Research on Photography Art based on VR Technology and Machine Vision

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Abstract: In order to improve the expression effect of photographic art, this paper combines VR technology and machine vision to conduct photographic art research. Based on the visual saliency algorithm in the frequency domain, this paper uses the virtual reality vision system to perceive signals of different frequencies, thereby converting the image signal to the frequency domain, and finding the spectrum signal that can attract visual attention. Moreover, this paper processes and calculates the frequency spectrum, and finally transforms it into the spatial domain to obtain a saliency map of the region of interest. In addition, this paper combines VR technology and machine vision to construct an intelligent photographic art research system to improve the analysis effect of photographic art. The experimental research results show that the photographic art method based on VR technology and machine vision proposed in this paper can effectively improve the expression effect of photographic art.

Keywords: VR technology, machine vision, photographic art, intelligent model
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1 INTRODUCTION

Digital photography replaces the photosensitive film with the photosensitive chip through the camera system, and the image combined by this specific digital code is the digital image. This method of generating digital photos is not unique. For example, the process of scanning traditional photos and then post-processing by computer also has the characteristics of digital photography, and image digitization is its essence.

Virtual reality photography art is divided into two categories and five sub-items. The two major categories refer to computer still frames and computer animation. The five sub-items are 2D still painting, 2D animation, 3D still painting, 3D animation and video collection art. In this paper, the research on this topic is mainly static photography, so the focus is on the static performance of realistic virtual reality photography. The combination of photography and computer images is mainly based on two-dimensional simulation hand-painting technology, which represents by Paimer. The combination of photography and computer graphics is mainly 3D virtual film and television image production software, which represents by Maya. As a visual technology, compared with traditional painting and photography, the profound changes brought about by virtual reality photography have led to a profound change in visual concepts. If painting is a symbol of reproducibility culture and camera is a symbol of reproduction culture, then virtual reality photography is no different from the representative of virtual reality culture. With the help of computers, people's visual imagination and the scope of space exploration are greatly expanded, and they are no longer confined to the clumsy material world, but enter the world of light and light, and the possibility of renewed combination and variation of visual images is greatly improved. Moreover, various computer software or programs provide more opportunities for visual innovation. From computer-generated images to virtual scenes, computers are omnipotent, especially in creating virtual reality. If photography is still a realistic imitation and objective recording of the ontology, computerized digital images will bring visual experience into a whole new field-the virtual world. If the function of painting depends on the actual image, and photography both relies on and changes the actual image, then this dependence has been completely subverted in the virtual space created by computer graphics. At the same time, people's imagination and expressiveness have been raised to a new height. Virtual images are everywhere, and they are always presented in a realistic appearance. Compared with paintings and chemically processed photos, virtual reality photography has fundamentally changed the situation of visual culture, and an important result is the appearance of simulacrum. There are many essential differences between simulacrum, painting and photograph. It is different from the time and space constraints of painting, and it is not equivalent to photography, but can only passively record real objects. In the words of French scholar Baudrillard, "The simulacrum is something that can be copied without the body, and it can be copied continuously, and although it is analog, it is very realistic."

From traditional visual culture to modern visual culture, and then to post-modern visual culture, visual symbols are getting farther and farther away from the real world. They gradually become a self-contained and independent world. In addition, the reproducibility or representational function of visual images is gradually declining, while virtuality has become more and more decisive. The visual image has gone through the historical evolution process from the initial sign and then reality to the sign virtual reality.

This article combines VR technology and machine vision to conduct photographic art research, and builds an intelligent photographic art research system to improve the analysis effect of photographic art and promote the development of subsequent photographic art.

2 RELATED WORK

Literature [17] believes that the intervention of virtual reality photography is a breakthrough in the post-digital photography technology, which only shows the author's supportive attitude towards this combination, but fails to develop it. Literature [1] believes that the virtual reality photography art has a relationship of putting the cart before the horse and photography. Only virtual images can be introduced into photography as symbols, and large-scale and realistic interventions are not allowed. Otherwise, photography will inevitably become impossible. Reference [15] specifically introduces the application and advantages of CGI new photography technology in automobile advertising. Literature [14] proposes that visual culture has gone through the process of simulation, copying and virtual. From a cultural point of view, the recognition of virtual images as the third stage of visual images can be regarded as an inevitable improvement in the development of photographic art. Literature [9] mentioned that modernism has transitioned to post-modernism, which has divided the conflict between elite culture and popular culture, differentiated artistic functions, and emphasized the boundaries between various categories; abstract photography caused by anti-tradition and anti-composition, a few people. of "aesthetic isolation". Postmodernism then de-differentiates and dissolves the conflict of modernism. It is not only the blurring of the boundaries between art and non-art, but also the blurring of the boundaries between various categories within art, a large number of splicing and mixed "hodgepodge" art. It can be cited that the fusion between different art categories is the trend of postmodern culture [6]. Due to the correlation between photography and film technology, literature [4] introduced the application of virtual reality photography in film, as well as the relationship between film and 3D technology, and the relationship between technology and art. Literature [5] talks about the nature of photography and the need for constant updating as far as photography itself is concerned, both technically and thematically, because the development of the art of photography largely depends on the updating of technology, while photography and other Unlike art, the separation of technology and art, especially in modern times, where cameras are highly automatic, and personal new perspectives and themes can easily be plagiarized.

Traditional photography techniques and craftsmanship have advantages that cannot be replaced by contemporary digital in image creation. First of all, it is reflected in the artisan-style exploratory practice of traditional craftsmanship. Because of the professionalism of traditional image production craftsmanship, the author has to do a lot of work in the creative process. The whole process of practical exploration is carried out by hand, and the creator often has to invest a lot of time and energy. In this process, the creator's ability to continuously explore during creation can be better strengthened, which is conducive to the cultivation of the craftsman's spirit. This is what we In digital photography, it is only responsible for shooting and pressing the shutter, and the rest is handed over to automatic processing, which is essentially different [2]. Secondly, in terms of the materiality of works, traditional craftsmanship is also superior to contemporary digital craftsmanship in terms of originality and uniqueness. The particularity of traditional imaging materials reflects irreplaceable beauty in terms of texture. The material properties of the original works, such as texture, light and shadow, and color, can present their own visual effects [18]. In addition, in artistic creation, striving to seek one's own unique expression, and trying to distance yourself from other works in the exploration of artistic language are important basic creative qualities of a photographer, which are reflected in the traditional darkroom craftsmanship. The unique pursuit of above, the uniqueness of photographic works is based on traditional craftsmanship. The addition of a large number of handicrafts and various physical and chemical materials has led to rich visual possibilities in his works, which has also caused the characteristics that cannot be reproduced and reproduced. , which also ensures an important value as a work of art [20]. Uniqueness, on the one hand, has become the basic quality of artistic photographers, and at the same time has become a standard of photographic value. In such a process, the practice process is often more important than the result, and it also enables creators to cultivate their own innovative ability in the practice process [8]. Under the background of the rapid development of digital imaging technology, it is still recovering, which has attracted the attention of art creators [11]. In the contemporary photography environment, the learning and practice of traditional darkroom craftsmanship can well improve and enhance the negative impact of digital photography, and correct the homogenization defects formed by standardized processing and standardized output in the existing intelligent era. In the current digital age, the reflection and absorption of traditional darkroom craftsmanship can well promote the lack of certain concepts, ideas and technologies in image creation in the current intelligent age, improve the artistic level of the works, and cultivate creators in the aesthetic level and performance. It has important value in terms of form and innovative practice [12]. Literature [10] aims to cultivate photography professionals in the digital age through the traditional photography darkroom technology, through the construction of a virtual experiment platform, and through simulation experiments.

3 IMAGE ENTROPY ART ALGORITHM

Entropy is considered from the statistical characteristics of the entire set, and it characterizes the overall characteristics of the source in an average sense. Shannon concluded that the formula for calculating entropy is [7]:

$$H = -\sum_{i=1}^{q} P(a_i)\log P(a_i) \tag{1}$$

In the formula, H represents the entropy value of a source, and $P(a_i)$ represents the probability of each random variable. The unit of entropy depends on the base of the logarithm. In the calculation process, the base is usually 2 and the unit is bit. This formula reflects two physical meanings of information entropy: one is the average uncertainty of the signal before the source is output, and the other is the average amount of information carried by each variable or symbol after the source is output.

Information entropy mainly has the following basic properties:

(1) Symmetry: The entropy value has nothing to do with the order of each random variable. From a mathematical point of view, formula 3-4 satisfies the commutative law. From the perspective of random variables, entropy is related to the overall statistical characteristics of random variables.

(2) Incrementality: If a variable X in the original signal is divided into multiple elements m, then the sum of the probabilities of these m elements is equal to the probability of the original variable. While the probabilities of other symbols remain unchanged, the entropy of the new signal increases. This increase process is mainly caused by the newly generated uncertainty due to segmentation.

(3) Non-negativity: According to probability statistics, the probability distribution of each random variable satisfies $0 < P < 1$. When the logarithm base is 2, the entropy value obtained is always positive, and this non-negativity is only applicable to the entropy of discrete sources.

(4) Additivity: The entropy of the joint source of two statistically independent sources is equal to the sum of the respective entropies of the two sources.

(5) Extreme value: In the case of discrete signals, the entropy value can reach the maximum when the variables of the signal are distributed with equal probability. This property indicates that the average uncertainty of the equal probability distribution signal is the largest.

The image is an important carrier of information, and its information volume and uncertainty are determined by the statistical characteristics of all pixels in the image. According to Shannon's information theory, image entropy can be used to express the average amount of information of an image source. The image is a discrete source. The calculation formula for image entropy can be derived from formula 3.2[3]:

$$H = -\sum_{i=1}^{q} P_i \log_2 P_i \tag{2}$$

In the formula, H represents the entropy value of the calculated image, L is the number of gray levels that appear in the image, and P_i is the probability of each gray level. We call this calculation method of image entropy the one-dimensional entropy of the image, which reflects the chaos of the entire image. The one-dimensional entropy to form the two-dimensional entropy of the image.

The symmetry of information entropy shows that the size of the entropy has nothing to do with the order of each random variable, which means that after the pixel value of each pixel in an image is determined, the entropy of the image will not change. However, the arrangement order of pixels in an image is an important factor in the image output information, and the one-dimensional entropy of an image is a statistical form of characteristics. Moreover, it only shows the aggregation characteristics of the image gray value distribution, and cannot reflect the spatial characteristics of the image gray value distribution. In order to express the spatial characteristics of the image texture, we introduce the feature quantity that can reflect the spatial characteristics of the image gray distribution based on the one-dimensional entropy to form the two-dimensional entropy of the image.

When the human visual system (HVS) acquires image information, when the aggregation characteristics of a certain area are different from those of other parts, the area is likely to attract the attention of the human eye. The purpose of our research is to locate the defects in photographic works and extract the contours of the defects for recognition and classification. As mentioned above, the entropy value of the entire image cannot clearly express the spatial distribution of the image texture, and only a certain part of the image attracts visual attention. Therefore, we need to calculate the local entropy in the image to obtain the spatial distribution of the image texture information, so as to locate the saliency area.

This paper introduces a two-dimensional entropy calculation method that can reflect the spatial distribution characteristics of image texture. First, it processes the image boundary by mirror filling, and then simulates the image convolution operation. In the n×n pixel neighborhood of each pixel, it uses the one-dimensional entropy calculation formula (formula 3.2) to calculate the entropy at the pixel. In this way, the average amount of information and randomness measure around each pixel can be obtained. Finally, each pixel will have an entropy response output, and these entropy values can be arranged in the original position to get an entropy feature matrix with the same size as the original image, as shown in Figure 1[13].

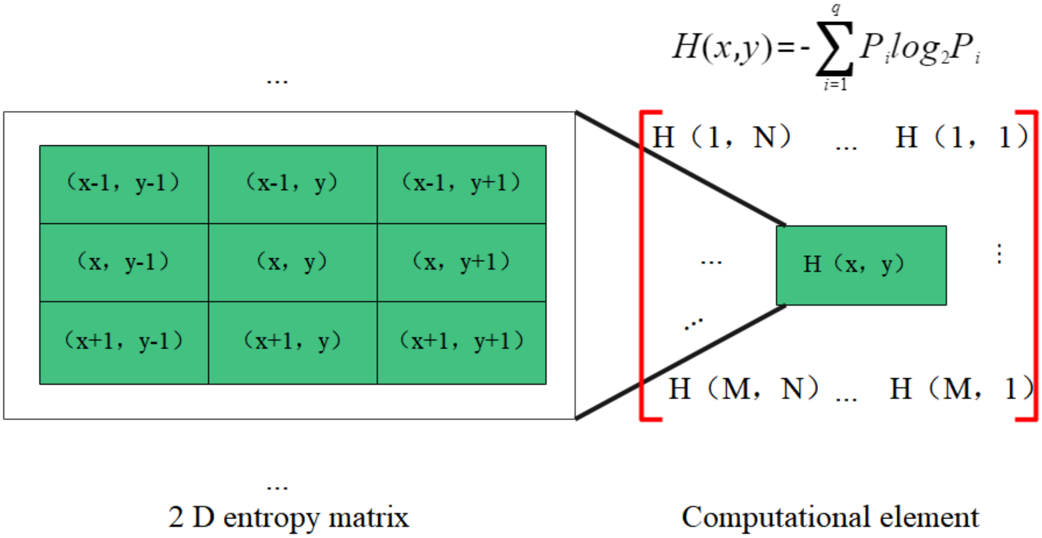
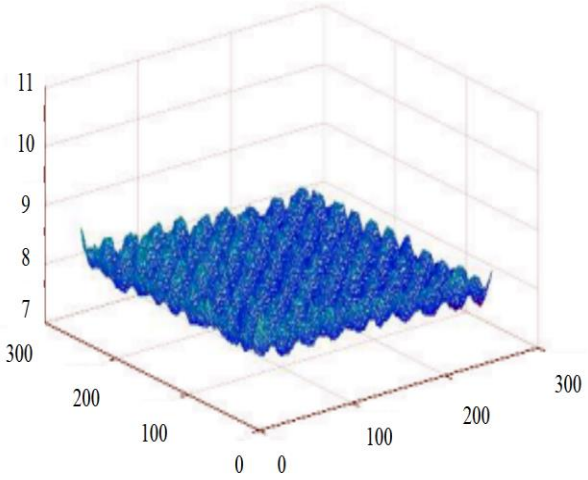


Figure 1: Two-dimensional entropy calculation method.

This article studies photographic images with periodic texture information. For areas without defects, the texture features are the same, the certainty of each pixel value is large, and the entropy value is small. When the defect appears, the texture feature of the image is destroyed, the gray level of the pixel expands, and the uncertainty of the pixel increases, so the entropy value will also increase. Figure 2 shows the two-dimensional entropy matrix of the flawless photographic image and the flawed photographic image. Therefore, we can intuitively see that two-dimensional entropy can effectively provide image texture and position information [16].

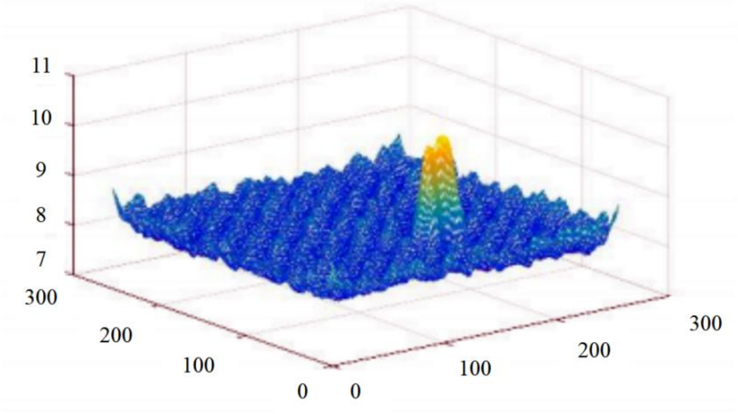
According to the analysis, the amplitude spectrum of the image contains important significant and insignificant information. Moreover, with the help of one-dimensional signal, it is proved that the repeated periodic signal is related to the peak of the amplitude spectrum, and the significant signal is related to the change of the rest of the amplitude spectrum. According to this relationship, the HFT model proposes a method of Gaussian filtering of the amplitude spectrum for natural images to locate and extract salient targets.

(a)Fabric without blemish



(b)2 D entropy matrix

(C) Blemished fabric

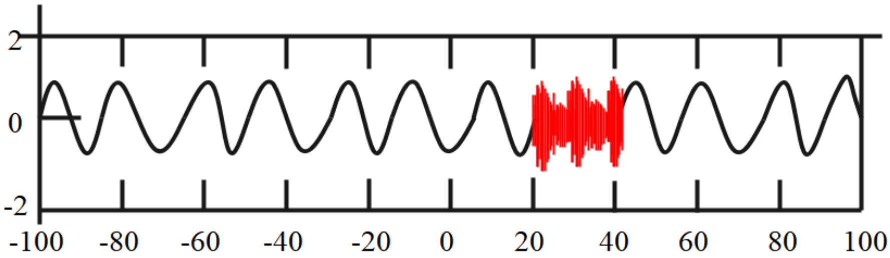


(d) 2 D entropy mat

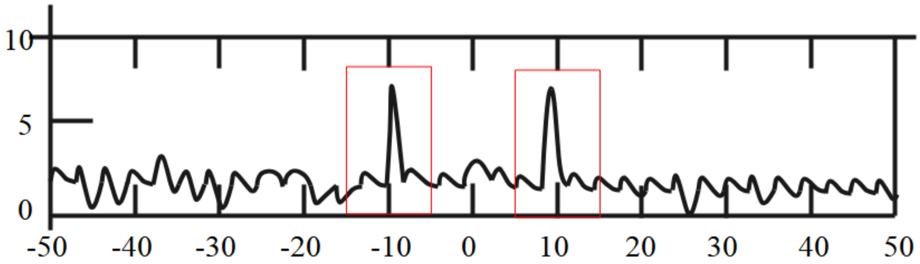
Figure 2: Two-dimensional entropy information of photographic images.

The processing process is shown in Figure 3. The input signal is periodic, but part of it is destroyed by the random signal (Figure 3(a)). This part is considered significant. In addition, when the signal is converted to the frequency domain, there are peaks related to the periodic repetitive signal in the amplitude spectrum (in the red box in Figure 3(b)). The HFT method performs Gaussian filtering on the amplitude spectrum to obtain a smooth amplitude spectrum (Figure 3(c)), which is used to suppress insignificant periodic signals [19].

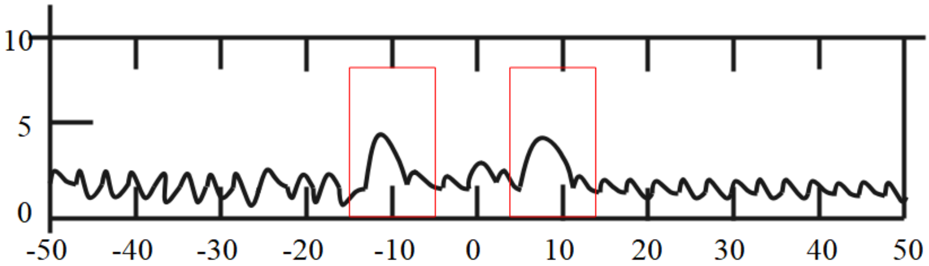
From the saliency map generated in Figure 3(d), although the periodic signal is partially suppressed, it still exists. The reason is that the HFT method does not completely suppress the peak value of the amplitude spectrum (in the red box in Figure 3(c)), and the significant signal does not maintain the shape of the original signal. The main problem of this method is that it is difficult to grasp the Gaussian filter scale of the amplitude spectrum.



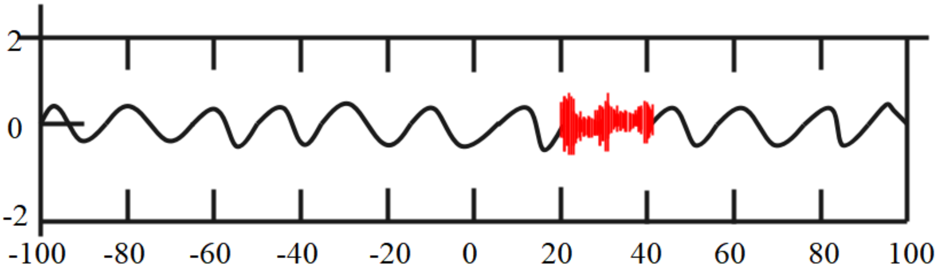
(a)Original signal



(b)The amplitude spectrum



(c)The amplitude spectrum of the global tuning



(d)The signal is reconstructed using (C)

Figure 3: The tuning process of the amplitude spectrum in the HFT model.

If the filter scale is too small, the repeated background part is difficult to suppress completely. If the filter scale is too large, other parts of the amplitude spectrum that represent significant information will be destroyed. The HFT model proposes a multi-scale analysis method to construct the following scale space:

$$\Lambda(u,v;k)=(g(u,v;k)*A)(u,v) \tag{3}$$

In the formula, we give the amplitude spectrum $A(u,v)$ and calculate the saliency map at each scale through a family of Gaussian kernels $g(u,v;k)$. Then, the minimum two-dimensional entropy criterion is used to select the saliency map. This method selects the optimal saliency map to a certain extent, but the global amplitude spectrum filtering will inevitably destroy the saliency of the target area, and the saliency map selection process has high computational complexity and low efficiency. In the detection of defects in photographic works, significant defects need to be retained, while non-significant background textures need to be removed. Therefore, when we consider removing the peak part of the amplitude spectrum, we should also retain the changes related to the significant defect area. This paper proposes the following method based on the HFT model. By locally filtering the amplitude spectrum, the repetitive background pattern can be suppressed and the saliency of the defect part can be preserved.

Step 1: The algorithm calculates the significance classification threshold of the amplitude spectrum:

$$T=\alpha M(A(u,v)) \tag{4}$$

In the formula, $A(u,v)$ is the amplitude spectrum, $M(\cdot)$ is the average value of the calculated amplitude spectrum, and the parameter α can be used to adjust the average value of the amplitude spectrum to obtain the ideal threshold.

Step 2: The algorithm uses the threshold T to tune the original amplitude spectrum:

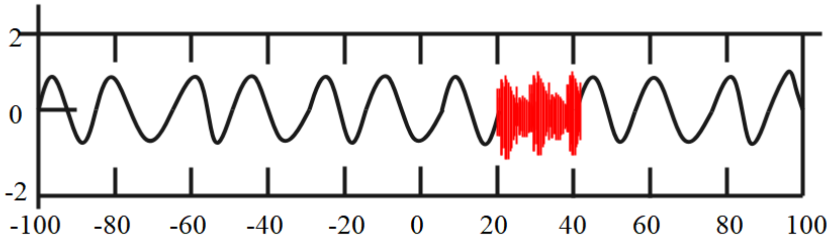
$$A_s(u,v)=\begin{cases}A(u,v)*h, & A(u,v)\geq T\\ A(u,v), & A(u,v)<T\end{cases} \tag{5}$$

In the formula, h is the Gaussian kernel function used to locally smooth the amplitude spectrum, which is defined as:

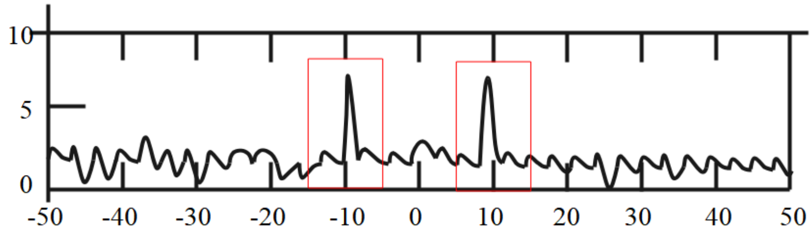
$$h(u,v)=\frac{1}{2\pi\sigma^2}e^{-\left(u^2+v^2\right)/2\sigma^2} \tag{6}$$

In the formula, σ determines the size of the filter scale.

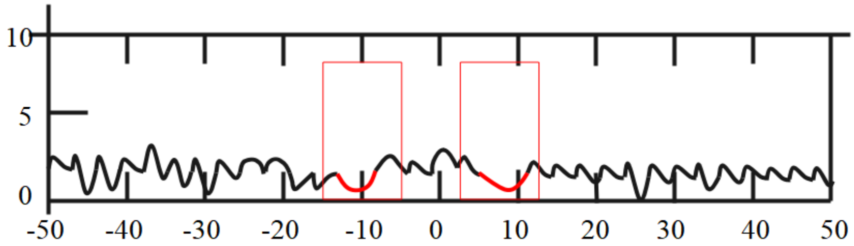
In the above steps, in order to deal with the significant defects and the non-significant background separately, we introduce the significance classification threshold T. The threshold is dynamically selected based on the mean value of the amplitude spectrum, and the threshold can be used to determine the boundary between the significant information and the insignificant information in the amplitude spectrum, so as to complete the local filtering process. In this method, only the “tip” related to the repeated texture pattern is locally filtered, and the amplitude spectrum of the salient part is not affected, and the larger the filtering scale, the more obvious the suppression of the background part. Therefore, we can select the filter scale σ to the maximum allowed. $\sigma_{max}\leqslant\min(H,W)$ and W represent the height and width of the image. However, in order to ensure that the filter contains the most Gaussian smoothing information, the size of the Gaussian kernel will increase as σ increases, and the computational complexity will also increase. In our experiment, we set $\sigma=0.04\times W$ so that while saving calculation time, it also achieves the effect of suppressing the peak of the amplitude spectrum



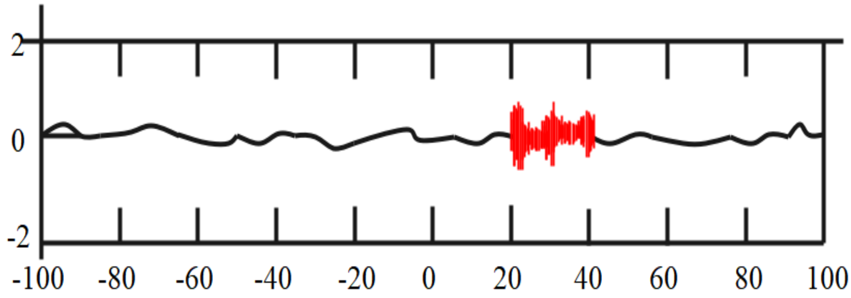
(a)Original signal



(b)The amplitude spectrum



d)The signal is reconstructed using (C)



(c)The amplitude spectrum of the global tuning

Figure 4: Saliency diagram of locally tuned amplitude spectrum.

It can be seen from the one-dimensional signal in the figure that the local filtering method proposed in this paper can selectively filter the amplitude spectrum. Observing Figure 4(b) and (c), it is found that this method only filters the "tips" (in the red box) that are related to signal insignificance, while the other parts of the amplitude spectrum remain unchanged. Therefore, it suppresses the repetitive non-significant information, retains the remarkable random signal, and solves the problem of the difficulty of selecting the filter scale in the HFT model. It can be seen from Figure 4(d) that the method in this paper not only suppresses the repetitive background signal almost completely, but also maintains the shape of the original signal in the salient regions extracted. Compared with Figure 3(d), the method in this paper has better results.

An image of a photographic work can be re-represented by a quaternion, and the image can be converted to the frequency domain for processing by using the super-complex Fourier transform based on the quaternion. The tuned amplitude spectrum $A_s(u,v)$ is obtained. Only the part related to the significant defect remains in $A_s(u,v)$, and the part related to the background pattern is suppressed by the Gaussian filter. Therefore, we can combine the tuned amplitude spectrum $A_s(u,v)$ with the original phase spectrum information $P(u,v)$, and perform the super-complex inverse Fourier transform using formula 3.7 to obtain a saliency map in the space domain. The salient part is the defect of interest.

$$S = g * \| F_H^{-1}(A_s(u,v) e^{\chi p(u,v)}) \|^2 \tag{7}$$

In the formula, g is a Gaussian filter used to enhance the saliency map. Figure 5 summarizes the entire process of generating saliency maps for photographic works in this paper.

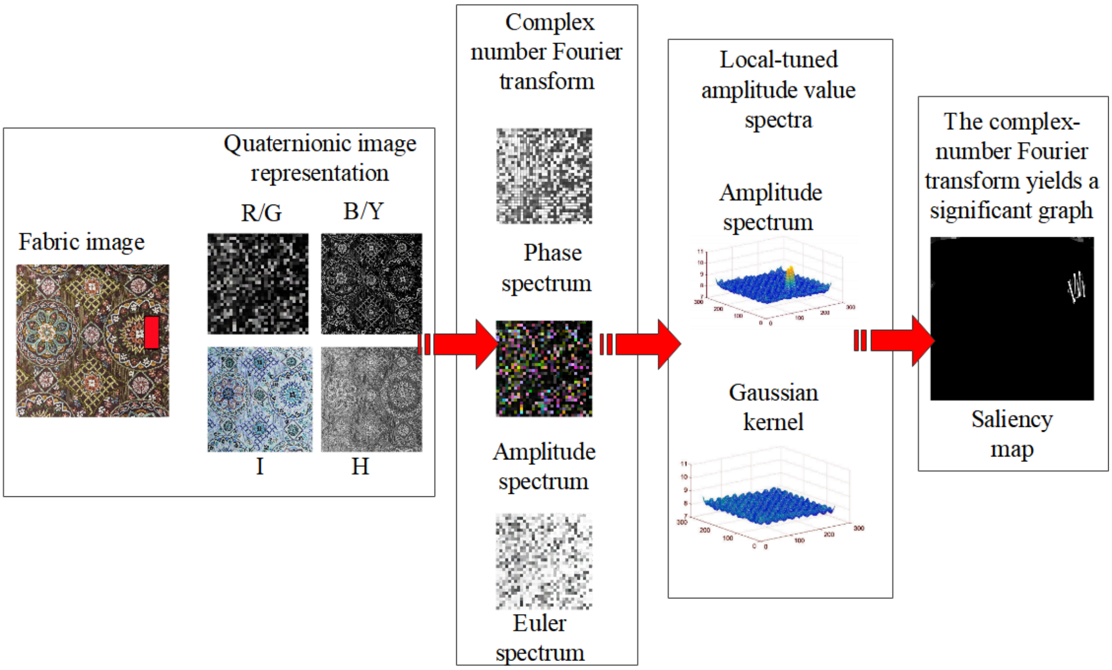


Figure 5: The saliency map generation process.

Similar to the one-dimensional signal above, the texture pattern of the photographic image is also periodic. When the photographic image is transformed into the frequency domain, the amplitude spectrum will show a "tip" representing the texture period information. The method of locally tuning the amplitude spectrum in this paper is to suppress the "tip" in the image amplitude spectrum of the photographic image. However, unlike the one-dimensional signal in the above example, the analysis of the image amplitude spectrum of a large number of photographic works reveals that the peak part of the amplitude spectrum is very different from the other parts, that is, the variance of the photographic image amplitude spectrum is relatively large. If only the mean value of the amplitude spectrum is used as the significance threshold, it is difficult to completely extract the image defects of the photographic work. In order to obtain an ideal classification threshold, this paper introduces the parameter ɑ to adjust the size of the significance classification threshold. During the experiment, we set $a = 2^{k-1}$, where $k = 1, 2, ..., 8$.

When the value of k is too large or too small, the defect detection effect is poor. The reason is that when the value of k is too small, the saliency classification threshold is small (T1 in Figure 6), and the amplitude spectrum related to the saliency is also suppressed by the Gaussian filter, resulting in unsatisfactory extraction of the defect area. When the value of k is too large, the saliency classification threshold is large (T2 in Figure 6), and peak suppression related to non-saliency is incomplete or not suppressed, resulting in unsatisfactory removal of background patterns and affecting the extraction of defect regions. When the k value is between 3 and 6, that is, when the significance classification threshold is 5 to 30 times the average value of the amplitude spectrum (ɑ=5-30), the defect detection effect is ideal.

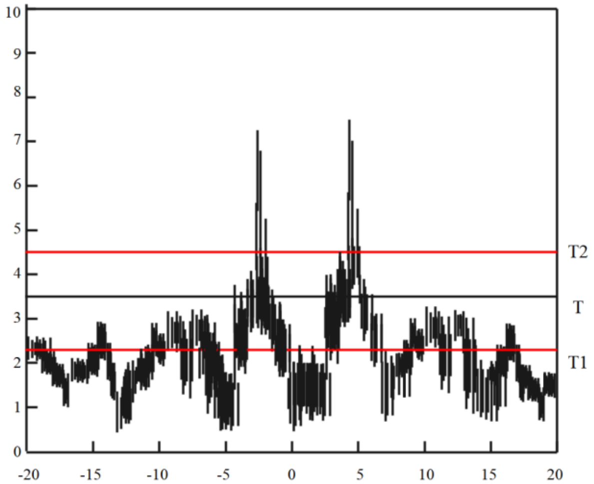


Figure 6: Schematic diagram of significance classification threshold.

4 RESEARCH ON PHOTOGRAPHY ART BASED ON VR TECHNOLOGY AND MACHINE VISION

Based on the above algorithm, the photographic art system based on VR technology and machine vision proposed in this paper is shown in Figure 7.

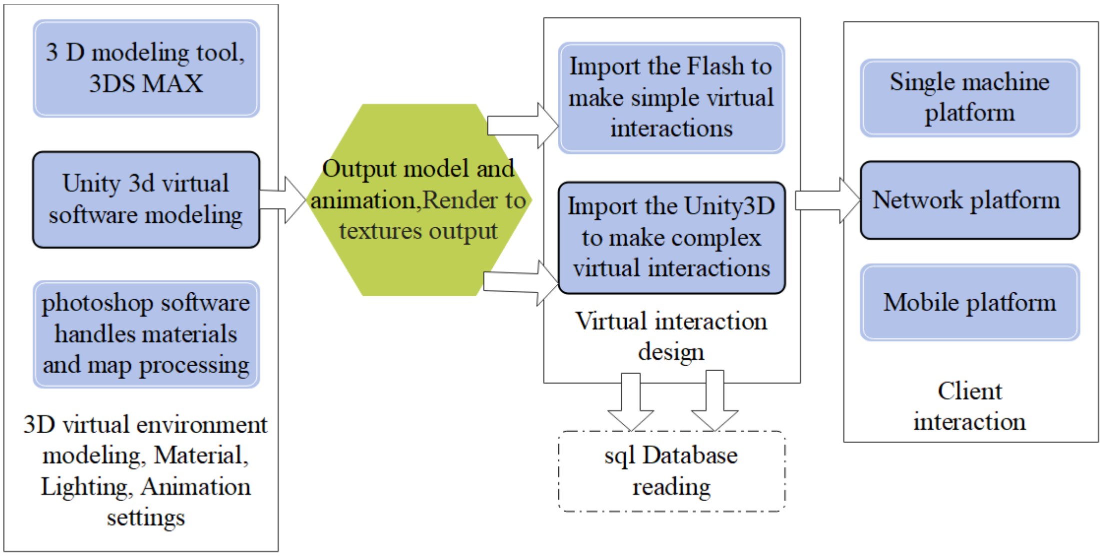


Figure 7: Flow chart of system technology.

The functional design of the virtual simulation module is shown in Figure 8.

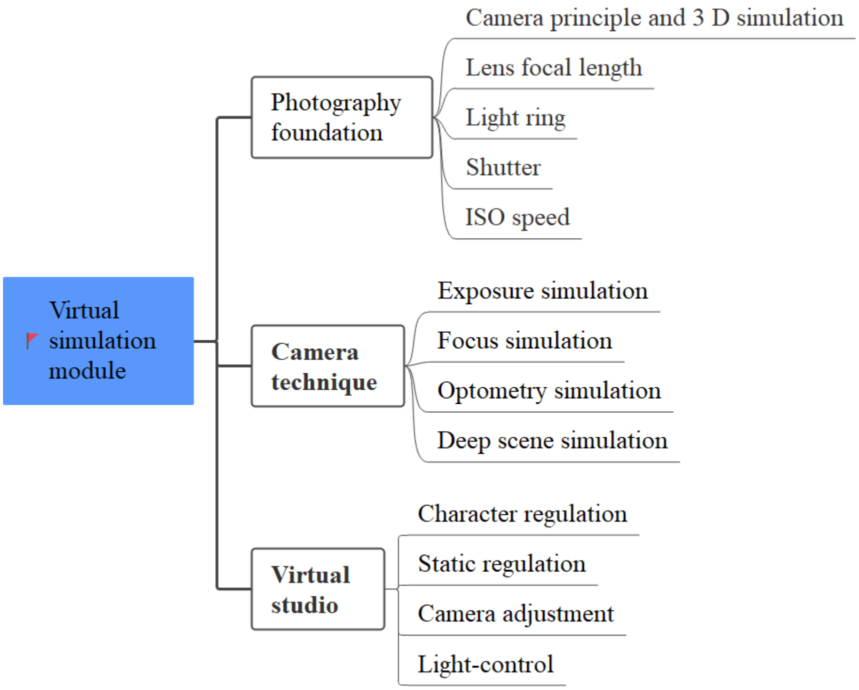


Figure 8: Functional design of virtual simulation module.

(a) The background of virtual reality photography

(b) The digital processing of virtual reality photography

(c) The output of virtual reality photography

Figure 9: Photographic art case images based on VR technology and machine vision.

From the above Figure 9, we can see that the image output effect of the photographic art case based on VR technology and machine vision proposed in this paper is very good. On this basis, this paper evaluates the effects of this model through experimental research, and evaluates data through multiple sets of simulations. The results are shown in Table 1.

Number	*Photographic art evaluation*	*Number*	*Photographic art evaluation*
1	*89.36*	*28*	*85.66*
2	*86.28*	*29*	*90.22*
3	*90.95*	*30*	*85.39*
4	*87.69*	*31*	*86.95*
5	*91.34*	*32*	*89.46*
6	*89.21*	*33*	*84.85*
7	*92.77*	*34*	*85.04*
8	*84.90*	*35*	*85.43*
9	*90.72*	*36*	*90.98*
10	*86.94*	*37*	*90.63*
11	*89.07*	*38*	*91.65*
12	*92.49*	*39*	*86.10*
13	*84.58*	*40*	*87.34*
14	*85.49*	*41*	*87.28*
15	*92.03*	*42*	*85.90*
16	*88.20*	*43*	*87.98*
17	*87.23*	*44*	*84.08*
18	*84.63*	*45*	*90.53*
19	*84.40*	*46*	*91.91*
20	*85.08*	*47*	*92.05*
21	*87.62*	*48*	*84.45*
22	*92.19*	*49*	*86.73*
23	*89.68*	*50*	*84.50*
24	*88.02*	*51*	*84.16*
25	*91.24*	*52*	*84.56*
26	*84.59*	*53*	*91.32*
27	*92.26*	*54*	*84.04*

Table 1: Effect evaluation of photographic art method based on VR technology and machine vision.

From the above experimental results, it can be seen that the photographic art method based on VR technology and machine vision proposed in this paper can effectively improve the expression effect of photographic art, and has an important role in promoting the further development of subsequent photographic art.

5 CONCLUSION

The art of photography is an artistic activity that must express artistic beauty. The so-called artistic beauty is an artistic image that embodies the meaning of human life in perceptual form, expresses the emotion and vitality of human life, and the fundamental characteristics of its creative activities.

On the basis of long-term and in-depth observation, feeling and experience of life, the artist concentrates, generalizes, and refines the things and phenomena in real life according to his own certain aesthetic ideals, concepts and tastes, and uses certain material materials and skilled artistic skills to create new creations, thereby materializing people's will, emotions and ideals in various perceptual symbol forms. This article combines VR technology and machine vision to study the photographic art, and builds an intelligent photographic art research system. The experimental research results show that the photographic art method based on VR technology and machine vision proposed in this paper can effectively improve the expression effect of photographic art and play an important role in promoting the further development of subsequent photographic art.

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