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Research Article

Construction of Digital Virtual Cultural and Creative Product Design Model Based on Partial Differential Color Feature Extraction

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The digital virtual design model in the field of cultural and creative product design has attracted much attention of researchers due to its high adaptability. The traditional cultural and creative product design method has poor color feature interpolation effect, so algorithm improvement is urgently needed. Based on the theory of partial differential color feature extraction, this article proposes an improved design method for segmenting digital virtual cultural and creative products and introduces a color feature item on the basis of the original model. The improved partial differential algorithm can not only solve the re-initialization problem in the process of feature evolution, but also adopt a more flexible initialization method (the level set partial differential function can be loosely defined as the signed distance partial differential function). The simulation results show that the partial differential color feature extraction algorithm has a good performance in determining the target area of the product, the target segmentation rate reaches 91.7%, and the calculation speed of the algorithm is increased to 0.216s, which effectively improves the color feature interpolation effect of cultural and creative products by bringing results closer to the digital virtual trend.

1. Introduction

The segmentation method based on color edge cultural and creative product design information generally has better localization effect on the color edge, but it does not have the global segmentation ability, whereas the color-based segmentation method is global cultural and creative product design information, and sometimes the edge positioning of the product is accurate. In fact, the segmentation of colors should be the optimal division of color regions, but without the design information of edge cultural and creative products, the exact position of the color boundary cannot be determined [1]. Since the direct variation of color feature functionals often boils down to specific partial differential equations and corresponding boundary conditions, the task of color inpainting can be attributed to proposing color feature functionals that meet best guesses or designing partial differential equations that meet specific visual requirements. In practice, it is difficult to establish a partial differential function of color characteristics that fully conforms to the "best guess," or it is difficult to select an ideal partial differential function to digitize the virtual space. Therefore, the best guess principle is to study the problem in a statistical way, which is similar to the analysis of the real world by Bayesian theory. Models must be able to repair broken smooth narrow edges. The principle contains two meanings. First, the principle emphasizes that the edge is the most important visual feature in color, so the repair of the broken edge is the most important; second, due to the influence of the scale factor, it is not necessary to expect the model to be able to repair the wider edge [2–4].

Through 3D scanning, the digital virtual space coordinates of each measurement point on the surface of the object can be obtained, and some devices can even obtain the design information of the structure and cultural and creative products inside the object. For the scanning method, in the

early days, multiple probes were used to contact the surface of the object from different directions to obtain 3D cultural and creative product design data on the surface of the object. Later, the principle of radar was used to replace the probe with laser and ultrasonic waves. Using color and video modeling is to use the principles of computer graphics to restore the geometric structure of three-dimensional shapes from two-dimensional colors [5–7]. Compared with the above two methods, this method has the advantages of low cost and high degree of automation. Among them, the design method of cultural and creative products based on digital virtual space scatter can be summarized into three main steps: constructing partial differential color features, extracting features, and smoothing cultural and creative products. Thanks to the unremitting research of many researchers in related fields over the years, many efficient and rigorous partial differential algorithms and ideas have been proposed and put into practical applications. However, these methods still have many shortcomings. At present, there is no partial differential algorithm that can construct a smooth cultural and creative product while keeping the surface trend unchanged for the design data of geological cultural and creative products. In the field of geological cultural and creative product design data processing, there is no feature extraction partial differential algorithm with particularly good effect. In this article, the design of cultural and creative products on the surface of the target body is studied, and the construction of partial differential color features, feature extraction, and smooth processing of cultural and creative products of elevation models are deeply explored, and a complete set of cultural and creative product design is realized [8–10].

Based on the theory of partial differential color feature extraction, this article first determines the highest priority in order to determine the order of filling, so as to ensure that the color line structure is propagated before texture filling and to ensure that the target boundary is connected; finding the best sample block is to find the most matching block in the original area according to the similarity of texture; copy the best sample block is to copy the selected block to the appropriate position in the target area; and update the confidence is to determine the new sample area. Compared with other partial differential algorithms, this partial differential algorithm makes the filling order more reasonable according to the structural characteristics and has nothing to do with the topology of the repaired area. Then it may describe the mathematical basis of partial differential equation color segmentation, study partial differential feature evolution theory and level set method, and discuss several classical geometric active contour models. For the simplified color feature, functional active contour model (CV model), combined with color edge model, proposed a geometric active contour model based on edge and regional cultural and creative product design information and applied it to medical color. The V model is extended to the virtual space of vector digitization and multichannel segmentation of colors. We improved the velocity partial differential function of the CV vector model to remove the suppression of nonzero level sets by the Dirac partial differential function, allowing the model to detect color edges far from the initial contour lines. Using the similarity measure partial differential function to improve the synthesis method, a better repair partial differential algorithm that conforms to the human visual characteristics is proposed, which improves the image repair quality and speed.

2. Related Work

The color segmentation method based on partial differential equation usually needs to introduce some prior knowledge, such as introducing the differential geometric characteristics of color and smoothness prior constraints in the model, transforming the color segmentation problem into the minimization problem of color feature functional, and using variational methods to find the final solution to the problem. The research object of variational methods is the functional extreme value problem. The generality of the variational Euler equation can be approximated by the partial differential equation of the partial differential characteristic evolution. It depends on the specification of the starting point of the partial differential characteristic. It can be seen that for an open partial differential feature, the positive or negative sign of the curvature depends on the specification of the starting point of the partial differential feature. However, for the closed partial differential feature, the starting point and the end point are at the same position, but the detour direction of the partial differential feature can still be specified at this time. By convention, the detour direction is counterclockwise, so C will point to the interior of the closed partial differential feature, so when the curve is convex, the curvature is positive; otherwise, the curvature is concave, and the curvature is negative [11–14].

The basic idea of Kang [15] is to represent partial differential features, cultural and creative products, and color evolution as hyperplane level sets with higher dimensions. This technology not only provides a more accurate numerical calculation method, but also solves the problem of color topology change that has long plagued color processing scholars. Of course, the level set representation of target objects in color is not a new technology for computer vision and color processing, because it is the basic method of mathematical morphology. Work on color segmentation has also had a profound impact on the field of color segmentation. Later, many scholars put forward many improved models and methods on its basis. The general theoretical framework of color segmentation studied by Martínez [16] is a key contribution. Their work unifies a large number of segmentation partial differential algorithms, opening up a new field for color segmentation by functional variational partial differential equations, showing the broad application prospects of partial differential equations in color processing are presented. Live contour models include parametric live contour models and geometric live contour models. Most of the classic parametric snake models use the gradient of the color material to locate the edge of the object. In these models, some gradient-related edge partial differential functions are often defined first, and their values are positive in the homogeneous region and zero at the edge. Wang [17]

gives the color feature functional for C, the partial differential feature obtained by minimizing this functional eventually converges near the edge. This color feature functional usually consists of two terms: the first term controls the smoothness of the partial differential feature, and the second term is related to the gradient.

Martínez[18] believed that the closed partial differential feature evolution problem is a smooth and closed simple partial differential feature in a two-dimensional Euclidean digital virtual space moving at a certain speed along its normal direction, forming a series of partial differential features with time as a variable. The equations of closed partial differential feature evolution are divided into two types: explicit and implicit. The model starts from the minimization of the partial differential function of color characteristics and makes full use of the regional cultural and creative product design information of color to divide the entire color. Song [19] found that by introducing the external constraint color feature items based on the design information of cultural and creative products in the color region into the color feature partial differential function, the scope of action of the model was effectively expanded, and the position requirements of the initial contour line were greatly reduced. This is a big improvement over the traditional level set approach. However, this model does not consider the inherent properties of the level set partial differential function itself. In some applications, the level set partial differential function needs to be re-initialized to make it close to the signed distance partial differential function to ensure the accuracy of the model evolution. Explicit expression is a direct expression of how the parameters describing partial differential characteristics change during the evolution process. A general framework of PDE method applied in color processing is proposed. The framework is based on color feature minimization and variational method, so that PDE method can be widely used in various fields such as color segmentation, color enhancement, and color restoration. Among the various color processing methods based on PDE, the active contour model based on the variational method and the level set method embodies the superiority of the partial differential equation segmentation method and is currently a hot research issue in the image segmentation based on PDE. The basic idea of the active contour model is as follows: given an initial partial differential feature C, under certain constraints of color, the boundary of the target is detected by deforming the partial differential feature. It is characterized by combining the low-level features of color with high-level knowledge such as the position, size, and shape of objects and can integrate color cultural and creative product design data, initial contour estimation, features of contours to be extracted, and knowledge-based constraints in a single extraction process [20–25].

3. Color Feature Extraction Based on Partial Differential Equation

3.1. Distribution of Solutions of Partial Differential Equations. The first-order differential component of the feature of the partial differential equation is the tangent plane and normal vector of the cultural and creative product, and the second-order differential component of the feature of the partial differential equation is the curvature of the cultural and creative product. Curvature is an important cultural and creative product design information characterized by partial differential equations, and it expresses the degree and direction of curvature of the characteristics of cultural and creative products. In the three-dimensional partial differential equation, for a point, the degree of curvature in different directions is different, and the corresponding curvature is also different. The larger the absolute value of the curvature, the more severe the curvature.

$$W^t(u,v) \times x(u,v) + b \geq 1, if\{y - 1 = 0\}. \tag{1}$$

It can express the rich geometric details and lighting details of the surface through texture, and even express the geometric shape of the object through the deformation of the texture after mapping. But texture mapping can usually only perform one-to-one mapping in the texture digitized virtual space and the surface parameter digitized virtual space. Due to the limitation of the sampling area, the acquired texture samples are usually small textures. If a small texture is mapped to a large cultural and creative product, the surface texture will be blurred after mapping. If repeated mapping technology is used, problems such as surface texture seam aliasing may occur.

$$Y(s,t) = \begin{cases} f(s) - f(t), s > t, \\ f(s) + f(t), s \leq t. \end{cases} \tag{2}$$

Each subblock of the first layer will not be equally divided if the partial differential color feature attributes are consistent; if the attributes are inconsistent, the subblocks must be split into four equal blocks as the second layer, and so on. The principle of splitting and merging is as follows: merging: when the partial differential color features in the four blocks of the same layer satisfy the uniformity of a certain characteristic, they are merged into a mother block; and splitting: when one of the first layer, the partial differential color features in the subblock do not meet the characteristic uniformity condition, they are divided into four subblocks. The uniformity of a certain feature can be the uniformity of grayscale or the uniformity of a certain texture feature. The splitting and merging method have a better effect on the segmentation of complex colors, but the partial differential algorithm is more complex and requires a large amount of calculation, and the splitting may also destroy the boundary of the region.

$$\begin{bmatrix} a(1) & b(1) \\ b(t) & a(t) \end{bmatrix} = \begin{bmatrix} f(a) & f(b) \end{bmatrix} \times \begin{bmatrix} f(t) \\ f(t') \end{bmatrix}. \tag{3}$$

When k is taken as the average curvature, the color will shrink into a unit circle and then gradually shrink into a point; when seven is taken as the minimum curvature, all the concave points in the color move outward, and the convex points remain unchanged; when k is taken as the minimum curvature, all the convex points in the color move inward, and the concave points remain unchanged. The max-min

curvature flow equation is an adaptively selected curvature equation. The time domain and frequency domain are unified to study the signal, and the wavelet transform has multiscale characteristics, which can analyze the signal at different scales, and is more suitable for multiscale edge detection of color.

3.2. Color Feature Optimization Clustering. Color models can be obtained from color cultural and creative product design data through filtering, parametric or nonparametric estimation, and entropy methods. These statistical methods are important for restoration of rich textured colors. In order to reconstruct the design information of the geometric cultural and creative products, the color model needs to solve these geometric features in advance, and most traditional probability models lack such features. On the one hand, since the Mumford–Shah model minimizes the edge length, the repaired edges directly connect the existing edges, resulting in two visible artificial angles instead of a smooth partial differential feature; on the other hand, it also undermines the principle of connectivity in visual psychology.

$$g(x) - \begin{bmatrix} W^t \times a + b & -1 \\ 1 & W^t \times a - b \end{bmatrix} \times \begin{bmatrix} h & -h \\ -h & h \end{bmatrix} = 0. \quad (4)$$

The evolution speed of the partial differential feature is almost zero, and the partial differential feature stops at the edge of the color. This kind of velocity partial differential function works well for color segmentation with good contrast. However, if the target edge is not obvious or there is a gap, the geometric active contour line may leak out from the color edge. Once this happens, the evolution partial differentiating features makes it difficult to return to the correct color edge. In this way, the regional growth, active contour model, and Bayesian criterion are integrated. Regional competition is based on the statistical cultural and creative product design information of the area surrounded by the contour line to determine the advance and retreat of each point on the contour line and is similar to Tunothy's method to improve the correctness of the statistical estimation of the region and thus the correctness of the segmentation of Figure 1.

First, this type of partial differential algorithm models color in a digital virtual space with bounded variation and regards color as a piecewise smooth partial differential function, which does not contain any design information of texture cultural and creative products; second, the partial differential algorithm is essentially a diffusion process, that is, the design information of cultural and creative products around the damaged area is diffused into the damaged area. Once the damaged area is wider or has rich textures, the repaired area will become blurred. Quasi-RETs have some of the features and functions of RETs through unique product design, while avoiding some current domestic objective restrictions. By analyzing the development process of RETs in the country and the analysis of RET-like products, this article summarizes its product design ideas and key points of operation in combination with financial-related laws and theories and proposes possible problems and corresponding responses to the current design ideas of RET-like products.

$$\left\{ M^t(x,y) + f(a,b) \geq 1, if \left\{ y - 1 = 0, M^t(x,y) + f\prime(-a,-b) \leq 1, if \{ y + 1 = 0. \right. \right. \quad (5)$$

Two important parameters to describe the geometric features of PDEs are unit normal and curvature. The unit normal describes the direction of the partial differential feature, and the curvature describes the degree of curvature of the partial differential feature. Partial differential feature evolution theory is to use only geometric parameters such as unit normal vector and curvature of partial differential features to study the deformation of partial differential features with time. In the parametric active contour model, the evolution of partial differential features depends on any parameterized partial derivatives of differential features. The Shah model divides the color gamut into two subregions and then judges whether each subregion needs to be further divided. If a subregion needs this, it will be limited to this subregion to perform another segmentation and continue this process until each subregion has no requirement for division. The method does not require prior knowledge of the number of target species and can achieve the segmentation of multiple heterogeneous regions.

3.3. Partial Differential Digital Virtual Space Fitting Value. According to the different types of cultural and creative product design data in the digital cultural and creative product design model, different processing methods are derived. The feature extraction of product design data and the feature extraction based on partial differential color feature can be divided into feature extraction based on regular grid and feature extraction based on arbitrary triangular network. Since the method of this article to process the design data of digital virtual space point cloud cultural and creative products is to construct partial differential color features, the partial differential algorithm of terrain feature extraction based on contour line is not studied.

$$\sqrt{a_1^3 - a_3^3 + b_1^3 - b_3^3} = \left(f(x_1) + f(t,x_1)\right)^2 - \left(f(a_3) + f(t,x_3)\right)^2. \quad (6)$$

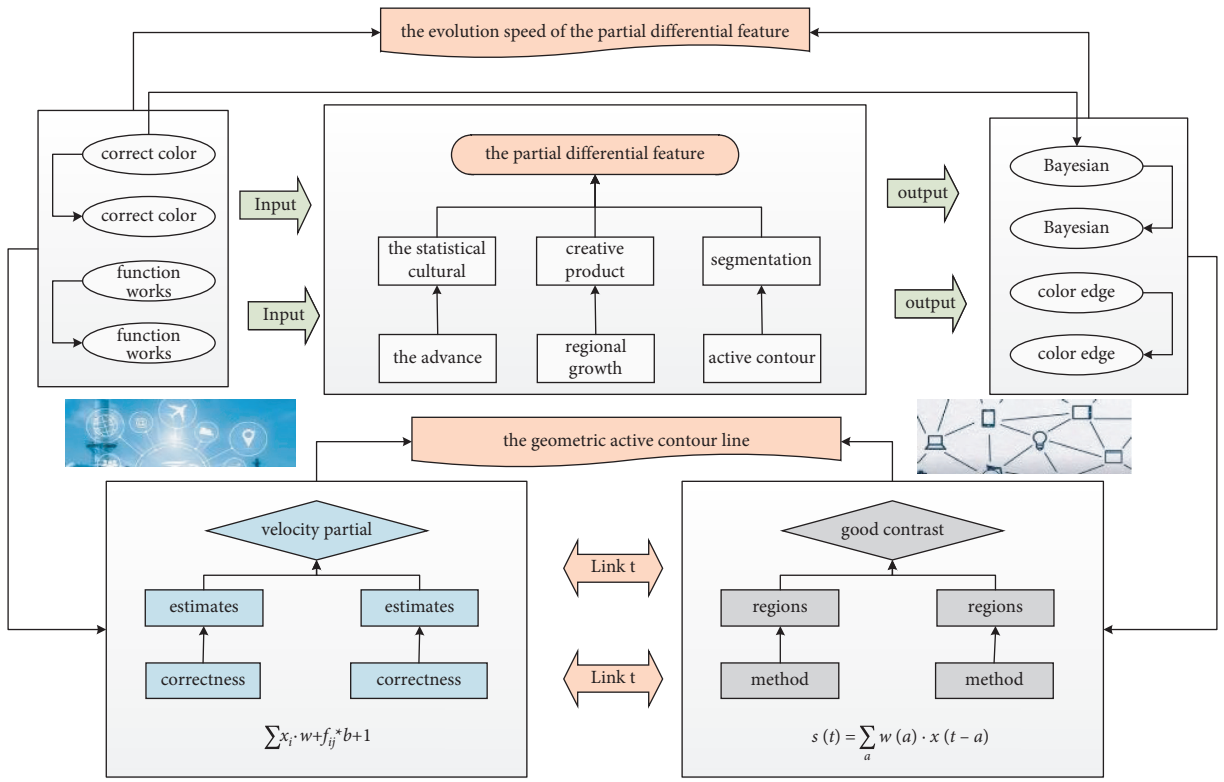

Figure 1: Evolution framework of partial differential color features.

There are many differences between regular grid and arbitrary triangulation models, which should be studied before introducing partial differential algorithms for feature extraction. The biggest advantage of this model is that as long as an appropriate level set partial differential function is given during initialization, the constraint effect of the internal color feature term can force it to always approach the signed distance partial differential function in the evolution process. Considering the shortcomings of the classical boundary-based geometric active contour model and the CV model, and combined with the advantages of the model without reinitializing the signed distance partial differential function, we propose a geometric active contour model based on the design information of regional and edge cultural and creative products. For the internal color feature, item of the model still starts with the features of the signed distance partial differential function and then introduces the internal color feature partial differential function.

$$F(c,t) \leftrightarrow \{[c0, c1, c2, \ldots, cn], [t0, t1, t2, \ldots, tn]\}. \quad (7)$$

The LIF local force stops accurately at the edge of the target, and the phenomenon of edge leakage or insufficient segmentation occurs; when the grayscale unevenness of the color is relatively light, only the GIF global force can pull the evolved partial differential feature closer to the edge of the target. In this case, this article chooses the smaller item as the weight of the LIF local force. In this way, the activity of the EPD mainly depends on the global force of the GIF until the EPD approaches the edge of the target.

At this time, the local force in Figure 2 becomes the dominant force, which starts to pull the evolution partial differential feature and finally stops exactly at the edge of the target. After a large number of experiments on uneven grayscale colors, this article finally chooses an appropriate value of CO = 0.9 for the parameter, which is effective for the segmentation of most uneven grayscale colors. Experiments show that the model in this article inherits the advantages of the improved CV model and LIF model at the same time. It is not only insensitive to the size, shape, and position of the initial contour, but also can better segment the uneven color of gray.

$$\begin{cases} L(s,t) + W(s,t) = s\sin\theta, \\ L(s,t) - W(s,t) = t\cos\theta. \end{cases} \quad (8)$$

In the traditional level set method, the initial contour line is generally a simple closed partial differential feature, that is, there is no intersecting closed partial differential feature. However, we use a nonclosed straight line as the initial contour line to extract all three targets, which cannot be achieved by the traditional level set method. It avoids the re-initialization process of the level set partial differential function in the traditional geometric active contour model; the flexible initialization method of the level set partial differential function makes the selection of the initial contour more free, and the calculation is much simpler. It increases computational speed by reducing the time required for each iteration. The calculation speed of this method is fast, and for some models that only rely on local cultural and

creative product design information, it can meet the needs of rapid calculation, but for some global optimization models, because each iteration requires color global cultural and creative product design information, the local fast solution cannot be used.

3.4. Feature Hierarchy Extraction Analysis. The proportion of local information set at the feature level is greater than the proportion of global cultural and creative product design information, specifically, set CO = 0.1. Other parameters are selected as follows: $c = 1$, $P = 1$, At = 1, $n = 5$, the value of seven is the largest integer less than it, and the values of parameters are given in each experiment. The parameters of the SLGS and RSF models were chosen as their default parameters. The selection of the common parameters of the model in this article is consistent with that of the RSF model. It is also consistent with the selection of the common parameter a of the SLGS model.

$$\begin{cases} f\max(u,v) = \sqrt{L_{loc}(t^u,v) + L_{cls}(p,u)}, \\ f\min(u,v) = \sqrt{L_{loc}(t^u,v) - L_{cls}(p,u)}. \end{cases} \tag{9}$$

The regular grid digital cultural and creative product design model is the most commonly used cultural and creative product design data model in terrain analysis. Many important digital cultural and creative product design models are in the form of regular grid cultural and creative product design data. The regular grid cultural and creative product design model uses the rectangular partial differential color feature to design the location of the cultural and creative product design data. The positional relationship between the value and the grid coordinate system is mapped on each subpartial differential color feature vertex, and each terrain point contains the cultural and creative product design value of the point.

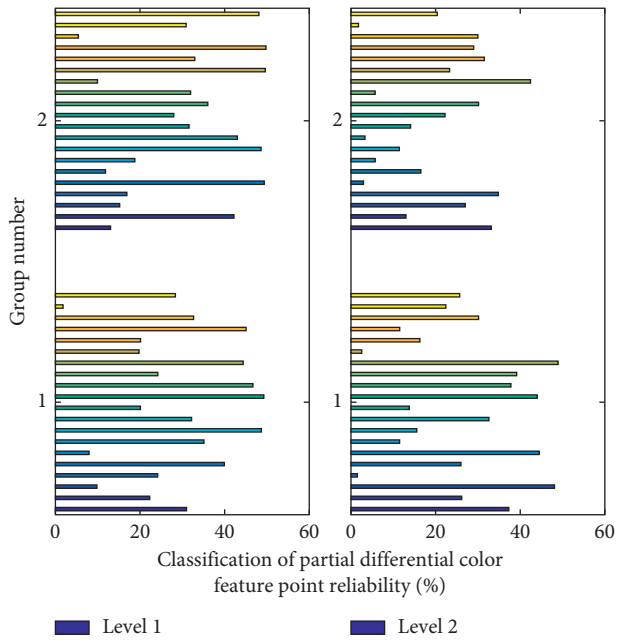

Figure 2: Comparative analysis of partial differential characteristic color uniformity.

$$f_{x,y}(y+x, y-x|x, y<0) = \left(\frac{1}{2}\sum_{i=1}^{n}x_i^2, \frac{1}{2}\sum_{i=1}^{n}y_i^2, \frac{1}{3}\sum_{i=1}^{n}x_i^2, \frac{1}{3}\sum_{i=1}^{n}y_i^2\right). \tag{10}$$

This repeated initialization scheme is a numerical remedy for level set evolution, which can maintain the stability of level set evolution and ensure ideal segmentation results. However, it is quite complicated and time-consuming to implement this method, which severely limits its practical application. In addition, it also faces a series of problems such as when and how to repeat the initialization most reasonably, and there is no uniform standard for the answers to these questions.

From the perspective of Table 1, a numerical remedy is adopted to ensure the regularity of the level set partial differential function. From the above discussion, it can be seen that solving the extremum problem of the color feature functional boils down to solving the corresponding Euler equation. In general, the Euler equation is a nonlinear PDE, and the discretization will obtain a system of nonlinear simultaneous algebraic equations, which is difficult to calculate numerically. The introduction of a "time" auxiliary variable turns the problem of solving a static nonlinear PDE into a dynamic PDE problem. When the evolution reaches a steady state, the solution of the Euler equation of the variational problem is obtained.

$$\frac{\partial T_j(i,j)}{\partial e(i,j)} = \frac{\partial A(i,j+1)}{\partial e(i,j)} - \frac{\partial A(i,j-1)}{\partial e(i,j)}. \tag{11}$$

The constants q and c2 of the level set partial differential function respectively approximate the average gray value of color inside and outside the evolution partial differential feature and contain the global cultural and creative product design information of color, which is a global quantity. However, since the model does not contain any local cultural and creative product design information of color, when the color is not uniform in grayscale, the segmentation result will have a large error. In addition, the initial contour line can be set at any position in the color, and only a closed contour line can be used to detect objects with internal holes in the color. The

Table 1: Initialization scheme of cultural and creative product design.

Product index	Uniform standard/%	Scheme label	Factor sign
Design-s1	53	The initialization	0.79
Design-s2	54	Design data point	0.82
Design-s3	55	Positional relationship	0.85
Design-t1	24	The regularity of the level	0.88
Design-t2	26	Horizontal and vertical coordinates	0.92

segmentation model does not rely on the design information of cultural and creative products on the edge of the color, even if the edge of the color is blurred or discrete, it can still obtain a better segmentation effect.

4. Partial Differential Color Feature Design and Iterative Method of Cultural Creative Product Design Elements

4.1. Partial Differential Color Feature Design. The cultural and creative product design data structure based on the regular grid color feature model is the mainstream cultural and creative product design data format in digital terrain research and processing for all cultural and creative product design information of creative products. For the cultural and creative product design data points in the regular grid digital cultural and creative product design model, and other adjacent cultural and creative product design data points related to their topology are usually used together as the source cultural and creative product design data for the modeling processing of the current point. It is mainly the closest point in its digital virtual space relationship, which are four directly connected points and four indirectly connected points at the diagonal corners of the partial differential color feature, namely the upper point, the lower point, the left point, and the right point, lower left point, upper left point, lower right point, upper right point, called the eight field points of the point.

$$u(\max(Q(on)) \times H(ide) \times \beta) \leftarrow v(\min(Q(on)) \times H(ide) \times \beta). \tag{12}$$

This experiment focuses on the experimental selection of the DFB decomposition series included in the extraction process of the rotation-invariant contourlet feature. By using the different geomorphological regions of the remote sensing color to perform the rotation-invariant contourlet feature calculation test, the appropriate medium and high-frequency components of the remote sensing color are selected with DFB decomposition series. In the feature extraction process, when using DFB decomposition for the middle and high-frequency subbands of $j = 1$ and 2, the DFB can be decomposed into eight directional components by three-level decomposition, or 16 directional components can be obtained by further four-level decomposition. In the experiment, the DFB three-level decomposition and four-level decomposition were calculated respectively in the process of extracting the features, that is, the remote sensing color rotation invariant. The first row of the parallel class is the calculation result of the eight-direction decomposition feature, and the first row is the 16-direction decomposition feature calculation result.

It can regard the area between the layers in Figure 3 as internal voids. When the contour line is located far outside the cultural and creative product, the original partial differential algorithm iteration 50 or more times cannot detect internal voids. The improved partial differential algorithm can not only detect internal voids, but also greatly improve the evolution speed. The triangulation of 3D point cloud is a key technology of 3D modeling. Different from the partial differential color feature cultural and creative product design data, the distribution of cultural and creative product design data points has no obvious rules and rigid regulations. For terrain analysis, the design data of cultural and creative products of Triangle Network has an irreplaceable role in the design data of cultural and creative products with partial differential color characteristics. For the situation where the terrain in some areas is flat and the terrain changes obviously in some areas, the design data of Triangle Network cultural and creative products can be sparsely distributed in the flat area and densely distributed in the undulating area, which can effectively represent the characteristics of the terrain.

$$\frac{\partial w'(q(1)) \times \partial w''(q(1))}{\partial w\imath(q(i)} > 0, \frac{\partial v'(q(2)) \times \partial v''(q(2))}{\partial v\imath(q(i)} > 0. \tag{13}$$

The parametric active contour line model is actually a color feature minimization model. Its deformation process is the process of the active contour line approaching the edge of the object under the action of external color features and internal color features, and the external force pushes the contour line to move towards the edge of the object. The internal force maintains the smoothness and continuity of the contour line, and the contour line converges to the edge of the object when the total color feature reaches the minimum value. Therefore, by solving the minimization problem of the partial differential equation, the color feature of this partial differential feature can be gradually minimized during the movement, and finally stop near the contour of the object to be found. However, this model has some shortcomings: the segmentation result depends on the setting of the initial contour line, the convergence speed is

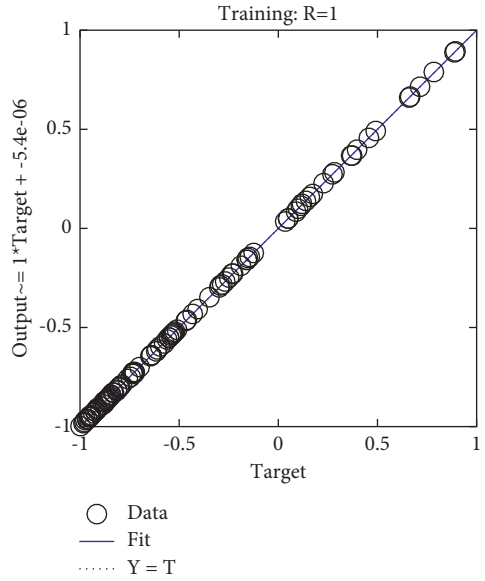

Figure 3: Partial differential color rotation fitting distribution.

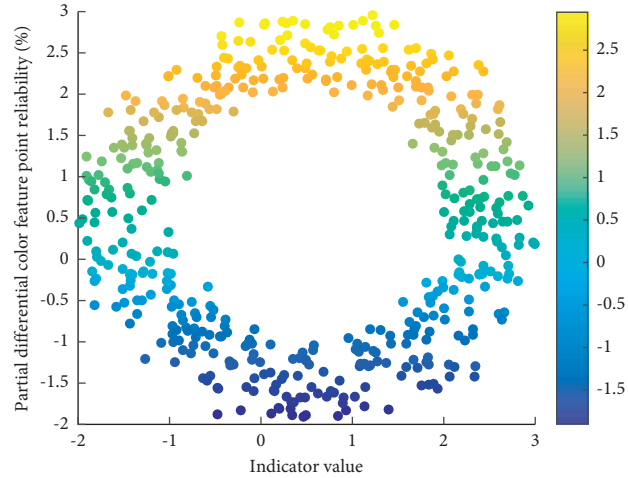

Figure 4: Reliability distribution of partial differential color feature points.

slow, the capture range is small, the evolution partial differential feature is difficult to enter the concave area, and there is no corresponding theory to guide the parameter determination.

4.2. Analysis of Digital Virtual Demand. In order to ensure the stability and accuracy of the numerical calculation, we adopt the method of combining the nonoscillating upside-down scheme and the central difference scheme. The digital virtual demand equation contains parabolic and hyperbolic terms. For the parabolic term, the definite solution area of the differential equation contains the design information of cultural and creative products in all directions, so it is only necessary to use the central finite difference format for discretization. For the hyperbolic term, its direction is always parallel to the gradient direction of the level set partial differential function.

$$\begin{cases} \dfrac{\partial w(x)}{\partial x} - \sum \alpha(y+x) = 0, \\ \dfrac{\partial w(y)}{\partial y} + \sum \alpha(y-x) = 0. \end{cases} \tag{14}$$

To ensure that the design information of cultural and creative products is transmitted along the direction of the characteristic line, for the stability of the numerical value, it is necessary to use the upwind style to solve. Since the stability of numerical calculation depends on the time step, the digital virtual space step, and the moving speed of the ultra-dimensional cultural and creative products, etc., so when setting parameters, first ensure that the time/digital virtual space step is less than or equal to l. In our experiments, some parameters are fixed as: the digital virtual space step size h, and the weight parameter of the inner and outer regions of the segmentation. The influence factor of geometric properties, the time step address, and the weight factor of the color gray gradient item are adjusted with different colors.

$$\frac{\partial b\{f[(w \times t) + b]\}}{\partial b \times x} \Rightarrow \frac{\partial a\{f[(w/x) + b]\}}{\partial a \times x}. \tag{15}$$

It may set an own color feature value for each terrain point. After calculating the inflow and outflow of color features, the color feature values of different terrain points will be superimposed. If the catchment obtained by superimposing a certain topographic point exceeds the set threshold, it can be judged that the point is a valley point. This method can remove tiny features. The judgment of the ridge point only needs to flip the cultural and creative product design model and perform the same processing once. Therefore, this method does not preprocess the color features, but selects the point with the smallest design value of the cultural and creative products in the edge point set of the color feature area as the color feature outflow point, so that the color feature is added to its outlet in the subpot. Taking the edge confluence processing method in river network analysis as a reference, the partial differential algorithm of valley line extraction in this article sets that the valley line segment must be an edge in the triangulation. So, when tracing the valley lines, the area confluence must be taken into account. Facing sinking is the flow of color features through the face of the triangle rather than through an edge of the triangle.

After the update of the reliability of the partial differential color feature point in Figure 4 is completed, it can be considered that the sampling process of a color is completed. At this time, the filling front will also change, resulting in a new filling front. If the partial differential color feature point of the filling front edge is not zero, continue to repeat the above three steps to determine the block to be repaired with the highest priority, find the best matching block of the block to be repaired with the highest priority in the source area, and copy the highest priority block to be repaired. The color cultural and creative product design data and update reliability of the best matching block until the entire area to be

Table 2: Description of fitted partial differential characteristic data.

Description code	D1	D2	D3	D4
P1	0.87	0.35	0.46	0.94
P2	0.40	0.72	0.13	0.83
P3	0.45	0.43	0.19	0.92
P4	0.77	0.76	0.82	0.29
P5	0.43	0.43	0.49	0.46
P6	0.11	0.88	0.19	0.67

repaired are filled. It is difficult for the restored color to be exactly the same as the color before the damage (original color), and there is always a difference, which reflects the quality of the color restoration. A range of quality measures have been proposed for color, ranging from the simplest, mathematically tractable measures such as mean squared error (MSE) to complex measures including the human visual system.

4.3. Iteration of Cultural and Creative Product Design Factors. The intelligent cultural and creative products serve the visually impaired group. The overall shape is low-key and simple. The outer frame adopts black lacquer surface, which is smooth and does not hurt the hands. Considering the psychology of users, the overall shape is de-labeled. The cultural and creative products have a total of three lenses, two ultra-wide-angle lenses on the left and right sides, and the main camera in the middle is a 10X hybrid optical zoom lens, which implements monitoring of 175° obstacles in front of them; when reading, you can intelligently scan the text on the book, through voice to transmit written content, you can also swipe your finger over the place, and your eyes can intelligently analyze the text part for voice broadcast. Built-in bone conduction engine, intelligent noise reduction, makes the sound transmission more comfortable, the whole product has only one button, namely the function button, which reduces the misoperation of visually impaired people.

$$\sqrt{a_1^3 - a_2^3} + \sqrt{b_1^3 - b_2^3} = \frac{\left(\log\left(a_1\right) + \log\left(a_1 + b\right)\right)^3 - \left(\log\left(a_2\right) + \log\left(a_2 + b\right)\right)^3}{\text{down step}}. \tag{16}$$

A color iso-illuminance line, also called a homochromatic line, refers to a line or a surface on a color that constitutes a locus of points with equal illuminance or illuminance for a given light source. The fitting method uses known points to design a fitting partial differential algorithm to make the reconstructed cultural and creative products close to the original cultural and creative products. The main basis for judging the pros and cons of the designed fitting partial differential algorithm is the approximation degree of the designed cultural and creative products to the original cultural and creative products. Different from the interpolation method, the fitting method does not require the known cultural and creative product design data points to maintain their own cultural and creative product design information unchanged. Both the interpolation method and the fitting method have some shortcomings, such as a large amount of calculation, the effect of retaining the trend in cultural and creative products is not good, and the processing results are not smooth enough. The newly emerging method of using partial differential equations for cultural and creative product design can overcome the above shortcomings.

In terms of segmentation method, the difference between grayscale color and color is mainly reflected in the description of each partial differential color feature in Table 2. The former is a one-dimensional brightness digitization virtual space, while the latter is a three-dimensional color digitization in virtual space. Colors contain more information on the design of cultural and creative products than grayscale colors and are more realistic descriptions of the objective world. Therefore, in many cases, it is necessary to segment colors. From the point of view of the segmentation principle, the segmentation of color and gray color is the same, both are based on the similarity of partial differential color feature values and the proximity of digital virtual space, but only the inspection and feature extraction of partial differential color feature attributes and other technologies from one-dimensional digital virtual space to high-dimensional digital virtual space. The biggest feature of vector color segmentation based on CV model is that the segmentation is global and can detect the interior of objects with holes.

5. Construction of Digital Virtual Cultural and Creative Product Design Model Based on Partial Differential Color Feature Extraction

5.1. Partial Differential Color Feature Data Analysis. In the process of color feature reconstruction, data point thinning, smoothing, interpolation, editing, etc., on the surface of the 3D model, it is often hoped that the processing results can be maintained and the characteristics of cultural and creative products can be restored. To this end, it is necessary to extract the surface features of the 3D model. The features of cultural and creative products are an important part of the 3D geometric model, including ridges, valleys, sharp edges, and sharp points, which are very important to accurately represent the outline of the model. The threshold segmentation method refers to that when segmenting grayscale colors, first select one or several values in the color grayscale value range as the threshold value, and then compare the grayscale values of each partial differential color feature in the color with this

Table 3: Numerical algorithm description of partial differential function.

Part node	Numerical algorithm description	Function text
1	$z\ (i, j)$ into Many subdomains	Class autounboxingtest {
2	For problems $L\ (s, t)$	Public static void main (String[] args) {
3	By analytical methods $\cos\theta$	Integer a = new Integer(3);
4	Numerical methods $\sin\theta$	System.out.println (a = = b);
5	Solution conditions by the division	Public static void main (String[] args) {
6	To the appropriate numerical differential	If (i≥integercache.low &&;)
7	The characteristics of the distance $\lvert\nabla i * \nabla j\rvert$	I≤integercache.high
8	In order to ensure $g(i, j)$	Integer $f1 = 100$, $f2 = 100$, $f3 = 150$;
9	The accuracy of numerical calculation $dpdu$	Return integercache.cach
10	The block to be repaired $\nabla x(i, j)$	System.out.println ($f1$ = = $f2$);
11	$\sum \partial L/\partial W$ will be relatively high	System.out.println ($f3$ = = $f4$)
12	The level set partial differential function	Private static class integercache {
13	These places contain $L_{loc}(t^u, v)$	Public static integer value of (int i) {
14	With corners $\int L(p, u, v, t^u)$	Static final integer cache[];
15	Reliability of the block to $\min(u, v)$	Return integercache.cache
16	Tendril $x \le y$ will be filled	String integercachehighpropvalue =
17	There are many filled $df(x, y)$	Sun.misc.VM.getsavedproperty
18	It can be seen from this $y_i \cdot (x, x_i)$	Cache = new Integer [(high - low) + 1];

value. The thresholds are compared, and each partial differential color feature in the color is divided into two or more categories according to the comparison result, so as to achieve the purpose of segmentation. The key of this method is to determine an optimal threshold. Therefore, most of the existing partial differential algorithms focus on the study of how to determine the threshold, but it is often difficult to determine the appropriate threshold size.

$$\begin{cases} \dfrac{\partial x(1, 2, 3, \ldots, t)}{\partial t} \in t \sin(i, j, k), \\ \dfrac{\partial y(1, 2, 3, \ldots, t)}{\partial t} \in t \cos(i, j, k), \\ t \in R(c + 1). \end{cases} \tag{17}$$

For problems that cannot be solved by analytical methods, numerical methods are generally used. Numerical methods reduce the problem into many subdomains in some way, and then use relatively simple known partial differential functions to approximate the related problems of the equations. Unlike the solution of the analytical method, the solution of the numerical solution can be expressed by the explicit partial differential function in Table 3, and a series of discrete values can only be obtained by numerical calculation. The idea of this method is to first divide the problem in the domain of definition with partial differential color characteristics, and then convert the integral in the definite solution problem into an integral sum and the differential quotient into a difference at the points obtained by the division according to the appropriate numerical differential formula. The difference equation is obtained by discretizing the original problem. The original equation and the definite solution conditions are approximated as algebraic equations and then the numerical solution is obtained.

Windows with corners or tendril edges will be filled in the front, because these places contain more known partial differential color eigenvalues, which can provide more reliable design information for cultural and creative products. It can be seen from this that when there are many partial differential color feature points in the sample area in the block to be repaired, or there are many filled partial differential color feature points, the reliability of the block to be repaired will be relatively high; on the contrary, the block to be repaired will be more reliable. If there are few partial differential color feature points that already exist or have been filled, and there are many partial differential color feature points located in the target area, the reliability of this partial differential color feature point will naturally be lower.

This development will result in the accumulation of errors, resulting in the final calculation result deviating from the real situation, and finally causing inaccurate or failed color segmentation. Therefore, in order to ensure the accuracy of numerical calculation, r, the level set partial differential function, should always be kept as the signed distance partial differential function. There are two reasons: one is because the implicit representation of the geometric partial differential feature is equivalent to its signed distance partial differential function. Another reason is the dissimilarity of the explicit representation of geometric partial differential features from their signed distance partial differential functions.

5.2. Design and Simulation of Digital Virtual Cultural and Creative Products. For the color of digital virtual cultural and creative products, it is either converted to grayscale color and then divided, or divided channel by channel and then merged. None of these methods can effectively utilize the design information of chroma cultural and creative products, which greatly affects the final segmentation effect. For the former, the shape characteristics of objects in color are not necessarily the same in different color channels, and conversion to grayscale will lose the available design information of cultural and creative products, so that complete

objects cannot be detected. As for the latter, the segmentation accuracy is affected by ignoring the correlation between different channels. If a boundary-based active contour model is used, such as the Li method, the color results have a lot to do with the selection of the initial contour, and it is necessary to iterate many times, and the segmentation cannot reach the ideal boundary. We choose this model to detect the geometric property influence factor $t = 1$, the time step and = 1, and the gray item weight $w = 0.1$,

$$\begin{cases} \dfrac{\sum_{i=1}^{N} \partial X_i \times \partial S_j}{\partial N - 1} + 2\Delta X(m,n) = 0, \\ \dfrac{\sum_{i=1}^{N} \partial Y_i \times \partial T_j}{\partial N - 1} - 2\Delta X(m,n) = 0. \end{cases} \tag{18}$$

The sparse point cloud belongs to the low-frequency cultural and creative product design information of cultural and creative products, and the characteristics of cultural and creative products belong to the high-frequency cultural and creative product design information of cultural and creative products. It is very simple to obtain low-frequency cultural and creative product design information from the high-frequency cultural and creative product design information. It is very difficult to recover high-frequency cultural and creative product design information from creative product design information, so how to extract the characteristics of cultural and creative products using a small amount of uneven cultural and creative product design data is a research problem. The result of feature extraction for cultural and creative product design data with uneven partial differential color features must be inaccurate, so a method must be designed to construct uniform partial differential color features that can restore the trend in cultural and creative products.

$$\frac{\partial \sqrt{f\left(t - t^2 + 1\right)}}{\partial \sqrt{f\left(t - t^2\right)}} - f(t, t-1) \times |\nabla f(t)| = 0. \tag{19}$$

(1) Partial differential color feature cultural and creative products based on language recognition, speech synthesis, and color recognition technology provide voice broadcast reminders for obstacles encountered by users when traveling. In the form of auditory compensation, users can easily face some life problems. (2) The lens of the product is completely embedded in the frame, no acute angle is exposed, the type-c interface is charged, and the power is automatically cut off when fully charged, so as to avoid fire caused by overloading of the circuit, and bone conduction technology avoids the problem of ear inflammation caused by in-ear headphones. (3) The product will intelligently judge user behavior according to the user environment and automatically feed back real-time information according to different scenarios. (4) The weight of the product itself is the same as that of conventional cultural and creative products, so there is no pressure when wearing it. The product switch and the voice assistant wake up, and after the voice assistant is quickly called out, the whole process of voice control is adopted.

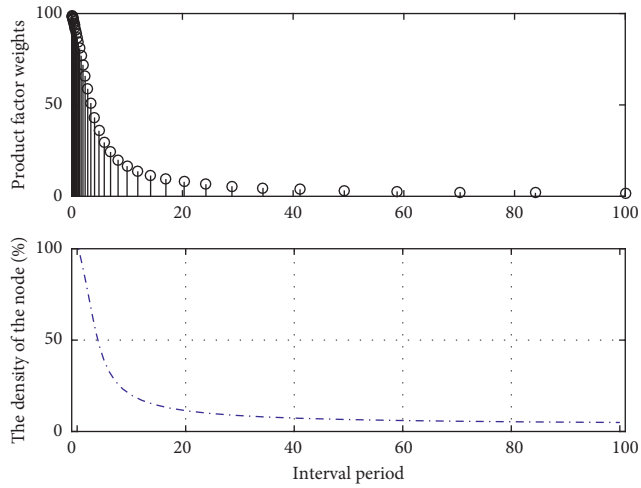

Figure 5: Feature extraction distribution of cultural and creative products.

In order to keep the trend in the original creative product in the final processing result, the features of the original creative product in Figure 5 are also extracted. The first problem to be solved is to calculate the block to be repaired with the highest priority on the filling front. Before determining the block to be repaired with the highest priority, the priority of all the blocks to be repaired on the filling front should be calculated first. The priority determines the filling and repairing order of the damaged color. The priority is determined by two factors: one is whether the window is located in the obvious edge position in the color. These positions have important structural information and should be filled first. The second is the reliability of the partial differential color feature around the window. The higher the reliability, the more surrounding information, and the more accurate the filled partial differential color feature value.

$$\begin{cases} \sum\sum u(i+x) + \mathrm{u}(i+x) - \sum u(y+x) = 0, \\ \sum\sum v(i+x) + \mathrm{v}(i+x) - \sum v(y+x) = 0. \end{cases} \tag{20}$$

At the same time, the rotation-invariant wavelet feature calculation is also carried out for these different landform regions. After angular rotation of different geomorphological regions, it is verified whether the rotation-invariant contourlet feature and the rotation-invariant wavelet feature still have the same rotation-invariant characterization characteristics of various regional features of remote sensing colors.

The partial differential feature family generated by the deformation contains an infinite number of points in the interface, which means that the interface needs to be discretized into an infinite number of blocks accordingly. Suppose we are now going to evolve a cultural and creative product in a two-dimensional digital virtual space. Even without changing the topological structure of the cultural

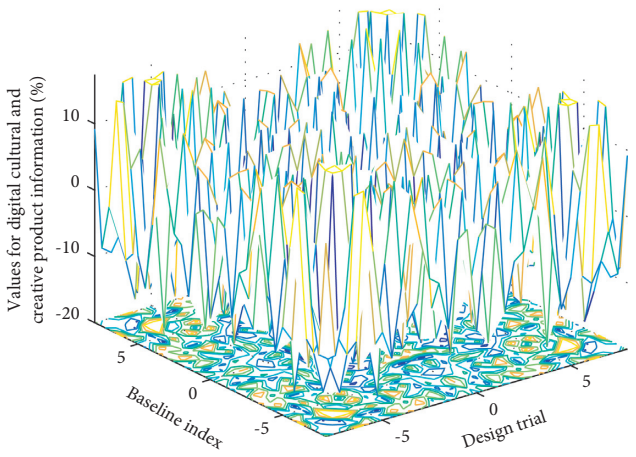

Figure 6: Three-dimensional distribution of digital cultural and creative product design information.

and creative product, we still need to ensure the smoothness of the cultural and creative product and the quality of the cultural and creative product during the entire evolution process. Once the cultural and creative products are singular, this will not be able to get a correct solution. When applying the PDE evolution theory to color processing problems, the PDE equation of motion often comes from a "color feature" functional (such as a variational model) that minimizes the closed PDE feature variational models in color segmentation need to be segmented.

5.3. Experiment Verification and Result Analysis. For the feature extraction partial differential algorithm of the design model of cultural and creative products, there is a relatively classic color feature method based on the relevant principles of color feature analysis, but the color feature method has its limitations. Lower points or lines cannot extract places where the curvature of cultural and creative products changes drastically. The curvature-based feature extraction partial differential algorithm extracts the curvature features of cultural and creative products, but the obtained results are seriously fragmented.

In the design of the partial differential algorithm, each partial differential color feature point in the template has a gray value and a confidence level (indicating the filling status of the point: 1 means filled, 0 means not yet filled). The order of filling should be that the outline is gradually filled from the outside to the inside, making full use of the existing cultural and creative product design information, and ensuring that the structural cultural and creative product design information is generated first. Each window in Figure 6 has a temporary priority, which determines the priority order in which each window to be repaired is filled.

Combining the SLGS and RSF models, an active contour model expressed in the form of partial differential equations is proposed. The SLGS model is an active contour model based on global cultural and creative product design information, which allows flexible contour initialization, but cannot deal with uneven grayscale colors. The RSF model is

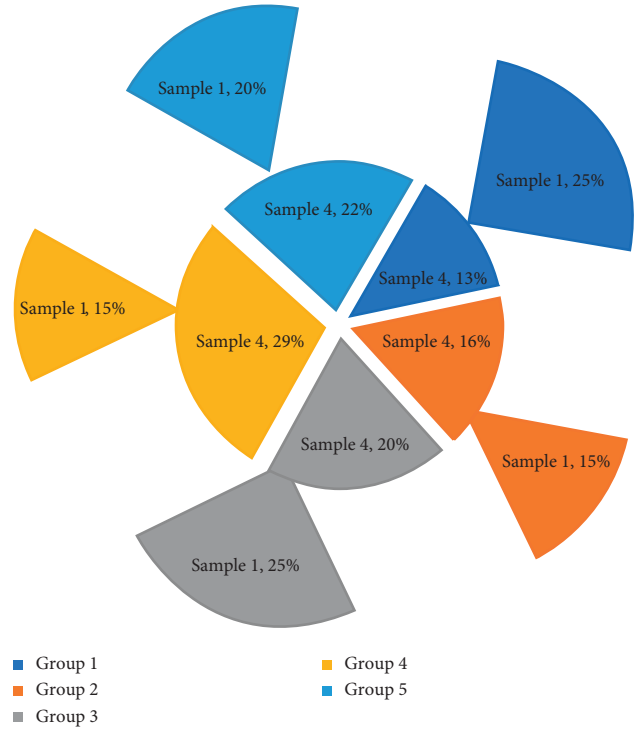

Figure 7: The amount of product information extracted from color features.

an active contour model based on local cultural and creative product design information. It can segment grayscale uneven colors, but is sensitive to the initialization of contours. In this article, the local cultural and creative product design information defined by the RSF model is integrated into the SLGS model, and a new active contour model is proposed. Experimental results show that the model can not only effectively deal with uneven grayscale colors, but also allow flexible contour initialization. In addition, for some colors with weak and blurred edges, more accurate segmentation results of the ELSLGS model are obtained.

$$\begin{cases} \dfrac{\partial z(i,j)}{\partial y(i,j)} \times \dfrac{\nabla z(i,j)}{\nabla y(i,j)} = -g(i,j), \\ \dfrac{\partial w(i,j)}{\partial x(i,j)} \times \dfrac{\nabla w(i,j)}{\nabla x(i,j)} = -f(i,j) \times |\nabla i \times \nabla j|. \end{cases} \tag{21}$$

Using HIS color digital virtual space can reduce the complexity of color processing, thereby increasing the speed. Arithmetic operations or partial differential algorithms commonly used in color processing, such as the Sobcl operator (convolution operation) for edge detection or edge enhancement, can achieve good results as long as they operate on the luminance signal of the HIS color digitized virtual space. It is very inconvenient to do the above operations in the RGB color digital virtual space. A large number of partial differential algorithms in color processing and computer vision can be conveniently used in the HIS color digitization virtual space, and they can be processed separately and independently of each other.

Therefore, in the HIS color digital virtual space, the workload of color analysis and processing can be greatly simplified. It can be seen from the experiment that if the optimal basis selection strategy is used in the redundant contourlet decomposition process of remote sensing colors, the number of subbands to be decomposed will be reduced, thereby greatly reducing the calculation amount of the feature extraction process: at the same time, the selected optimal basis selection strategy also ensures that the subbands obtained by the final decomposition contain the largest amount of cultural and creative product design information. Finally, according to the described method for the obtained decomposition subbands, the optimal remote sensing color redundancy contourlet feature can be finally obtained.

Through the practical consideration of user scenarios, the design of visually impaired products is realized under the framework of partial differential color feature technology, and the application technology of partial differential color feature in Figure 7 is reasonably selected. The transformation and functional positioning of partial differential color feature technology, the relationship between human and machine, and the relationship between indirect users and products are defined as the design elements of the product, and the product is established on the basis of the principles of physiological sensory compensation, functional safety, emotional experience, and ease of operation. Finally, the feasibility of the method is verified through the design practice of visual barrier products based on partial differential color feature technology.

It should be noted that the first interpolation only considers the direction of the terrain and ignores the continuity of cultural and creative products. The number of smoothing is a small amount, not more than 10 times. Because feature extraction has not been performed at this time, and there are no fixed feature points, too much smoothing will smooth the features. After a small amount of smoothing of the partial differential color feature points, and then triangulation, a uniform triangulation cultural and creative product design model can be obtained.

6. Conclusion

Based on the application and analysis of partial differential color feature technology, this article deeply analyzes the current application field of cultural and creative product design technology and elaborates the architecture of partial differential color feature technology through literature research. The application technology analysis of the existing typical partial differential color feature products in the market is carried out. Aiming at the problem that the local color fitting (LIF) model is sensitive to contour initialization, combined with improved CV model, proposes an active contour model that integrates local and global color cultural and creative product design information. After the user selects the area to be repaired, the partial differential algorithm extracts the structural features (contour lines) around the area to be repaired, naturally extends the contour lines from the area boundary inward, and spreads the design information of the boundary cultural and creative products smoothly along this direction. This type of partial differential algorithm can fill in areas containing different structures and textures, and there is no limit to the topology of the area to be repaired and is suitable for repairing narrow areas such as scratches, smudges, and text. Another type of partial differential algorithm for color restoration is the texture synthesis partial differential algorithm based on sample images. The global grayscale fitting force in the V model and the local grayscale fitting force in the HLIF model are composed of a linear combination. The filtering regularized level set partial differential function method is used to realize the regularization of the level set partial differential function. Experimental results show that for some real and artificial colors, the proposed model shows strong robustness to contour initialization and better ability to handle grayscale uneven colors.

Data Availability

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

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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