Product design difference perception model based on visual communication technology

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Abstract: In order to overcome the problems of high output error rate and low signal-to-noise ratio in the current product appearance design difference perception model, a product appearance design difference perception model based on visual communication technology is proposed and designed. Based on the data analysis of product appearance design difference perception, the basic information of difference perception is introduced to adjust the overall image information of product appearance design, and the product appearance design difference perception model is set based on visual communication technology, so as to achieve the purpose of design research of the overall model. The experimental results show that the output error rate of the designed model is small, the average output error is 3.08%, the peak signal-to-noise ratio is high, and the highest peak signal-to-noise ratio is 47.2. It shows that the designed model meets the needs of improving the effect of product appearance design.

Keywords: visual communication technology; product appearance; appearance design; design difference perception model.

Reference to this paper should be made as follows: Wang, Y. (2022) 'Product design difference perception model based on visual communication technology', *Int. J. Product Development*, Vol. 26, Nos. 1/2/3/4, pp.64–76.

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1 Introduction

Due to the continuous development of social science and technology, product packaging technology also develops. The gradual improvement of material life stimulates people's demand for product design. Good product design can stimulate consumers' purchase intention. There are many design problems in the field of product appearance design in China, and the attention to product appearance is not high. At present, the main problem of product appearance design in China is the simplification of design, which cannot meet the needs of different users. At the same time, the timeliness of product appearance is short, which affects the consumer awareness. For this reason, many researchers build difference perception model for product design requirements. Through the principle of user demand and product design concept, we can continuously improve the design quality of product appearance, and then create a better product appearance to meet the needs of economic and social development.

In order to improve the visual effect of product design, a lot of academic research work has been carried out on product design difference perception model at home and abroad. For example, Wang (2020) proposed a product design difference perception model based on three-dimensional contour reconstruction. In the visual effect optimisation design of product packaging, we should combine the ecological natural elements with visual performance, and use the image feature detection and three-dimensional contour reconstruction analysis method to analyse the visual effect characteristics of different product packaging. At the same time, the corner labelling method is adopted to extract and analyse the information of the feature data, and the partial information entropy feature quantity of the product appearance visual information feature image is obtained. The computer analysis method is used to obtain the basic pixel distribution of the visual image of the product appearance, so as to realise the visual optimisation design of the product appearance and improve the artistic effect of the product appearance design. But the output error of this model is high. Helia et al. (2019) proposed a product design difference perception model based on automatic control. According to the product appearance information design input area and output area, automatic control mode is used to provide background data for complex product appearance design cases, and real and graphic data sources are used to adjust the model differences to meet the basic needs of model design. Based on the complexity of the product appearance design, the uncertainty and iteration in the design process are judged, and then the perception difference modelling method is used to analyse the product appearance design requirements, extract the reasonable initial design area, and complete the difference perception. However, the output SNR of this method still needs to be further improved. Yoo and Langari (2019) summarise the characteristics of user cognition based on the empirical model of user cognition product design innovation through observation, user interview and questionnaire survey. Based on this, the influence of different user cognition on product appearance design is analysed, and different difference perception models are designed according to the influence degree, but the output accuracy of the model still cannot meet the demand.

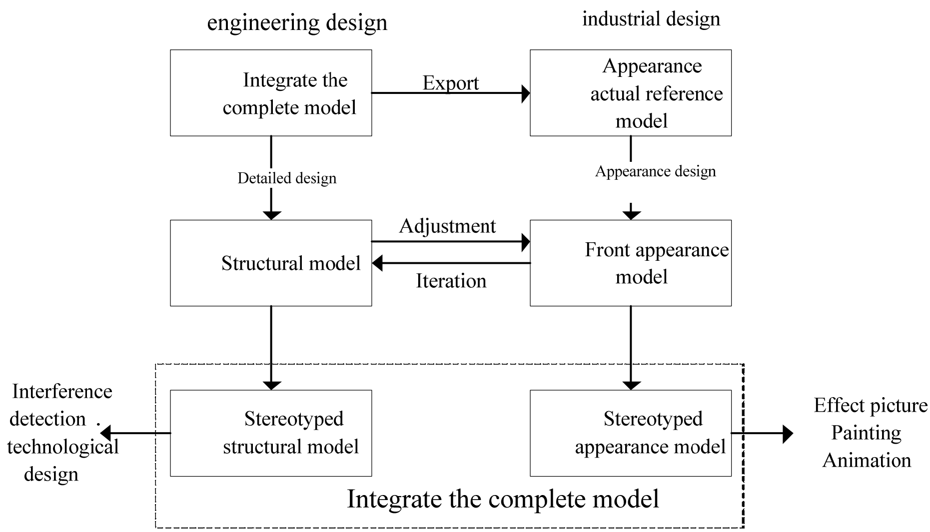
In order to improve the effectiveness of product appearance design difference perception, this paper proposes to use visual communication technology to analyse the product appearance design difference perception model. Starting from the product appearance design difference perception data, this paper analyses the data extraction steps, adjusts the parameter input mode of internal data neuron, and strengthens the management of the overall data information. Based on the analysis of the parameter data, this paper constructs the difference perception model, studies the product appearance design difference perception model based on visual communication technology, and verifies the application effect of the model through experiments.

2 Data analysis of product design difference perception based on visual communication technology

2.1 Difference perception data extraction

In order to better analyse the difference perception data of product appearance design, firstly, the difference perception data is extracted, the design framework of product appearance is analysed in the form of continuous function, and the product appearance design framework diagram is constructed (Fokin et al., 2019; Drummond et al., 2019; Qi et al., 2020). The frame diagram of product appearance is shown in Figure 1.

Figure 1 Product appearance frame drawing



According to the process analysis, the product appearance parameters are obtained, and the sample learning mode is adjusted to obtain the actual sample learning output value (Zhang, 2019; Muqtadiroh et al., 2019; Yoo and Langari, 2019; Silva et al., 2019). After obtaining the actual value, the discrete point data of learning parameters are extracted, and the data information of difference perception model within the learning parameters of samples is supplemented. Using multiple known continuous functions to evaluate the position of continuous functions. Based on this, the relationship formula between the sample learning parameter value and the continuous function parameter value is constructed:

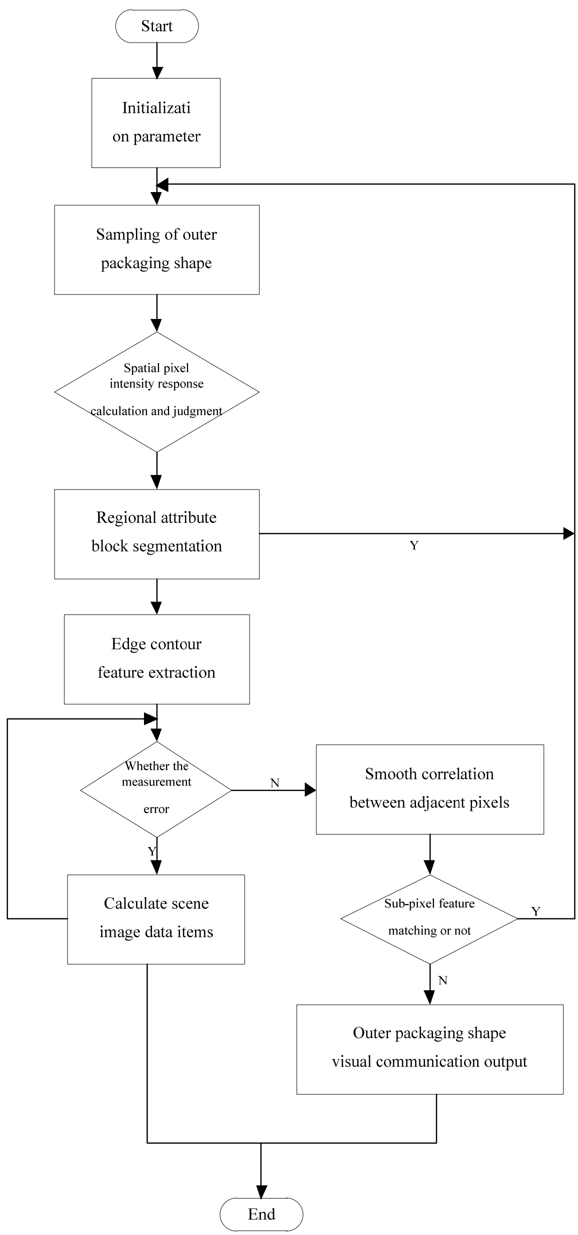
$$G = f^1, f^2_{\dots}, f^n \tag{1}$$

Among them, G represents the relationship parameter, and f represents the number value of the continuous function within the relationship. In order to improve the accuracy of the overall data extraction operation, the algorithm implementation flowchart is shown in Figure 2 (Ou et al., 2019; Zang and Sun, 2019; Wang et al., 2020). Further strengthen the correlation between parameters, and select appropriate parameter samples as the basis for data analysis. At the same time, the function sample is converted into the input function mode. The formula for constructing the mode is shown in (2), where T is the mode parameter.

$$D = \begin{bmatrix} Ix^2 & I_x Iy \\ I_x Iy & Iy^2 \end{bmatrix} \tag{2}$$

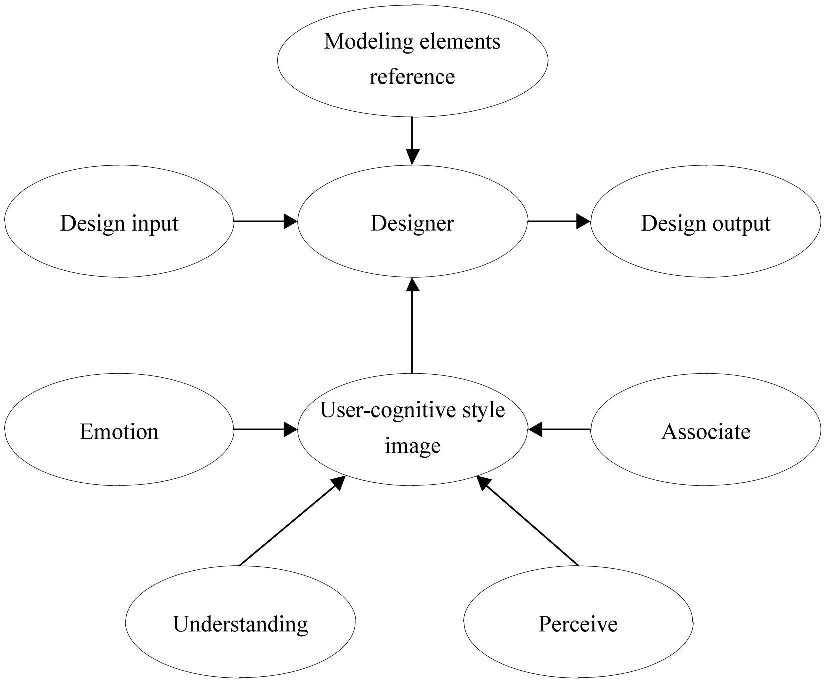
The algorithm implementation process is shown in Figure 2.

Figure 2 Algorithm implementation flow chart



In the process of data extraction, we need to constantly improve the operation of internal design information, strengthen the overall design processing, and set up the product design mind map. The product design thinking diagram is shown in Figure 3.

Figure 3 Product design thinking diagram



Combine the difference perception data in the same processing mode, strengthen the establishment of surface image feature data, allocate the operation form of the difference perception data (Liu et al., 2019; Haibing et al., 2020; Yi et al., 2020), manage the spatial data transmission mode of the extracted data, adjust the data information that does not conform to the transmission principle at any time, and increase Management efforts to achieve the overall difference perception data extraction operation.

2.2 *Differential sensing neuron data input*

After extracting the difference perception data, manage the internal neuron data input mode of the difference perception data, and implement internal monitoring operations in the neuron link field to ensure that the difference perception neuron data is in a reasonable input state at all times (Li, 2020; Yingying, 2020; Guo and Sun, 2019; Baochegn, 2019). And construct the neuron model expression as follows:

$$F_{(w)} = n\int \frac{1}{3}\left(\left|\nabla w\right| - 1\right)^2 adx \tag{3}$$

In the formula, w is the image matrix parameter of neuron model, a is the basic data parameter of neuron model, and n is the sequence value of neuron data matrix.

The neuron data information is adjusted in the central area, and the data weight is connected at the same time, and the pulse data is transmitted to the neuron data main control space to realise the visual perception operation. Timely change the internal state of the neuron, accelerate the rate at which the neuron releases synchronous pulses, and set the time threshold. Through L1 and F1 two modulation methods, the signal parameters connected to the input part are obtained during the modulation process. The internal state value of the neuron is obtained through the calculation of the data input formula. Control the internal feature distribution of neurons and construct the data control formula:

$$P\left(w, f_1 f_2\right) = k, \int \left[\int Z_\sigma \left(x - y\right) H_{(w)} dy \right] dx + K_2 \int \left[\int Z_\sigma \left(x + y\right) \left(1 - H_{(w)}\right) dy \right] dx \quad (4)$$

In the above formula, k is different neuron data, and $H(w)$ is the control parameter corresponding to the neuron data.

In the process of signal input, the signal rate will change. Therefore, it is necessary to adjust the overall data transmission signal in a short time to realise the differential neuron connection transmission operation. In the process of building product design, the information of product design difference perception is extracted, and the transmitted neuron data information is connected to the parameter storage space to judge the characteristic parameters of the difference perception model. On this basis, the difference perception model of product design is constructed to ensure that the neuron data is in the optimised processing state. And perform the following steps:

Firstly, the whole neuron data input matrix is set to control the operation range of grey value data in the matrix:

$$Q\left(w, f_i^a f_2^a\right) = k, \int \left[\int N_\sigma \left(x - y\right) H_{(w)} dy \right] dx + K_2 \int \left[\int N_\sigma \left(x + y\right) \left(1 - H_{(w)}\right) dy \right] dx \quad (5)$$

In the process of data transmission, it is transmitted to neuron input mechanism to avoid the influence of external stimulation on data transmission, and the neuron input program is quantified into a certain range. After connecting the data information of neurons, the total intensity of pulses released from each neuron was calculated. In order to facilitate the establishment of perceptual difference neurons in the digraph, the visual transmission method is used to determine the other execution order, and the sequence editing formula is set:

$$Z = \frac{1}{\pi} \cdot \frac{c}{c^2 + n^2}, n \in R \quad (6)$$

Set up neuron data structure matrix, corresponding to different neuron data, adjust the internal information of neuron data, at the same time, construct the internal relationship space between neuron data. When the data is lost, timely start the spatial mechanism, allocate the matrix relationship, and input the information in row, and output the information in column. If there are different transmission criteria in the transmission process, we need to adjust the internal circulation mechanism to ensure that the neuron data transmission is in a reasonable range.

3 Construction of product design difference perception model based on visual communication technology

After obtaining the product design difference perception data, build a difference perception model based on the data parameters, use image processing technology to collect product design visual images, extract the edge contour features of the product design visual images, construct a three-dimensional visual reconstruction model, and perform three-dimensional Feature analysis and sparse surface feature reconstruction operations. Combine the product appearance data image and the feature image extraction information to construct a feature reconstruction image. And adjust the grey value of the image, obtain the feature point distribution position of the grey value image data, realise the reconstruction of the visual effect, and construct the feature point distribution extraction formula:

$$T = \left[f^1, f_1^2, \cdots, f^n \to f^{n+1} \right] \tag{7}$$

In the formula, f is the parameter value of the characteristic point.

The corresponding image information is collected. On the basis of obtaining the product appearance image feature data, the product appearance design difference perception model is constructed. The visual feature distribution value of product outer packaging modelling is calculated. The visual communication technology is selected to reconstruct the product appearance parameters. The active contour distribution equation of product outer packaging modelling visual image is obtained as follows:

$$L_{(n)} = \exp(-\alpha) L(n+1) \tag{8}$$

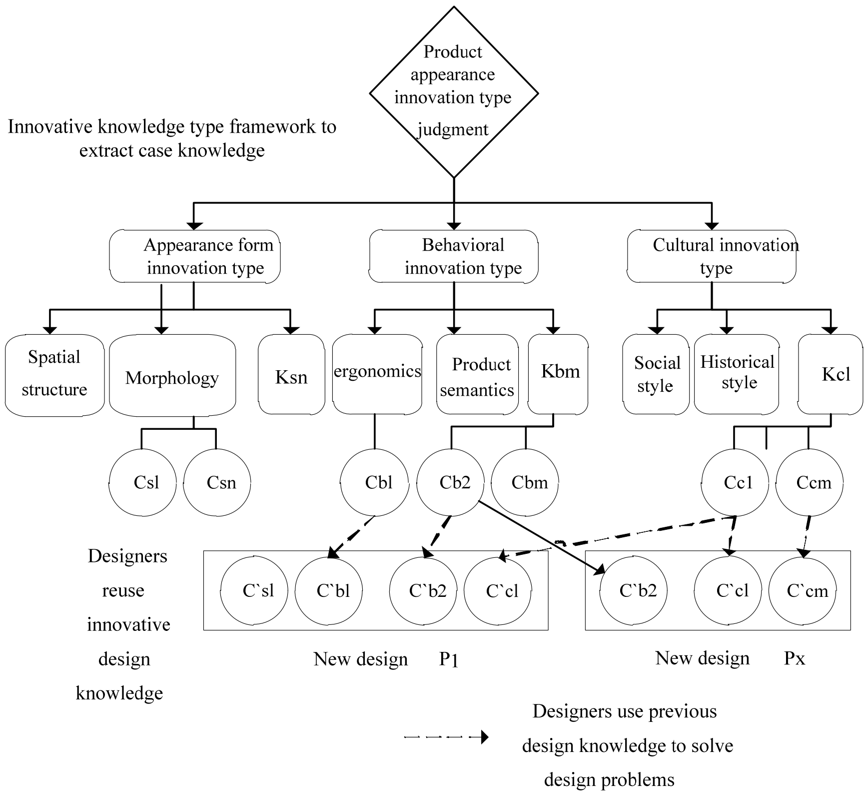
$$C = \left[X_1 X_2 \cdots X_n Y \right] \tag{9}$$

In the formula, X_n is the grey value of visual distribution of product appearance design, and Y is the distribution coefficient of edge fuzzy feature. The model parameters are reconstructed by VR virtual reality method, and the visual communication instructions are controlled in the operational range:

$$\frac{\partial^f}{\partial t} = -\sigma(f)\left[K(\lambda, e_1 - \lambda_2 e_2) + (1 - K)(\lambda_1 e_1 - \lambda_2 e_2) \right] \tag{10}$$

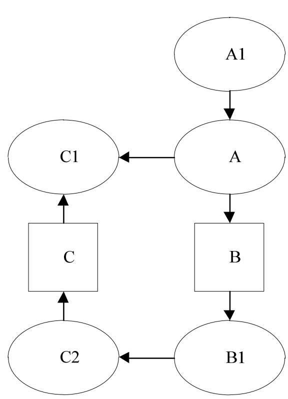
In the formula, K is the model parameters, σ is the virtual value of appearance design, and λ is the total number of model parameters. At the same time, the knowledge framework of the model is adjusted and the product design knowledge model diagram is constructed. The product design knowledge model is shown in Figure 4.

Figure 4 Product design knowledge model



Based on the above basic principles, the purpose of building a product design difference perception model based on visual communication is achieved. The product design difference perception model is shown in Figure 5.

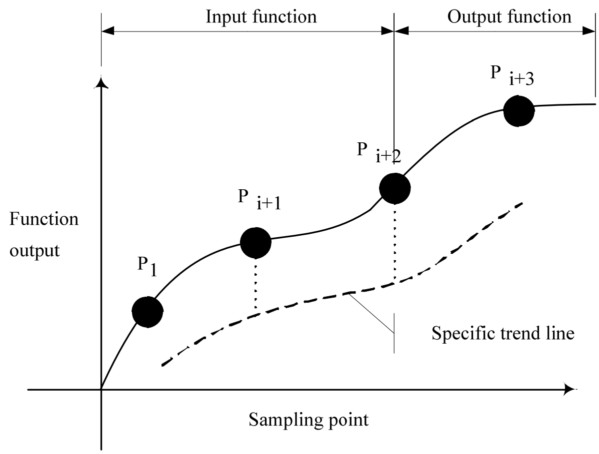
Figure 5 Product design difference perception model



4 Experimental research

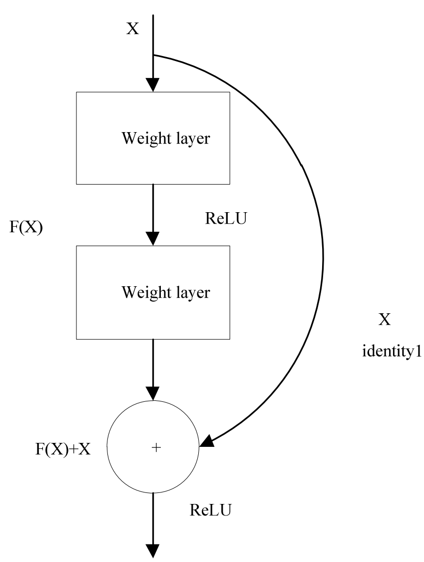
According to the basic data of the above product design difference perception model, the NN3 chaotic time series data is selected for the final experimental study, and the training data required for the experiment is randomly obtained. Taking NN3 data as the final judgment basis, it proves that the model constructed in this paper is reasonable. The experiment was conducted in July 2020 in our laboratory. The experimental function sample generation trend diagram is shown in Figure 6.

Figure 6 Trend chart of experimental function sample generation



Adjust the overall network parameters and set the network schematic diagram. The network schematic diagram is shown in Figure 7.

Figure 7 Network schematic diagram



4.1 Experimental indicators

Based on the above environment, comparative verification experiments were carried out. The overall experimental scheme is set as follows: Taking the output error rate and signal-to-noise ratio as the experimental comparison index, the model in this paper is compared with the model in Wang (2020) and the model in Helia et al. (2019).

1 *Output error rate*: output error rate refers to the error of perception results of different models. The lower the output error rate is, the better the perception performance is. The formula of error rate of perceptual output is as follows:

$$f(k)=\frac{N_{\sigma}(k)\cdot\left[H(\phi(x)).Z(x)\right]}{N_{\sigma}(k)\cdot H(\phi(x))} \tag{11}$$

In the formula, $(\mathrm{ERP})_x$ is the output program value of sensing signal, $(\mathrm{SLR})_a$ is the effective power data of neuron data information, $(\mathrm{ERP})_j$ is the internal communication parameter of information, and V is the data transmission rate parameter.

2 *Signal to noise ratio*: the output signal to noise ratio refers to the signal to noise ratio of the output results when different models are used for design difference perception. The higher the signal to noise ratio is, the more reliable the output results are.

4.2 Comparison of output error rate

In order to ensure the reliability of the overall experimental results, five experiments were carried out, and the output error rate comparison results of the three models are shown in Table 1.

Table 1 Comparison results of output error rate of different models

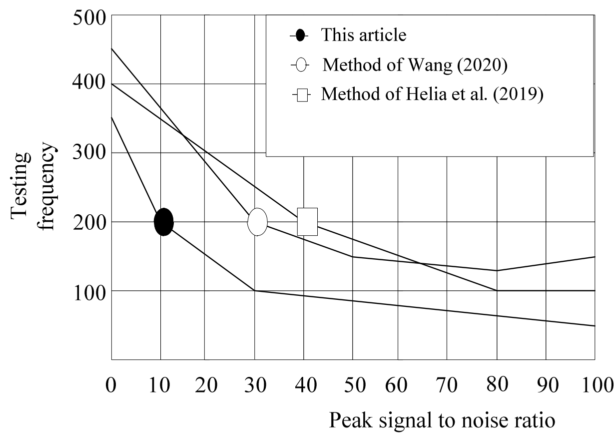
Sample	*Output error rate/%*		
	The designed model	*Wang (2020) model*	*Helia et al. (2019) model*
1	2.5	29.4	22.4
2	2.8	31.2	35.1
3	3.3	27.5	27.8
4	3.6	27.3	26.7
5	3.2	26.1	32.5
Average value	3.08	28.3	28.9

According to the above statistical analysis, the design difference perception model constructed in this paper has a lower output error rate. In five experiments, the average output error rate of this model is 3.08%, and the average output error rates of Wang (2020) model and Helia et al. (2019) model are 28.3% and 28.9% respectively. Therefore, this method has low output error rate.

4.3 PSNR comparison

After the above experimental research, MATLAB software is selected to simulate the product appearance data, and the program language is used to cross translate the file information inside the data, and the corresponding appearance design image acquisition pixel value is set to be 500 in height and 700 in width, the total number of training samples is 450, and the average grey value of the collected image is 2.4piex. According to the above experimental research operation, the overall contrast experiment is constructed, and the peak signal-to-noise ratio result data of the model test output in this paper is compared with the peak signal-to-noise ratio result data of the literature method. The SNR comparison results of the three algorithms are shown in Figure 8.

Figure 8 SNR contrast map



According to the above image, when the number of simulations is 100, the peak signal-to-noise ratio of the model in this paper is 47.2, the peak signal-to-noise ratio of Wang (2020) is 13.4, and the peak signal-to-noise ratio of Helia et al. (2019) is 21.3. When the number of simulations is 150, the peak SNR of the model in this paper is 53.1, the peak SNR of Wang (2020) is 15.7, and the peak SNR of Helia et al. (2019) is 24.5. From this analysis, the peak signal-to-noise ratio of the test output of the difference perception model in this paper is relatively high, and it has a strong visual effect of product appearance design. In the process of model construction, this paper continuously enhances the input intensity of the data principle of the overall model, improves the accuracy of the acquired image data, strengthens the information collection ability of the internal model, and studies the specific data differences of the difference perception model based on the analysis program algorithm At the same time, it compares difference information in time, analyses the perception relationship between different differences, and then extracts good data results. It has strong research operability, can conduct research operations in different environments, has a wide range of applications, and has good application effects.

In summary, visual communication technology not only has a small error rate, but also has a high output peak signal-to-noise ratio, which reflects the better technical application effect of visual communication technology. According to the experimental results, it can be analysed that the product design difference perception model based on visual communication technology has a strong application prospect and is more in line with the optimisation requirements of product design.

5 Conclusion

In order to improve the effectiveness of product appearance difference detection, a perception model of product appearance difference based on visual communication model is proposed. The performance of the model is verified from both theoretical and experimental aspects. The model has low output error rate and high output signal-to-noise ratio in the process of product appearance difference perception. Specifically, compared with the model based on 3D contour reconstruction, the output error rate is significantly reduced, and the average error is 3.08%; compared with the model based on automatic control, the output signal-to-noise ratio is greatly improved, and the highest output signal-to-noise ratio is 47.2. In the future research work, we should further reduce the output error rate and improve the effectiveness of the perception model.

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