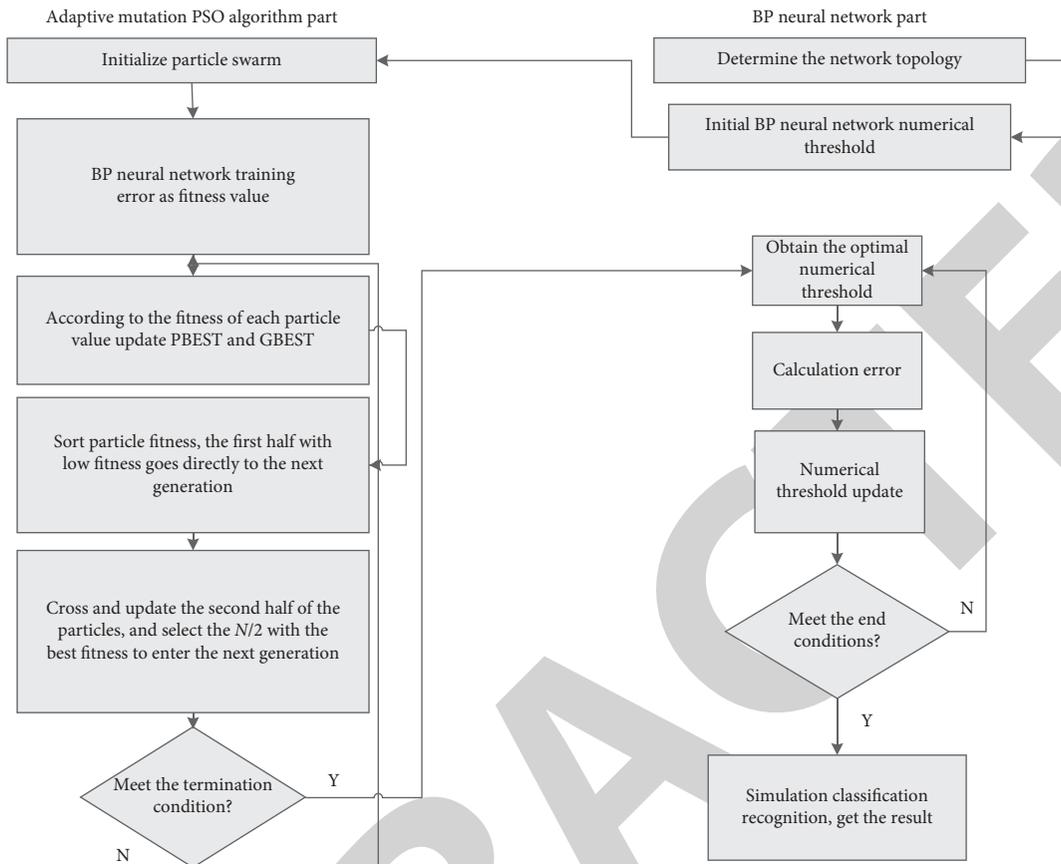


FIGURE 2: Algorithm flow chart.

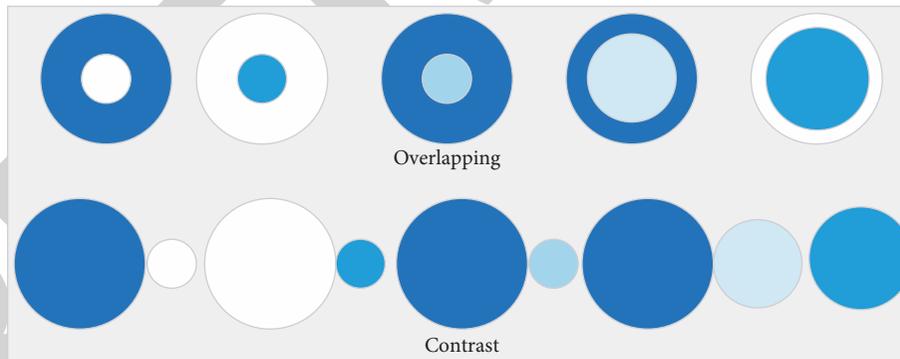


FIGURE 3: Overlapping and contrasting views.

information of the reference audio, and the right area shows the information of the singer’s singing; this view shows the pitch and volume at the same time, so that the singer can see the difference with the reference audio and help him/her to make adjustments. For example, in Figure 3, the left image shows the singer’s low pitch, and the middle shows the low volume, while the right image shows that the singer is still singing at a higher volume and higher pitch when they should be resting.

First, different people differently perceive colour and pitch. In terms of a continuous colour change from red to blue, physically, for flame and light, blue light generally

represents a shorter wavelength, higher temperature, and higher energy, while red light represents a longer wavelength, lower temperature, and lower energy, and in this sense, blue should represent a higher tone, and red should represent a lower tone. However, if we look at it in another way, we can see from many life experiences that blue is often associated with ice or water and low-temperature objects, while red is often associated with fire and high temperature, and people often call blue a cold colour and red a warm colour; in this sense, blue should represent the low tone, and red the high tone. Everyone has a different correspondence between pitch and colour, and even the same associates may

have different associative responses to the same thing in different scenarios and contexts, so colour-pitch correspondence is not necessarily a choice that applies to most people, even though it has been historically favored by people for sound and colour mapping.

The setting of the highest and lowest pitches of the system should also be carefully considered at design time. The average person's singing range is around two octaves without the use of special singing techniques such as whistling or hooting, and the better singers are around three octaves without the use of special singing techniques, with extremely few reaching a span of four octaves or more. If the system does use special singing techniques that span more than three octaves at the time of use, the settings can be individually "customized"; and to ensure a significant visualization effect, if the use of different registers is scattered, consider segmenting the periods by different registers. To ensure a more significant visualization effect, if the periods of the different zones are scattered, you can consider setting the periods by different zones, so that you can get a better visualization effect in each stage.

4. Experimental Simulation and Result Analysis

4.1. Classification of Different Styles of Music. The operation process of speech recognition is as follows. First, the speech to be recognized is converted into electrical signals and then input into the recognition system. After preprocessing, the speech characteristic signals are extracted by mathematical methods, and the extracted speech characteristic signals can be regarded as the pattern of the speech. Then, the speech model is compared with the known reference pattern, and the best matching reference pattern is the recognition result of the speech.

In this article, four different types of music are selected: folk songs, guzheng, rolling, and popular. For each piece of music, 500 groups of 24-dimensional voice characteristic signals are extracted by the cepstral method, and there is a total of 2,000 groups of voice characteristic signals. Since the voice feature input signal has 24 dimensions, and the voice signal is to be classified into 4 types, the structure of the BP neural network is 24-25-4; that is, the input layer has 24 nodes, the hidden layer has 25 nodes, and the output layer has 4 nodes. Randomly select 1,500 sets of data from the voice characteristic signal data as training data to train the network. According to the characteristics of the voice characteristic signal and referring to the classic PSO parameter set, the basic parameters of the algorithm are set as follows: (1) particle size $n=30$; (2) particle dimension $D=729$; (3) maximum velocity $V_{max}=1$; (4) maximum number of iterations is set to 100; (5) termination condition, the loop reaches the termination number of iterations or the optimal appropriate value for 50 consecutive iterations, and the calculation result difference is less than 0.0005; (6) use of the particle swarm node fitness function, Mean Squared Error (MSE) definition of the BP algorithm.

Use the optimal solution obtained by PSO to determine the weights and thresholds of the BP network. Randomly select 1,500 sets of data from 2,000 sets of voice feature

signals as training data to train the network, and 500 sets of data as test data to test the network classification ability, as shown in Figure 4. Compare this classification number with the entered classification number. If they are equal, the identification is correct; otherwise, the identification is wrong. Finally, the final recognition rate can be obtained by comparing the correct number of recognitions with all the numbers to be recognized.

In the space of unit beat time as the vertical axis, peaks appear in the case of long beats, dragging beats, and temporary slowing down of speed, which is suitable for showing the use of slow speed to enhance the musical expression in the piece, as shown in Figure 5, and the peaks marked with red dots are the tones in the piece with a relatively high pitch in the phrase and longer dwell time. These longer tones are crucial for the expression of emotion, so they dwell more time, using this effect that can be highlighted by this representation.

To verify the effectiveness of the adaptive mutation particle swarm algorithm to optimize the BP neural network, the improved particle swarm algorithm based on genetic crossover operator to optimize the BP neural network (HPSOBPNN) is effective, as well as other models (GA-Back Propagation Neural Network (GABPNN), Particle Swarm Optimization Propagation Neural Network (PSOBPNN), Backpropagation Neural Network (BPNN), Knuth-Morris-Pratt (KMP), Hidden Markov Models (HMM)). The results of the experiments are shown in Table 1 and Figure 6. It can be seen from Table 1 that the classification accuracy rate of HPSOBPNN is significantly higher than that of other model methods.

4.2. Visualization of Different Styles of Music Migration. The mean value of the standard deviation is calculated according to the instrument and the subjective attribute, respectively, to obtain a comparison of people's consistency for that instrument or each subjective attribute. Since the standard deviation characterizes the magnitude of data variation, the larger the variation, the larger the standard deviation, and, therefore, the lower the consistency. For example, in the analysis for consistency, the standard deviation of each subjective attribute is calculated as the mean, as shown in Figure 7.

By showing the subjective auditory attribute characteristics of musical instruments in the form of spider diagrams, in addition to visualizing the timbral character of each instrument, the similarity of subjective attributes of different instruments can also be obtained visually. Among the stringed instruments included in the experiment, for example, the middle beard has more balanced attributes and can play a foil function in the work, while the bass gehu has more distinctive character traits, being extremely unbright and uncrimp, and at the same time, extremely dark and muddy, etc. Among the stringed instruments, it is also clear from looking at their shapes that the jingju and banhu are relatively similar among the stringed instruments.

The features contained in music files are extremely complex, including frequency, amplitude, timbre, pitch,

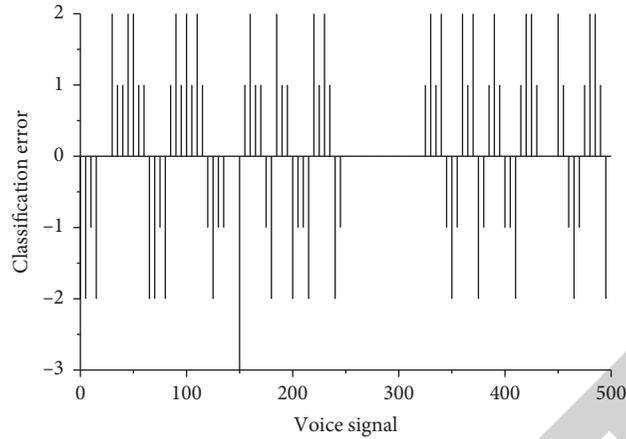


FIGURE 4: Classification error of BP neural network.

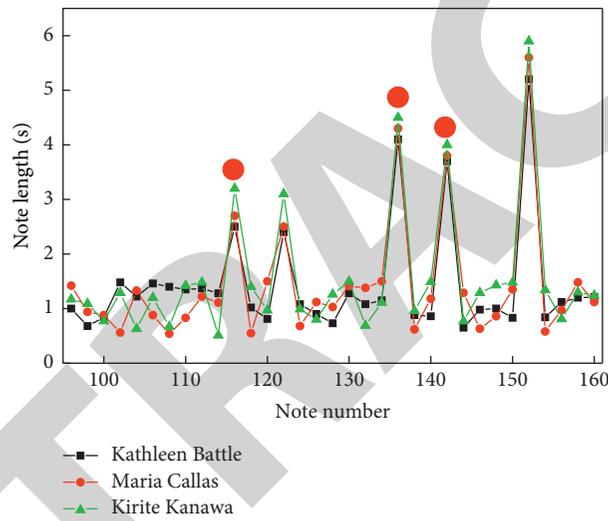


FIGURE 5: Comparison of different versions of the song in the space of beat duration-beat number.

TABLE 1: The classification accuracy rate of various models (%).

Voice recognition category	HPSOBPNN	GAB PNN	PSOBPNN	BPNN	KMP	HMM
Folk	92.68	88.71	90.17	80.62	77.40	76.89
Classical	100	100	100	100	96.00	95
Rock	90.87	83.33	86.42	81.43	78.17	77.34
Popular	94.79	93.23	93.15	92.24	88.55	87.63

pitch, pitch, chord, speed, loudness, beat, and melody, as well as features newly proposed with the development of technology, such as music energy, Spectrum matrix, spectrum stream, bandwidth, band period, noise, and frame rate. These digital music features can be used to analyze and apply visual expression, but if extracting and calculating each feature are time-consuming, you should extract the necessary features according to the visualization requirements, ignoring or removing those unnecessary features, thereby shortening the running time of the program and meet real-time requirements. The Minim library in the code library is mainly used to analyze music. In the visual design of

information visualization, the frequency, timbre, pitch, pitch, and length of the music correspond to the brightness, hue, purity, line thickness, and line length of the visualization in visualization, and the precise matching relationship is established through artificial intelligence for visualization.

Use particle guidance (Seeker) to establish the randomness of the appearance of the new picture, represent the coordinate pixels in the image space, and define the corresponding data structure. It has parameters such as position, speed, and inertia. When each note arrives, the speed and track size will be updated according to the intensity of the audio. When the instantaneous channel intensity is

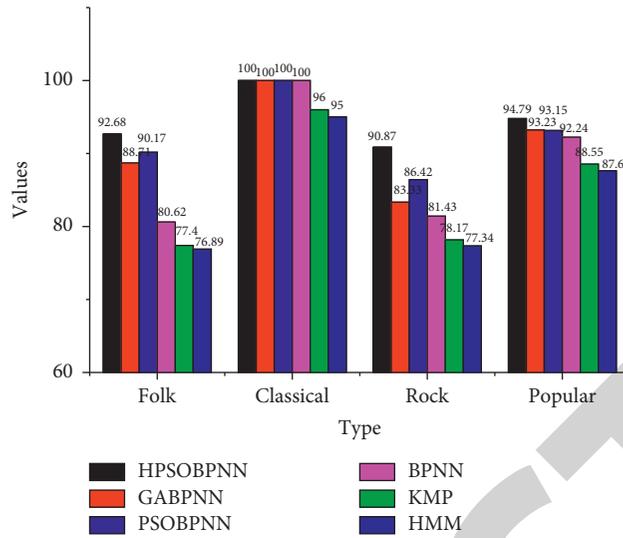


FIGURE 6: Classification accuracy of various models.

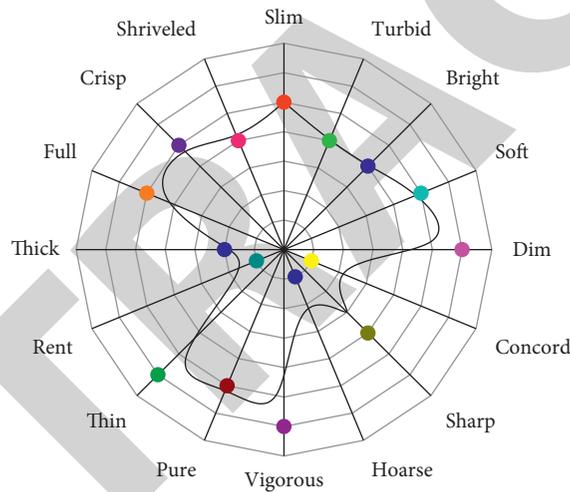


FIGURE 7: Tonal character diagram.

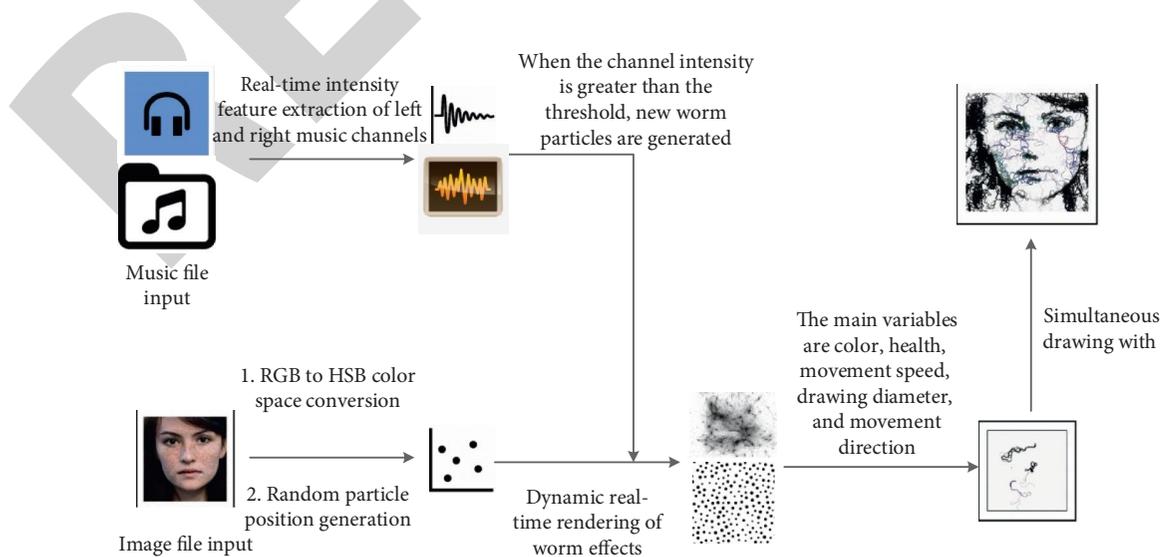


FIGURE 8: Image style migration operation process guided by music features.

greater than the threshold of 0.8, new worm particles are allowed to be generated, which is also the generation of new picture pixels. Then, the current particle position can be inferred based on the inertia of the object. Our results have high accuracy and fast efficiency.

In the process of dynamic image style transfer and reconstruction, the algorithm will grasp the rhythm of music and adjust the speed and content of drawing artistic effects based on drawing motion pixels. At the same time, the moving points are filtered to ensure that the generated artistic image retains the important edge information of the original image, as shown in Figure 8.

It can be seen from the results that our results have a significant improvement in efficiency and accuracy compared with the traditional moral SVM algorithm. The efficiency has increased by 20%, and the accuracy has increased by 10.5%.

5. Conclusion

The automatic classification of audio frequency research, especially the classification of voice and music, as one of the important means for extracting the semantic meaning and structure of audio frequency, has also attracted increasing attention. This article uses the Cestrum coefficient method to extract music characteristics and uses the adaptive variable particle group algorithm to optimize the BP neural network to classify music types. Compared with other methods, its classification accuracy rate is improved.

At the same time, in the process of realizing the visualization of music migration, based on the computer reading and processing the frequency, amplitude, and timbre of the music, the input music file is analyzed through the preprocessing stage, and the real-time intensity of the left and right channels in the music file is extracted to establish random Generate effects and use music features and image features as dependent variables to control the location and timing of particle generation. Finally, in the generation stage, each effective particle is dynamically displayed through the worm effect, and the position and number of new particles during the rendering process, as well as the shape, colour, and speed of the particles, are controlled, and the effective feature values updated in real-time guide the rendering effect. Compared with the traditional visual communication design that expresses the speed of the rhythm through the alternation and repetition of forms and colours, this new visualization method can provide users with customized personalized services on a large scale and generate personalization according to personal preferences. Portraits can also display real-time dynamic pictures during music playback, enhance the user's audio-visual experience, and symbolize the resonance between artificial intelligence and human emotions.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest reported in this paper.

Acknowledgments

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