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# Digital Rebirth of Dongba Pattern: An Improved Active Contour Model for Pattern Contour Extraction

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**ABSTRACT** In response to the time-consuming and laborious problem of manually drawing elements in existing poster designs, this paper proposes a method for extracting the contours of Dongba patterns based on improved active contour model. The improved active contour method adds discrete wavelet transform for energy minimization. Moreover, the minimization formula assigns greater weight to foreground pixels. In addition, to prevent evolutionary instability during the iteration process, we employed an optimization process that is specifically designed to maintain clear contours along the edges of the pattern. Based on the established Dongba pattern dataset, the qualitative and quantitative analyses are conducted on the proposed method. The results indicate that the proposed improved active contour model has advantages in contour extraction visual quality and evaluation indicators compared to existing methods, demonstrating the effectiveness of the proposed method. Finally, based on the proposed pattern contour extraction method, the design innovation practice of Dongba cultural posters is completed from two aspects: pattern selection and transformation, artistic processing and poster design. The code is available at: https://github.com/jsluen/IACM.

**INDEX TERMS** active contour, contour extraction, optimization, Dongba pattern, application method.

## I. INTRODUCTION

The Naxi ethnic minority stands as one of the rare communities in China that boasts its very own written language, a rich tapestry of history, and singular religious traditions. The term “Dongba”, literally meaning “wise man”, is reverently employed by the Naxi ethnic minority to designate their religious leaders, who embody a multifaceted role encompassing chronicling history, singing, dancing, painting, and even practicing medicine [1]. These ancient cultures have been passed down from generation to generation by Dongba. This unwavering dedication ensures the seamless perpetuation and vibrant resilience of this ancient tradition, which today is primarily embodied in the form of Dongba characters, Dongba scriptures, and Dongba paintings [2]. Each element in these patterns proves the enduring wisdom and artistic prowess of the Naxi ethnic minority, preserving the essence of Dongba culture for future generations [3]. As the times evolve, the economic and cultural landscape at home and abroad has grown increasingly competitive, especially under the pervasive influence of developed networks, trendy cultural phenomena, and fastpaced lifestyles, which collectively contribute to a societal climate that hinders people to savor and appreciate these ancient arts at a leisurely pace. Consequently, the traditional, niche, and unadorned Dongba culture of the Naxi ethnic minority has gradually faded into obscurity. These pose formidable challenges to the preservation and transmission of Dongba culture, threatening its very existence [4]. In order to effectively protect and inherit this cultural heritage, technological innovation and cultural integration have become feasible paths.

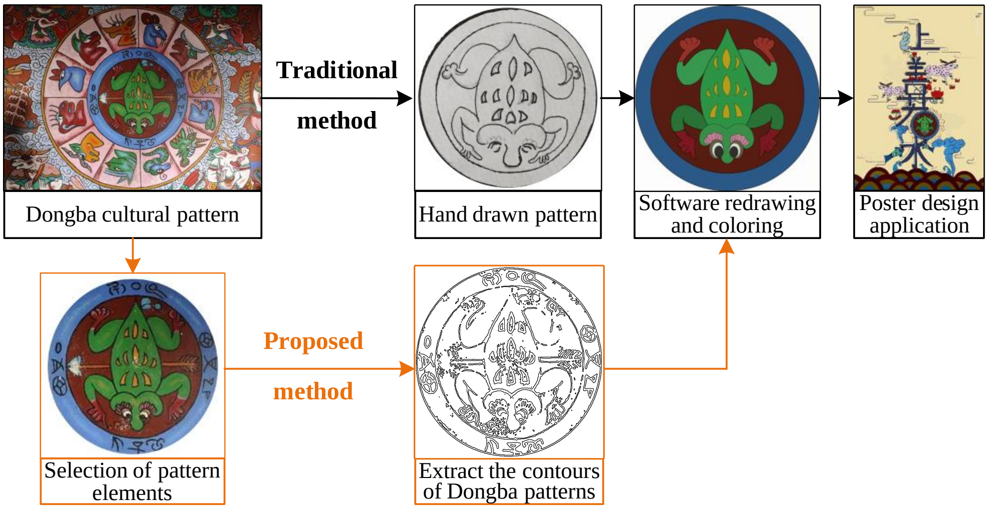


**FIGURE 1. Comparison between the traditional method and the proposed method in the poster design process.**

Posters are visually impactful notices posted in public places, serving as a link between the ideas that designers want to convey and the cognitive needs of the outside world. The graphics in the poster serve as the main body of the poster [5], endowing the intended message with specific colors, shapes, and ideological connotations. If the Dongba pattern is combined with poster design, it will undoubtedly inject new vitality and soul into the poster, effectively reducing geographical, cultural, and language barriers in Dongba cultural promotion [6]. However, in the process of poster design, designers often need to manually outline and extract the contours of the Dongba pattern, which is time-consuming and laborious, as shown in Fig. 1. This paper proposes to use modern image processing technology to automatically extract the contour of Dongba patterns and apply it to poster design. This is not only a digital representation of Dongba culture [7], but also a positive exploration of its protection and inheritance.

In the early stages of pattern contour extraction research, scholars have proposed first-order edge detection operators (Roberts, Sobel and Prewitt), second-order edge detection operators (Canny, Log, wavelet transform theory), etc. [8-10]. These algorithms are based on analyzing the changes in adjacent pixel values of the pixels to be calculated. The extracted image edges are easily affected by noise and have weak ability to determine whether they are edges [11]. Recently, advancements in deep learning, especially convolutional neural networks (CNN)'s outstanding ability in automatically learning image features, using neural networks such as CNN [12-14], richer convolutional feature (RCF) [15-16], visual geometry group network (VGG) [17-18] for edge detection into a burgeoning trend. However, these methods rely on an extensive collection of meticulously annotated images for training purposes, a process that is not only time-intensive and labor-intensive but also necessitates substantial hardware support [19].

Over the past two decades, active contour models have become one of the most effective tools for image segmentation and contour extraction, finding extensive applications in domains such as medical image processing and object recognition. Active contour model is an advanced image processing technique that integrates upper-layer information with diverse prior knowledge to ensure stable image segmentation and contour extraction. During the optimization process, it incorporates image grayscale and edge information [20]. Specifically, the energy functional minimization function, guided by the combined influence of external constraints and image forces, iteratively shifts the initial contour towards the target boundary. The CV (Chan and Vese) model, proposed by Chan and Vese, leverages the average grayscale values of the regions inside and outside the contour to independently delineate the foreground and background of the input pattern [21]. This method circumvents the dependence on image gradient characteristics and achieves borderless pattern segmentation and extraction. The fast global minimization (FGM) model, proposed by Bresson et al., defines a global minimization strategy to address the limitation of local optimization methods, which can often get trapped in local minima [22]. In order to ensure the inherent stability of the level set function, the distance regularized level set evolution (DRLSE) model, proposed by Li et al., incorporates a distance regularization term. This term controls the deviation between the level set function and the standard signed distance function during the curve evolution process [23]. By considering the image local characteristics, Liu et al. proposed a new region-based active contour model, namely local region-based Chan-Vese (LRCV) model, for segment images with intensity inhomogeneity [24]. Wang et al. constructed a linear combination of local and global Gaussian fitting energies, employing variable weights to balance these energies, thereby minimizing the dependence on the initial contour selection [25]. In response to the

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problem of poor segmentation in images with uneven or non-uniform intensity and high sensitivity to the initial contour position in existing active contour models, Fang et al. proposed a FRAGL (Fuzzy Region-based Active contour driven by weighting Global and Local fitting energy) model [26]. Shabani et al. improved the active contour model using a matched filter and Hessian matrix, proposed the ACMH (Active Contour model using Matched filter and Hessian matrix) method to solve the problem of vessel segmentation in low contrast and intensity non-uniformity retinal images [27]. Yang et al. designed a novel active contour model based on level set method and Kullback-Leibler Divergence [28]. George et al. proposed a novel method that combines a CNN with an active contour model to segment intraretinal fluid (IRF), aiding in the assessment of macular edema severity [29]. To solve the problem that the existing active contour models cannot accurately segment the synthetic aperture radar (SAR) water-land images, Shen et al. proposed a new active contour model based on the weighted hybrid signed pressure force [30]. Zia et al. combined the advantages of local and global information in the image level set function, resulting in a combined energy function that aids in the efficient evolution of contours on images [31].

Based on the previous analysis, we plan to use the Hessian matrix filter as a tool to address the challenge of minimizing energy destruction within the framework of CV model. Moreover, based on the characteristics of the Dongba patterns, a larger weight is assigned to foreground pixels in the minimization formula, which helps to more accurately capture the key features of the patterns in the contour extraction process. At the same time, in order to prevent evolutionary instability during the iteration process, a specially designed optimization process is adopted to ensure that the edges of the pattern maintain clear contours. Finally, based on the proposed pattern contour extraction method, the design innovation practice of Dongba cultural posters is completed from two aspects: pattern selection and transformation, artistic processing and poster design. The paper is organized as follows: The proposed pattern contour extraction method is introduced in Section 2. In Section 3, the proposed method is experimentally validated through qualitative and quantitative analysis. In Section 4, the application practice of the proposed method is completed. Section 5 gives brief conclusions.

## II. PATTERN CONTOUR EXTRACTION METHOD

The pattern contour extraction method proposed in this paper is a region-based image segmentation method, as shown in Fig. 2. Initially, a preprocessing stage involves channel selection and the application of contrast limited adaptive histogram equalization (CLAHE) to enhance pattern quality. Subsequently, to heighten the distinction between the targeted pattern and its background, an enhancement filter is deployed. Then, the improved active contour model, whose energy formulation is fortified through the integration of wavelet terms, is detailed alongside a meticulous optimization process. Finally, based on the established Dongba pattern sample library, this paper proves the superiority of the proposed method compared to existing methods from both qualitative analysis and quantitative analysis perspectives.

### *A. PATTERN PREPROCESSING AND ENHANCEMENT*

The preprocessing of this paper includes two steps, namely channel selection and CLAHE. Due to the heightened contrast discernible between the Dongba cultural pattern and its background in the green channel compared to the red and blue channels (as shown in Fig. 3), this paper only extracts the data from the green channel of the Dongba pattern, utilizing it as the input for our algorithmic framework. Furthermore, in order to improve the overall pattern quality, we introduce the second preprocessing stage, wherein CLAHE is applied to the green channel Dongba cultural pattern.

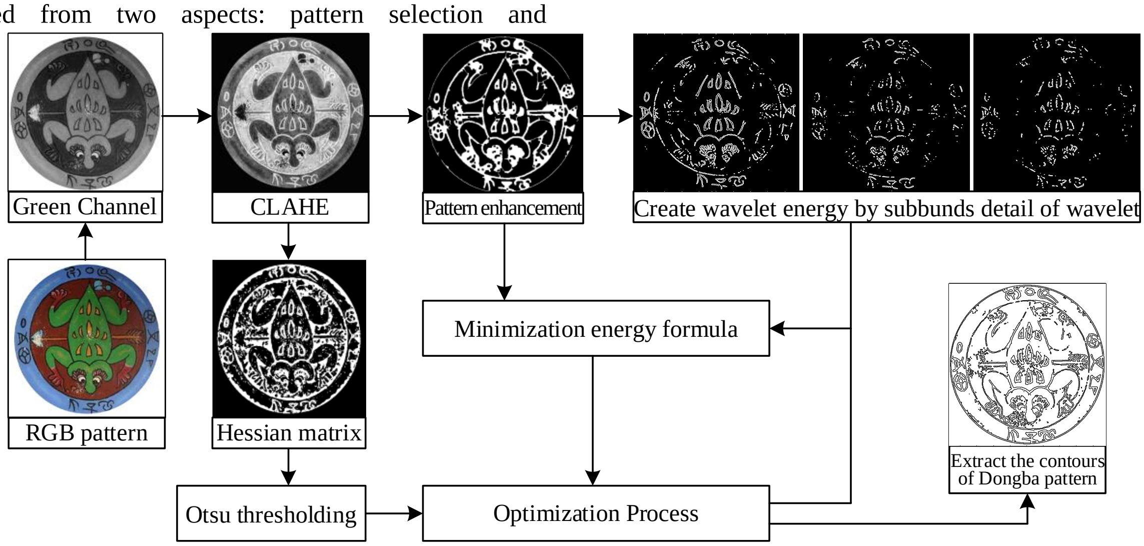


**FIGURE 2. Block diagram of the proposed pattern contour extraction method.**

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(a) (b) (c) (d)

**FIGURE 3. Comparison of different color channels in the Dongba cultural pattern: (a) RGB color Dongba pattern; (b) red channel of the Dongba pattern; (c) green channel of the Dongba pattern; (d) blue channel of the Dongba pattern.**

Afterwards, we opted for the algorithm outlined in reference [32], which relies on iterative morphological operators, to refine the contours present in the preprocessed Dongba cultural patterns. This algorithm leverages the discrepancy between the supremum and infimum values obtained from the opening operation applied to the original pattern, utilizing two linear structuring elements of varying lengths, thereby enhancing the contours for further processing.

### *B. IMPROVED ACTIVE CONTOUR MODEL*

The CV model utilizes the grayscale difference between the foreground and background to achieve pattern contour extraction [21]. We start by introducing the functional that forms the basis for the CV model, which we will refer to as the "fitting energy" functional. The goal of the contour extraction algorithm will be to minimize this fitting energy for a given pattern, and the minimizing level set function will define the segmentation [33]. In its most general form, the minimizing energy functional is shown as:

$$F(\phi)=\mu\left(\int_\Omega|\nabla H(\phi)|dx\right)^P+v\int_\Omega H(\phi)dx+\lambda_1\int_\Omega|I-c_1|^2H(\phi)dx+\lambda_2\int_\Omega|I-c_2|^2(1-H(\phi))dx \tag{1}$$

where $\mu$, $v$, $\lambda_1$, and $\lambda_2$ are positive constants; $H(\phi)$ is the Heaviside function, $I$ is the pattern to be extracted for contours, and $\Omega$ is the domain of that pattern; $c_1$ and $c_2$ are the gray mean values outside and inside the evolution curve respectively, and given by $c_1=\dfrac{\int_\Omega I\cdot H(\phi)dxdy}{\int_\Omega H(\phi)dxdy}$, $c_2=\dfrac{\int_\Omega I\cdot(1-H(\phi))dxdy}{\int_\Omega(1-H(\phi))dxdy}$.

The partial differential equation for the evolution of the final level set obtained using gradient descent method, and shown as follows:

$$\frac{d\phi}{dt}=\delta(\phi)\left[\mu.div\left(\nabla\phi/|\nabla\phi|\right)-v-\lambda_1(u_0-c_1)^2+\lambda_2(u_0-c_2)^2\right]=0 \tag{2}$$

where $\mu(\phi)$ is the Dirac function that $\delta(z)=\frac{d}{dz}H(z)$; $div\left(\nabla\phi/|\nabla\phi|\right)$ is curvature, $div$ represents divergence operator, and $\nabla$ is gradient operator. In the following, the improved active contour method is outlined in detail.

The initial curve shapes in Dongba cultural patterns are extracted using Canny edge detector [34], and the closing operator morphology is applied to refine and accurately extract the initial contour curves within these patterns. In the minimizing energy functional shown in (1), the pattern is divided into two different regions: foreground and background, and weights are intentionally added to emphasize foreground pixels. To further enhance the contour extraction, the algorithm incorporates the discrete wavelet transform [35], and the energy function is defined as follows:

$$F(\phi)=F_{CV}(\phi)+F_W(\phi) \tag{3}$$

In (3), the continuous average value of the root of local wavelet terms is represented as follows:

$$F_W(\phi)=\int_{in(C)|h}u_0(x,y).D_h(x,y)^{\frac{1}{2}}H(\phi(x,y))dxdy+\int_{in(C)|v}u_0(x,y).D_v(x,y)^{\frac{1}{2}}H(\phi(x,y))dxdy+\int_{in(C)|d}u_0(x,y).D_d(x,y)^{\frac{1}{2}}H(\phi(x,y))dxdy \tag{4}$$

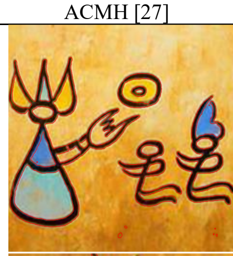
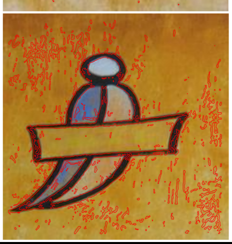
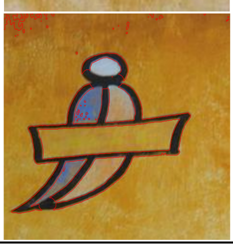
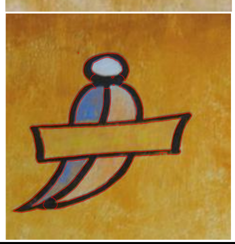
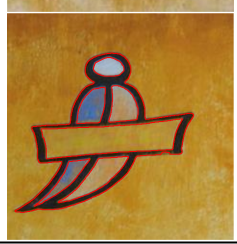
where $u_0$ is the input pattern; $D_h$, $D_v$, and $D_d$ are detail subbands of wavelet; $H(\phi(x, y))$ is the Heaviside function that acts on all level curves, and $H(\phi(x,y))=\frac{1}{2}\left(1+\frac{2}{\pi}\arctan\frac{x}{\varepsilon}\right)$.

Subsequently, in order to reduce erroneous edge detection, the energy function of the traditional active contour in (1) is rewritten as:

$$\begin{aligned}F(\phi)=&\mu\int_\Omega|\nabla H(\phi(x,y))|dxdy+v\int_\Omega H(\phi(x,y))|dxdy+\\&\lambda_1\int_{in(C)}|\mu_0(x,y)-c_1|^2H(\phi(x,y))dxdy+\\&\lambda_2\int_{out(C)}|\mu_0(x,y)-c_2|^2(1-H(\phi(x,y)))dxdy+\\&\lambda_3\int_{in(C)|h}u_0(x,y).D_h(x,y)^{\frac{1}{2}}H(\phi(x,y))dxdy+\\&\lambda_4\int_{in(C)|v}u_0(x,y).D_v(x,y)^{\frac{1}{2}}H(\phi(x,y))dxdy+\\&\lambda_5\int_{in(C)|d}u_0(x,y).D_d(x,y)^{\frac{1}{2}}H(\phi(x,y))dxdy\end{aligned} \tag{5}$$

where $\lambda_3$, $\lambda_4$, $\lambda_5$ are positive constants. Finally, the partial differential equation for the evolution of the final level set obtained using gradient descent method, and shown as follows:

TABLE I
QUALITATIVE ANALYSIS OF DIFFERENT CONTOUR EXTRACTION METHODS ON THE DONGBA PATTERN DATABASES

| Number | CV [21] | FRAGL [26] | ACMH [27] | Proposed method |
|---|---|---|---|---|
| (a) |  |  |  |  |
| (b) |  |  |  |  |
| (c) |  |  |  |  |
| (d) |  |  |  |  |
| (e) |  |  |  |  |
| (f) |  |  |  |  |
| (g) |  |  |  |  |

Note: The number of iterations is 100.

$$\frac{d\phi}{dt} = \delta_{opt}(\phi)\Big[u.\,div\big(\nabla\phi/|\nabla\phi|\big) - v - \lambda_1\big(u_0 - c_1\big)^2 + \lambda_2\big(u_0 - c_2\big)^2 + \lambda_3\big(u_0.\,D_h\big)^{\frac{1}{2}} + \lambda_4\big(u_0.\,D_v\big)^{\frac{1}{2}} + \lambda_5\big(u_0.\,D_d\big)^{\frac{1}{2}}\Big] = 0 \quad (6)$$

Although the wavelet terms' contribution to enhancing the precision of pattern contour extraction, their effectiveness wanes in areas featuring ambiguous or discontinuous patterns, potentially leading to contour extraction failures within those specific areas. Additionally, as the level set function evolves, it tends to develop irregularities that may compromise the stability of the entire evolution process. Therefore, the proposed algorithm introduces the following equation as a refinement and modification tool for the evolution function [36]:

$$E_{opt}(x, y) = \alpha_1 E_n(x, y) + \alpha_2 I_{Hess}(x, y) E_n(x, y) \quad (7)$$

where $\alpha_1>0$ and $\alpha_2>0$ are constants; $E_n(x, y) = E_{n-1}(x, y) + \Delta t F(\phi, x, y)$, and $F(\phi, x, y)$ is energy functional; $\Delta t$ is time step, and $n$ is number of iterations; $I_{Hess}$ is binary images from Hessian matrix [36]. The Hessian matrix is a square matrix that contains partial second derivatives, and $H(f) = \begin{bmatrix} f_{xx} & f_{xy} \\ f_{xy} & f_{yy} \end{bmatrix}$. Eigenvalues $\gamma_1$ and $\gamma_2$ are obtained as $\gamma_1 = 0.5(f_{xx} + f_{yy} + temp)$ and $\gamma_2 = 0.5(f_{xx} + f_{yy} - temp)$, and $temp = \sqrt{(f_{xx} - f_{yy})^2 + 4 f_{xy}^2}$. The Hessian matrix filter is given as:

$$Hess = \begin{cases} 0 & if\ \gamma_2 > 0 \\ \exp\left(-\dfrac{R_\beta^2}{2\beta^2}\right)\left(1 - \exp\left(-\dfrac{s}{2c^2}\right)\right) & \text{otherwise} \end{cases} \quad (8)$$

where $R_\beta = \gamma_1/\gamma_2$ and $s = \sqrt{\gamma_1^2 + \gamma_2^2}$.

In the above algorithms, there is no complete process to achieve threshold adaptation, and manual adjustment is required to achieve good results, which requires a lot of time and effort. Therefore, we use the maximum inter class variance method (Otsu) to obtain a simple threshold with a global threshold level [37].

## III. EXPERIMENTAL VERIFICATION

The program of the proposed improved active contour model in this paper is based on MATLAB 2017b and runs on the Windows 11 system. The hardware specifications are: AMD Ryzen 5 4600U, 2.10 GHz, 16 GB memory. The selection of parameters in the proposed improved active contour model are selected as follows: $\Delta t$=0.01, $\mu$=1, $v$=1, $\lambda_1$=0.5, $\lambda_2$=0.8, $\lambda_3$=2, $\lambda_4$=5, $\lambda_5$=3, $\alpha_1$=0.2, $\alpha_2$=0.05. To test the effectiveness of the proposed method, a dataset containing 30 Dongba patterns is created, and some Dongba patterns with uneven grayscale and low contrast are selected. Subsequently, the proposed method is compared and analyzed with the contour extraction results of the CV model [21], FRAGL model [26], and ACMH model [27].

### A. QUALITATIVE ANALYSIS

Randomly select 7 Dongba patterns from the dataset for qualitative analysis testing, and the results are shown in Table I. From Table I, it can be seen that the proposed method achieves better contour extraction results than other methods. Due to the fact that the CV model [21] extracts the contours of Dongba patterns through global information, it is unable to capture the non-uniformity in the Dongba patterns. The FRAGL model [26] has good contour extraction performance for Dongba patterns when the contrast between the target and background is high, but it cannot effectively extract contours from patterns with low contrast. Although the ACMH model [27] has achieved excellent results in extracting the contours of Dongba patterns, it still leads to local optima during the curve optimization process when the contrast is low, resulting in some small closed areas. The method proposed in this paper can effectively capture the non-uniformity in Dongba patterns through input pattern optimization, pattern enhancement, Hessian matrix filtering, etc. At the same time, through iterative optimization, using global information to drive the curve to evolve towards the target edge can effectively avoid the curve falling into local optima during the evolution process. The qualitative analysis proves that the method proposed in this paper has achieved the goal of extracting the contours of Dongba patterns.

### B. QUANTITATIVE ANALYSIS

In order to conduct a quantitative analysis of the performance of the pattern contour extraction model proposed in this paper, five indicators from references [38, 39], namely Jaccard similarity (*JS*), dice similarity coefficient (*DSC*), false negative ratio (*FNR*), false positive ratio (*FPR*), and ratio of segmentation error (*RSE*) are used to describe the accuracy of contour extraction results. Specifically, let $S_1$ and $S_2$ represent a predefined baseline foreground region (e.g., the true object) and the foreground region identified by the model [39], respectively. The definitions of these five indicators are outlined as follows:

$$\begin{cases} JS = \dfrac{N(S_1 \cap S_2)}{N(S_1 \cup S_2)} \\ DSC = \dfrac{2N(S_1 \cap S_2)}{N(S_1) + N(S_2)} \\ FNR = \dfrac{N(S_1 \setminus S_2)}{N(S_1)} \\ FPR = \dfrac{N(S_2 \setminus S_1)}{N(S_2)} \\ RSE = \dfrac{N(S_1 \setminus S_2) + N(S_2 \setminus S_1)}{N(\Omega)} \end{cases} \quad (9)$$

where $N(\cdot)$ denotes the count of pixels within the enclosed area. The ideal results are $JS \to 1$, $DSC \to 1$, $FNR \to 0$, $FPR \to 0$, and $RSE \to 0$.

Finally, the quantitative evaluation results of the five accuracy indicators and algorithm running time for contour extraction of Dongba patterns using different methods are

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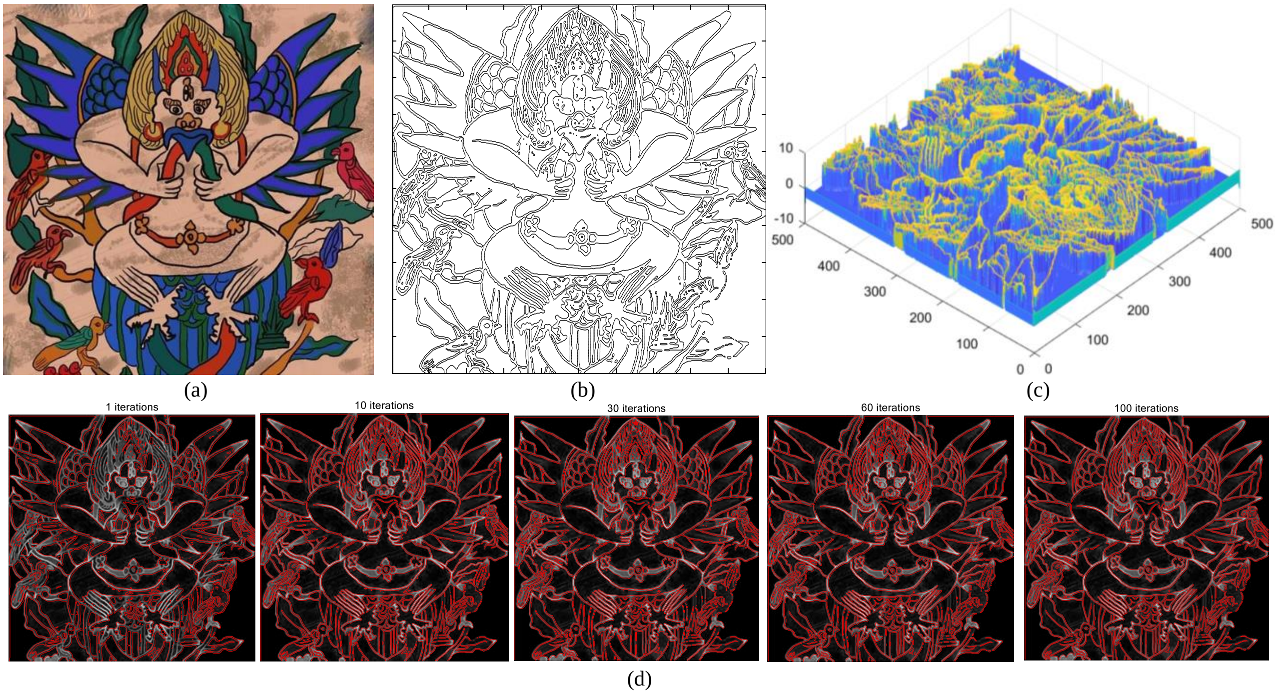


**FIGURE 4. Divine great roc in Dongba cultural patterns: (a) original pattern; (b) extracted contours; (c) final active contour function; (d) contour extraction optimization process.**

shown in Table II. From Table II, it can be seen that the contour extraction time of the proposed method is 13.1662 s, ranking second among all methods. In terms of *JS*, *DSC*, *FNR*, *FPR*, and *RSE*, the proposed method is 0.9619, 0.9811, $3.5148\times10^{-4}$, $7.9213\times10^{-5}$, and $1.0735\times10^{-4}$, respectively, ranking first among all methods. This proves that compared to existing methods, the method proposed in this paper has better performance in extracting the contours of Dongba patterns. Moreover, consistent with the previous qualitative analysis results, it proves the effectiveness of the proposed method in this paper.

TABLE II
QUANTITATIVE ANALYSIS OF DIFFERENT CONTOUR EXTRACTION METHODS ON THE DONGBA PATTERN DATABASES

| Indexes | CV [21] | FRAGL [26] | ACMH [27] | Proposed method |
|---|---|---|---|---|
| Time (s) | **11.2723** | 13.9584 | 14.2407 | 13.1662 |
| *JS* | 0.5639 | 0.8764 | 0.9317 | **0.9619** |
| *DSC* | 0.6568 | 0.8147 | 0.9132 | **0.9811** |
| *FNR* | 0.0915 | 0.0115 | 0.0089 | **$3.5148\times10^{-4}$** |
| *FPR* | 0.0131 | 0.0069 | $2.6110\times10^{-4}$ | **$7.9213\times10^{-5}$** |
| *RSE* | 0.4375 | 0.0917 | 0.0056 | **$1.0735\times10^{-4}$** |

Note: The number of iterations is 100; Bold indicates the optimal data.

## IV. APPLICATION OF CONTOUR EXTRACTION METHOD

In Section 2, a simple and effective method for extracting the contours of Dongba cultural patterns is proposed. On this basis, we can use this method to extract the design elements required in poster design, thereby simplifying the traditional poster design process, and improving efficiency.

### A. SELECTION AND TRANSFORMATION OF DONGBA PATTERNS

Firstly, we conducted research and collected patterns related to Dongba culture. According to the collected patterns, they are roughly classified into human, plant, and animal categories, and patterns that can represent Dongba culture are selected from them. Subsequently, using the proposed contour extraction method in Section 2, the selected patterns are subjected to contour extraction, and then imported into Adobe Illustrator (AI) software for pattern extraction and coloring processing. AI software supports importing and exporting multiple file formats, providing rich graphic design tools such as brushes, strokes, colors, and fill options. We can use these tools to convert the extracted contours into high-quality vector graphics.

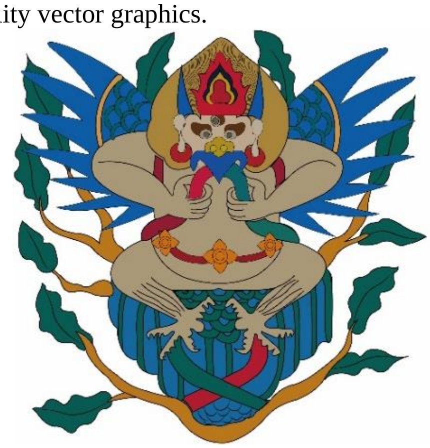

**FIGURE 5. AI software redraws and colors the contours of divine great roc.**

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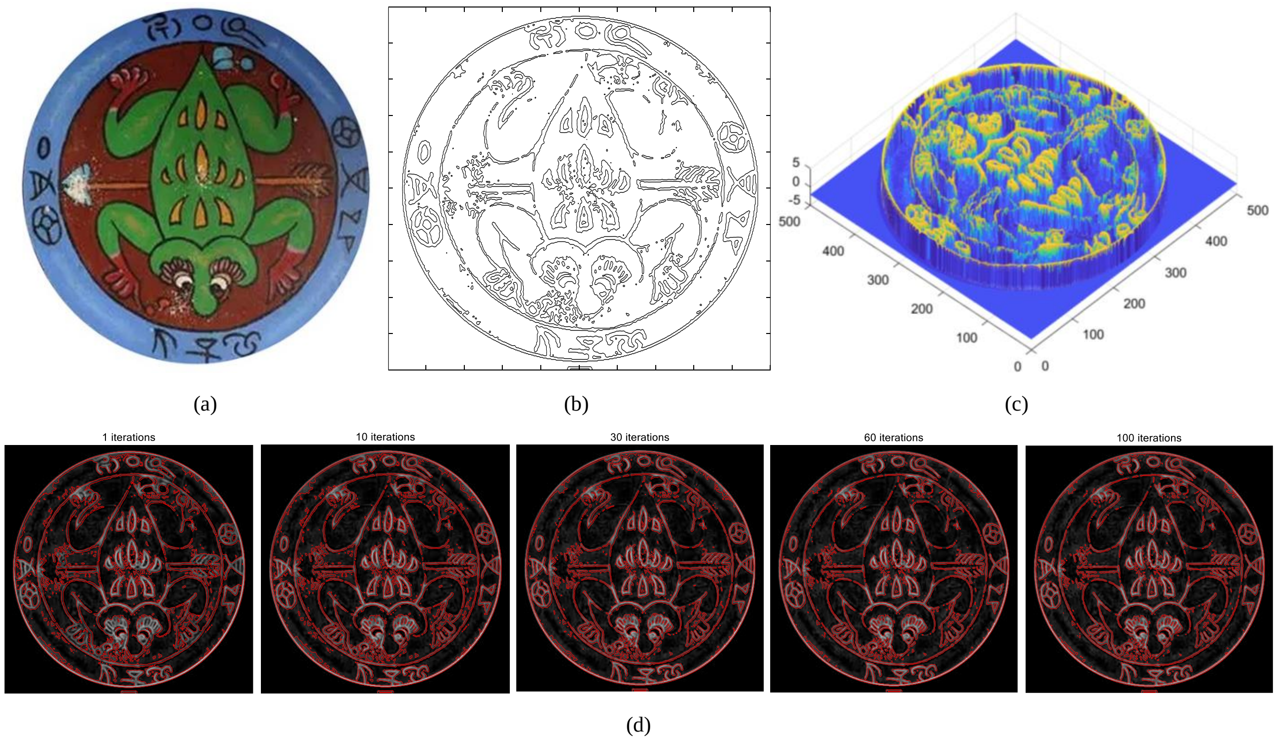


**FIGURE 6. Frog totem in Dongba cultural patterns: (a) original pattern; (b) extracted contours; (c) final active contour function; (d) contour extraction optimization process.**

**FIGURE 7. AI software redraws and colors the contours of rog totem.**

This paper takes the example of the divine great roc, which represents peace and auspiciousness in Dongba culture, as shown in Fig. 4. Fig. 4a is a picture of the divine great roc in Dongba culture. Fig. 4b is the extracted contours of the divine great roc using the contour extraction method described in Section 2. Fig. 4c is the final active contour function and the corresponding contour extraction optimization process is shown in Fig. 4d. It can be seen that the proposed method can successfully extract the contours of Dongba cultural patterns. The design diagram after being redrawn and colored by AI software is shown in Fig. 5. It can be seen that the extracted contours of Dongba cultural patterns can be successfully applied to poster design. Subsequently, we extracted the contours of the frog totem in Dongba culture for poster design, as shown in Fig. 6 and Fig. 7. This once again proves the effectiveness of the method proposed in this paper.

### *B. ARTISTIC PROCESSING AND POSTER DESIGN*

The Dongba cultural posters selected Chinese vocabularies with beautiful meanings, such as “everything is going smoothly”, “stand together through storm and stress”, “come up in the world”, “highest excellence like water”. The divine great roc in Dongba culture is a protector deity, rumored to be a natural deity who once helped humans overcome various disasters. Based on this symbolism, the design combines the divine great roc with the Chinese vocabularies “everything is going smoothly”. In Dongba culture, frogs are regarded as intelligent creatures second only to humans, and are not allowed to harm frogs and are used as totems. Based on this symbolism, design a combination of the frog totem and the Chinese vocabulary “highest excellence like water”. Using the same approach, we have completed the poster designs for “stand together through storm and stress” and “come up in the world”. Finally, the overall concept of the poster is designed in a way that interweaves and connects, so that the overall effect of the screen presentation is cohesive and not too loose, as shown in Fig. 8.

## V. CONCLUSIONS

This paper proposes a contour extraction method of Dongba cultural patterns based on improved active contour model, and applies it to poster design. The proposed method can effectively capture the non-uniformity in Dongba patterns through input pattern optimization, pattern enhancement, Hessian matrix filtering, etc., and adding discrete wavelet

(a) (b) (c) (d)

**FIGURE 8.** **Dongba culture poster design: (a) everything is going smoothly; (b) stand together through storm and stress; (c) come up in the world; (d) highest excellence like water.**

transform to achieve energy minimization solves the problem of false detection rate. Furthermore, through iterative optimization, using global information to drive the curve to evolve towards the target edge can effectively avoid the curve falling into local optima during the evolution process. Finally, experiments on contour extraction of Dongba patterns and poster design practices are conducted. The qualitative analysis results indicate that the existing methods (CV, FRAG and ACMH) can extract the contours of the Dongba patterns, but patterns with low contrast still have local optima during the curve optimization process, resulting in smaller closed-loop areas. Compared with these existing methods, the proposed method can achieve complete extraction of Dongba pattern contours without small closed-loop areas, resulting in the best performance. The quantitative analysis results indicate that the proposed method performs the best in all accuracy indexes (*JS*, *DSC*, *FNR*, *FPR*, and *RSE*), and ranks second in algorithm efficiency. This proves that compared to existing methods (CV, FRAG and ACMH), the proposed method has better performance in extracting the contours of Dongba patterns. In summary, the proposed improved active contour model has advantages in contour extraction visual quality and evaluation indicators compared to existing methods and its effectiveness is verified. Finally, based on the proposed pattern contour extraction method, the design innovation practice of Dongba cultural posters is completed. This proves that the proposed method can effectively reduce the time required for element extraction in traditional poster design processes, and the design ideas of this study have good reference value for the application of traditional culture to modern design.

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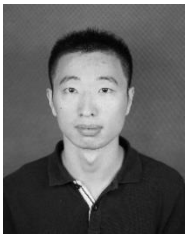

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