# Research on Oil Painting Image Extraction and Identification Method based on Intelligent Vision

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***Abstract***

*A high-precision and high-efficiency oil painting identification method is the auxiliary basis for authenticating works, because it can improve the efficiency and credibility of oil painting identification. Therefore, an oil painting image extraction method based on intelligent vision was proposed.An intelligent visual detection model was constructed to obtain the characteristics of oil painting images.The oil painting feature fusion method based on intelligent vision was adopted to integrate the color and shape features of oil painting features, calculate oil painting feature difference coefficient and difference feature threshold, and realize oil painting image extraction by oil painting image extraction rules.The research results verified that the proposed method could effectively identify the authenticity of oil paintings. Compared with the expert identification method and the identification method based on deep learning, it can be seen that the method had the highest identification accuracy, the shortest identification time, the best anti-interference, and the remarkable identification performance, so it had a high application value.*

***Keywords:*** *oil painting, image feature extraction; Intelligent vision; appraisal*

## I. Introduction

Oil painting is a key type of paintings with a history of hundreds of years, and it belongs to traditional western painting art.The painting method of oil painting is quite different from other kinds of paintings, and it has a unique charm.However, due to various reasons, many counterfeits appear in the existing traditional oil paintings, and a large number of counterfeits appear in the works of famous historical painters. Therefore, the authenticity identification of oil paintings is a hot issue in the field of oil paintings collection. Authenticity identification is to use relevant identification methods to determine whether a certain oil painting is really pained the author of the painting.However, in the past, when authenticating the authenticity of oil paintings by using the experience of experts, the authentication results are relatively subjective and there are some errors in theauthentication accuracy, which makes it difficult for the masses to fully convince[1].Therefore, high-precision and high-efficiency oil painting image extraction methods have become an urgent problem to be solved.Based on this premise, this paper proposed an oil painting image extraction technology based on intelligent vision, and carried out in-depth research on oil painting image extraction methods[2].

## II. Study on oil painting image extraction methods

### 2.1 Intelligent visual detection model

A person's perception of the nearby environment is mainly completed through vision. With the gradual maturity and integration of information processing technology and automation technology, relevant researchers used intelligent robots to replace the role of human eyes, and finally developed an intelligent visual detection model.The intelligent vision detection model is composed of hardware and software[3]. The hardware system consists of the light source, control center, input and outputmodules;The functions of the software system are mainly divided into oil painting image acquisition, processing, handling, analysis and feature recognition.The intelligent vision detection model realizes the intelligent vision operation mainly through the cooperation of hardware and software functions.In this paper, an intelligent vision model was constructed to collect image features of oil paintings and serve as a basis for subsequent authenticity identification[4].The overall structure of the intelligent vision detection model is shown in Figure 1.

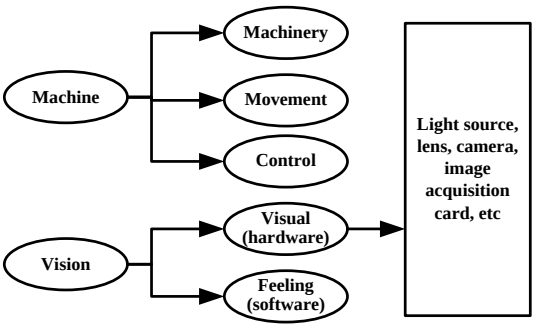


***Fig.1 Overall structure of intelligent vision detection model***

2.2 Oil painting feature fusion based on intelligent vision

Because color is one of the most basic features of oil painting image intelligent vision, the previous image classification methodsare mainly based on the color features, but the color histogram expresses the image color statistics, without analyzing the appearance features of the image.Therefore, after the intelligent vision detection model detects the oil painting image features, in this paper, the color and shape features of oil painting features are fused through feature extraction[5-6].

1)Color feature operation.Oil painting color space belongs to the way of color display, while RGB color space belongs to the color space commonly used in intelligent visual images, and there is a big difference between it and human eye perception.In this paper, HSV color space was used, because it can not only approximate people's color understanding of oil painting images but also judge the correlation between two colors[6].HSV color space has three components, hue (H), saturation (S), andvalue (V), and it transforms the values of $r, g, b$ of oil painting imagesinto those of $h, s, v$, and the method is as follows[7-9]:

$$v = \max(r, g, b) \tag{1}$$

$$s = \frac{v - \min(r, g, b)}{v} \tag{2}$$

$$h = \begin{cases} 5 + b', & r = \max(r, g, b) \text{and } g = \min(r, g, b) \\ 1 - g', & r = \max(r, g, b) \text{and } g \neq \min(r, g, b) \\ 1 + r', & g = \max(r, g, b) \text{and } b = \min(r, g, b) \\ 3 - b', & g = \max(r, g, b) \text{and } b \neq \min(r, g, b) \\ 3 + g', & b = \max(r, g, b) \text{and } r = \min(r, g, b) \\ 5 - r', & \text{other} \end{cases} \tag{3}$$

In Formulas (1) ~ (3) : $r, g, b$ represent the three colors of red, green and bluechannel; $h, s, v$ are the tone, saturation and value of the oil painting.

According to people's color perception, the three components of HSV are quantified at non-consistent intervals of intelligent vision for the oil painting. The tone h of the oil painting is divided into 8 parts, and the saturation S and value V are divided into 2 parts and 1 part, respectively:

$$H=\begin{cases}0, & h\in(344,24]\\ 1, & h\in(24,54]\\ 2, & h\in(54,107]\\ 3, & h\in(107,164]\\ 4, & h\in(164,219]\\ 5, & h\in(219,274]\\ 6, & h\in(274,315]\\ 7, & h\in(315,344]\end{cases} \tag{4}$$

$$S=\begin{cases}0, & s\in(0.2,0.66]\\ 1, & s\in(0.66,1]\end{cases} \tag{5}$$

$$V=0,\quad v\in(0.14,1] \tag{6}$$

Where the value range of $H,S,V$ is open in front and closed in back.

According to the optical principle of intelligent vision, there is a correlation between the color of oil painting and the wavelength and frequency of light.There are differences in wavelength and frequency interval of different color lights in vacuum, so the oil painting tone can be quantified at inconsistent intervals.In Formulas (4) ~ (6), 0~7 represent the type of each hue successively.In the calculation, theinconsistent weights were set for the three dimensional feature vectors $H,S,V$ to form one-dimensional feature vector, which was conducive to analysis.In these three vectors, the human eyes' judgment of oil painting color was mainly based on the oil painting hue H, followed by the saturation S, and finally the value V.In addition, one-dimensional vector AB, $AB=HC_SC_V+SC_V+V$, could be obtained according to the quantization series and frequency bandwidth of $H,S,V$, and the quantization series represented S and V in turn. Based on the above description, $C_S=2,C_V=1$. Then, $AB=2H+S+V$ the value range of AB was an integer between 0 and 15, and the 16-handle one-dimensional histogram of oil painting was obtained by calculating AB.Then the three components $H,S,V$ were all dispersed in one-dimensional vector. The weights of $H,S,V$ were 8, 2, and 1, which could not only reduce the interference of oil painting image value V to the later identification results but also decrease the interference of oil painting saturation.However, the oil painting images with different color distribution could be fully identified, so the intelligent visual color information features of oil painting images meet people's needs for oil painting image extraction, and the color histogram of oil painting images can be obtained.

2) Operation of shape features. The shape is the core feature of oil painting.At present, the classification and retrieval of shape build the oil painting image index mainly based on the contour features and regional features of shape.The contour feature of the oil painting shape is reflected by the straight line segment, and the regional feature of the oil painting shape is reflected by the area of the region.The line segment quantitative characteristicAC represents the total value of the number of line segments retrieved after Hough transform processing.The parallel line feature AD represents the number of parallel lines.Through normalization of the total number of line segments, then the following formula can be obtained:

$$AD=\begin{cases}0, & AC=0\\ \sum_{i=1}^{AC}QE_i \Big/ AC, & AC\neq 0\end{cases} \tag{7}$$

According to the special shape of the oil painting, the regional density F of the oil painting was set as:

$$F = E / Q^2 \tag{8}$$

Where E represents the area of the oil painting image;Q represents the perimeter of the oil painting image.

According to this criterion, the circle in the oil painting was the figure with the highest density, and the ratio of the remaining figures was small[8].If the circle leaned back, it became an ellipse, and the area became smaller but the circumference decreased more slowly, so it became less dense;When it leaned back to the limit angle, the ellipse was compressed into a line of finite length with a density of 0.In the oil paintings based on intelligent vision, area M represents the number of pixels of the oil painting, a certain connected part in the oil paintingL had foreground points, and its area was M1.In the four-connected rules, as long as there was a background point in the four directions of the four adjacent pixels, then the background pointwould be the boundary point. The calculation method of connected domain features of the oil painting images is as follows:

$$\mathrm{Max}\, F = \frac{\max\left\{E_i\right\}}{\varpi^* h} \tag{9}$$

$$\mathrm{EMax}\, E = \max\left(E_i / Q_i^2\right) \tag{10}$$

Where $\mathrm{Max}\, F$ represents the maximum density of the effective region; $\mathrm{EMax}\, E$ represents the maximum area of the effective region; $\varpi$ represents the weight.

3) Feature fusion.Based on the above method, the five-dimensional feature vector of oil painting could be obtained, including $AB, AC, AD, \mathrm{Max}\, F$ , and $\mathrm{EMax}\, E$ . All dimensional features of the oil painting were represented by R after normalized processing, which laid a foundation for later oil painting image extraction.

2.3 Oil painting image extraction based on intelligent vision

A real oil painting and a fake oil painting were set, and the difference coefficient and threshold of the two oil paintings' features were calculated based on the oil painting image features analyzed in Section 1.2, and then the oil painting image extraction was realized through oil painting image extraction rules. The fuzzy set $R_1, R_2, \cdots, R_p \in H(Y)$ established in the center of the oil painting intelligent visual image was. If there was a subset, N could be used for description.The oil painting sample with the minimum distance between N and Rpcould be calculated by the following formula:

$$t\left(N, R_p\right) = \min\left\{t\left(N, R_1\right), t\left(N, R_2\right), \cdots, t\left(N, R_p\right)\right\} \tag{11}$$

The absolute distance between authentic and fake oil painting samples is:

$$t\left(R_j, R_k\right) = \sum_{j=1}^{n}\left|x_{jl} - x_{kl}\right| \tag{12}$$

The Euclidean distance between authentic and fake oil painting samples is:

$$t\left(R_j, R_k\right) = \sqrt{\sum_{l=1}^{n}\left(x_{jl} - x_{kl}\right)^2} \tag{13}$$

The Mahalanobis distance between authentic and fake oil painting samples is:

$$t\left(R_j, R_k\right) = \sum_{l=1}^{m}\left|\frac{x_{jl} - x_{kl}}{x_{jl} + x_{kl}}\right| \tag{14}$$

Where x represents the component; $j, l, k$ are numerals.

According to the above method, the foreground features in the oil painting intelligent visual image were screened out[9].The characteristic parameters of oil painting differences were obtained through Formula (15) :

$$U(y,z) = \frac{\sum_{j=1}^{q}\left|Z\left(q_j(y,z)\right) - Z\left(q_{j-1}(y,z)\right)\right|}{q-1} \tag{15}$$

Where $q_j(y,z)$ represents the intelligent visual image of qth frame of oil painting;Z is the corresponding gray mean value.

The characteristic difference coefficient of intelligent visual image of oil painting can be obtained by Formula (16) :

$$\Omega_j = \frac{U(y,z) - \varpi}{\sigma} - \frac{h(y,z)}{\sigma} \tag{16}$$

Assuming that the threshold value of differential features of oil painting intelligent visual image samples wasσ, the identification of differential features of oil painting samples was completed by the oil painting image extraction rules According to the above method, the oil painting image extraction based on intelligent vision could be completed by integrating a large number of intelligent visual images and following the oil painting image extraction rules[10].

## III. Experimental results and analysis

In order to analyze the effectiveness of the proposed method, 10 groups of oil painting counterfeits with different quantities were set up, and their authenticity was identified by the proposed method, and the results are shown in Table 1.By analyzing the data in Table 1, it can be seen that 178 fake oil paintings were set in the experiment, and 177 fake oil paintings were identified by the proposed method, with only one piece. The error was very small, indicating that the proposed method could effectively identify the authenticity of oil paintings.

**Table 1 Identification results of the proposed method**

| Serial number of oil painting | Actual number of fake oil paintings/piece | Identification results in this paper/piece |
|---|---|---|
| 1 | 12 | 12 |
| 2 | 13 | 13 |
| 3 | 12 | 11 |

| | | |
|---|---|---|
| 4 | 12 | 12 |
| 5 | 11 | 11 |
| 6 | 11 | 11 |
| 7 | 25 | 25 |
| 8 | 25 | 25 |
| 9 | 26 | 26 |
| 10 | 31 | 31 |
| Total | 178 | 177 |

To deeply analyze the performance of oil painting image extraction by the proposed method, the proposed method, expert identification method and authenticity recognition method based on deep learning were used for comparative analysis.The comparison indexeswere set as identification accuracy and identification efficiency. As the famous oil paintings have been spread for a long time, and there are often some missing edges, so anti-interference was set in the comparison index.

1) Identification accuracy. Ten oil paintings of different types were set, and the three methods were used to authenticate them. The identification accuracy of the three methods was tested and compared, and the comparison results are shown in Figure 2. After analyzing the data in Fig. 2, it can be concluded that after the identification of 10 oil paintings by the three methods, the identification accuracy of the proposed method was the highest, followed by the identification method based on deep learning, and the expert identification method had the lowest identification accuracy. Besides, the identification accuracy of the proposed method was always greater than 95%, and the identification results were the most accurate.

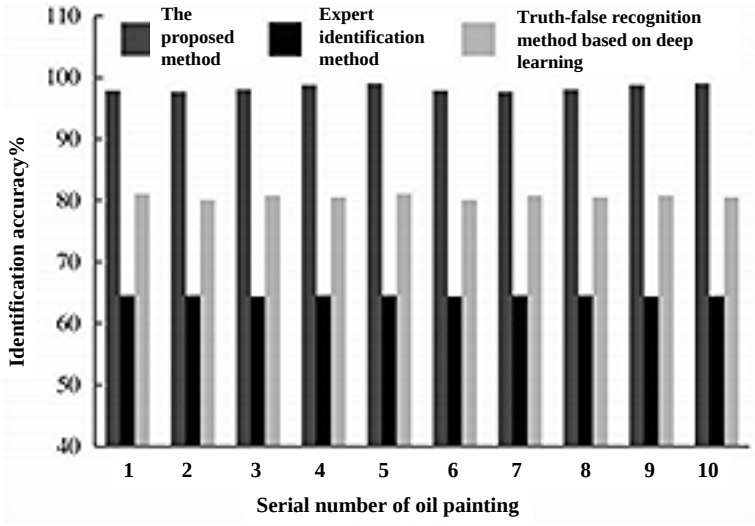


***Fig. 2 Comparison results of identification accuracy***

Identification efficiency.The evaluation time cost data of the three methods in the above experiment were analyzed and compared, and the comparison results are shown in Table 2.As shown in Table 2, the average time cost of this method for the identification of 10 oil paintings is 23.32ms. Compared with the other two methods, this method saved 36.12ms and 21.8ms, respectively.Therefore, the proposed method has the shortest identification time and the fastest identification efficiency.

**Table 2 Comparison results of identification time cost data ms**

| Serial number of oil painting | Proposed method | Expert identification method | Truth-false recognition method based on deep learning |
|---|---|---|---|
| 1 | 23.34 | 59.32 | 43.67 |
| 2 | 23.43 | 59.09 | 45.65 |
| 3 | 23.43 | 59.67 | 45.73 |
| 4 | 23.12 | 59.76 | 45.23 |
| 5 | 23.34 | 59.34 | 43.67 |
| 6 | 23.43 | 59.32 | 45.65 |
| 7 | 23.43 | 59.09 | 45.73 |
| 8 | 23.12 | 59.67 | 45.23 |
| 9 | 23.43 | 59.76 | 45.73 |
| 10 | 23.12 | 59.34 | 45.23 |
| Average value | 23.32 | 59.44 | 45.12 |

Anti-interference.Seven oil paintings with different degrees of fuzzy edges were set, and three methods were used to authenticate their authenticity. Then the degree of anti-interference of the three methods was tested and compared, and the comparison results are shown in Figure 3.According to the data in Figure 3, the maximum anti-interference performance of the proposed method is 0.98, that of the expert identification method is 0.54, and that of the authenticity identification method based on deep learning is 0.91.By comparison, the proposed method has the best anti-interference and identification performance.

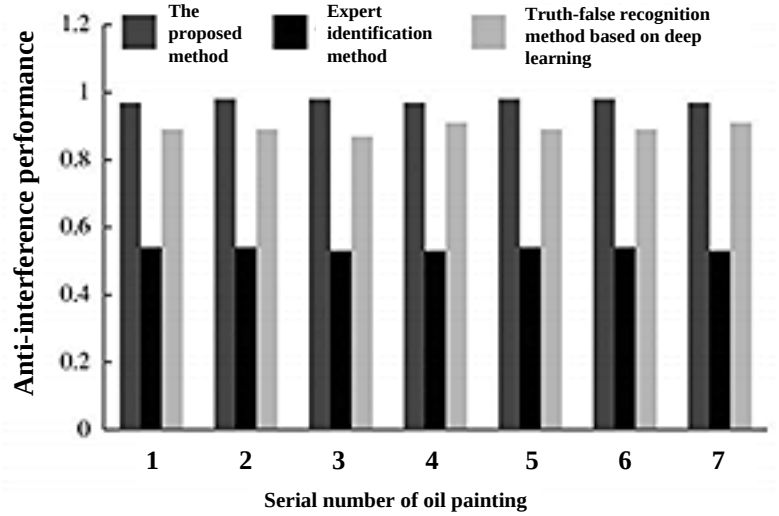


*Fig. 3 Comparison of anti-interference performance*

## IV.Conclusion

In order to overcome the disadvantages of large error and low efficiency in the previous oil painting image extraction technology, this paper proposed an oil painting image extraction technology based on intelligent vision, which can effectively use the intelligent visual detection model to obtain oil painting features for subsequent oil painting image

extraction operations.It has been proved that the identification accuracy of this method was always more than 95%, and the average time cost of the identification of 10 oil paintings was 23.32ms, and the anti-interference performance was as high as 0.98. Therefore, compared with similar identification methods, this method has a better identification performance.

**Acknowledge**

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**Reference**

[1] Cheng Yan. Application of computer image processing technology in oil painting [D]. Inner Mongolia Normal University
[2] Wang Huali, Wang Wei. Restoration of damaged area of oil painting based on image processing technology [J]. Modern electronic technology, 43 (13): 4
[3] Liu shuaiqi. Research on digital oil painting based on digital image processing technology [D]. Zhongyuan Institute of technology
[4] Cheng Yan. Application of computer image processing technology in oil painting [D]. Inner Mongolia Normal University, 2010
[5] Wang Tao, Deng Lijun. A method to realize the special effects of fluid style (vortex) Van Gogh oil painting [J]. Information and communication, 2014, 000 (007): 38-40
[6] Du J. visual ontology construction for art image retrieval [J]. Computer science \ & \ technology, 2005
[7] Guo Dan. The influence of the application of image materials on oil painting [J]. Art review, 2015, 000 (003): p.176 -
[8] Zhang Xudong, LV Yanyan, Miao Yongwei, et al. Image super-pixel generation based on regional covariance [J]. Computer science, 2016 (43): 322
[9] Li Shengchao. Application of image ink style rendering based on deep learning [D]. Nanjing University, 2017