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# *New Denoising Algorithm in Crop Image Processing*

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***Abstract:*** The purpose of this paper is to address the problem of difficulty in denoising after acquiring images in crop digital image processing. This paper introduces a median filtering method using wavelet transform to effectively solve the application of denoising algorithms in crop image processing. Through the lack of effective analysis of traditional denoising algorithms on the propagation characteristics of signals and noise in different decomposition layers, the basic principle of the lifting method is introduced, and the implementation method of constructing traditional wavelets using the lifting principle is given. Daubechies (9/7) lifting format wavelet is applied to the two-dimensional image denoising process, and a white color block processing is performed on the horizontal, vertical, and diagonal high-frequency coefficient matrices at each level after wavelet decomposition. Adaptive threshold denoising method. Compared with traditional algorithms, the method in this paper is simple to calculate, improves the operation speed by 50%, and increases the denoising effect by 64%. It improves the peak signal-to-noise ratio (PSNR) and minimum mean square error (MSE) of the image, and it is better Ground retains the texture and details of the image.

## 1. Introduction

When the door of the century opens, if you look closely at today's era, you will find that Heidegger's prophecy of the "world image era" has arrived and image culture is being generated [1]. Nowadays, from printed publications to electronic media, from outdoor advertising to daily records, the method of images has become a common way to perceive and understand things, and has entered the family and personal life, and has a personal spiritual life [2-3]. However, the various original images that people obtain from the outside often contain too much complex information and cannot be used directly. Image processing technology can help people solve these problems[4-5]. With the continuous development of multimedia technology and communication technology, image signals with measurement information are more and more widely used in various fields, but because they are often interfered by various noises in the process of generation, transmission and recording, it has been seriously affected The visual effects of the image have brought a lot of inconvenience to subsequent processing tasks such as edge detection, image segmentation, feature extraction, and pattern recognition [6]. Therefore, before these processing tasks, it is very important to reduce noise by using appropriate image denoising algorithms. Important processing steps. This paper has carried out a series of research work under such a background [7-8].

Image denoising is a classic problem in the field of digital image processing [9]. Image denoising-the general method is to reconstruct or restore the image contaminated by noise from some prior knowledge of noise[10]. Image filtering-generally can be divided into spatial domain filtering, frequency domain filtering and wavelet domain filtering [11]. The wavelet analysis method was not proposed in the 1980s-a new type of mathematical analysis. The proposed wavelet analysis method effectively overcomes the shortcomings of Fourier transform in time or without any resolution[12]. It uses telescoping and panning operations to gradually refine the signal at multiple scales, and finally achieves time subdivision at high frequencies and frequency subdivision at low frequencies, which can automatically adapt to the requirements of time-frequency signal analysis. In 1995, Donohon et al. Proposed a soft threshold for denoising timidity. At the same time, he also proved that the threshold is optimal in a progressive sense [13]. In the history of image denoising, researchers have proposed a large number of denoising algorithms to remove noise from images, and this denoising process has become image filtering. The classification of image filtering can be divided into linear filtering and non-linear filtering according to the filtering method used, and can be divided into spatial domain and transform domain method according to the position of the signal domain[14]. Since most of the noise in the image is in the high frequency band, a large number of algorithms decompose the noise image into high and low frequency parts, and filter only in the high frequency part, and then combine the filtered high frequency part with the low frequency part. To get the final denoising result[15]. The wavelet threshold image denoising method is widely used because it is relatively simple to implement and has a small amount of calculation. However, the advantages of wavelet analysis in one dimension cannot be generalized to two-dimensional or even higher dimensions, that is, it cannot be generalized from singular point singularity to singular line singularity or singularity. And for the image, the edge discontinuities are distributed according to space. This singularity affects many terms in the wavelet expansion series. Therefore, the wavelet transform shows many deficiencies in denoising. To this end, researchers have proposed multi-scale transformation tools. Among many multi-scale transformation tools, non-downsampling Shearlet transformation has the advantages of fast decomposition and direction sensitivity, and there is no down-sampling process, which makes it invariant to translation. Compared with the wavelet decomposition coefficient, its decomposition coefficient can more accurately represent the details of image content, which is conducive to improving the denoising effect [16,17].

With the development of image acquisition technology and the continuous improvement of people's living standards, people have become more and more dependent on images. It has become a fashion to collect and publish various pictures. However, because image data is often interfered by the external environment or the system itself during the process of generation and transmission, the image data obtained by people cannot accurately reflect the actual information. This situation brings actual production and life. After a lot of inconvenience, it can not meet people's requirements for picture quality. Therefore, it is very meaningful to conduct further research on image denoising algorithms. In addition, the image denoising link is the basic link of the entire image processing system.Its quality will directly affect the performance of the subsequent steps of the entire image processing system, including edge detection, image segmentation, feature extraction, pattern recognition, etc. It is very meaningful to research the noise algorithm to improve the denoising performance of the algorithm, and to improve the performance of the entire image processing system [18].

Through the study of wavelet analysis theory, this paper further clarifies the ideas from wavelet theory to the application of wavelet image denoising.In the analysis of the current wavelet domain image denoising algorithms proposed by domestic and foreign literatures, a paper is proposed to address the shortcomings of the current algorithms. An improved wavelet denoising algorithm, based on the wavelet transform's median filtering method, which performs median filtering of high-frequency subbands in the wavelet domain, and then selects the corresponding threshold for noise reduction processing. Simulation results show that the method Not only can the mixed noise in the crop image be filtered, but the edge details of the crop image can be better retained, and its filtering effect is ideal.

## 2. Proposed Method

### 2.1. Denoising Algorithm Basics

(1) Basic principles of denoising

With the rapid development of network technology and communication technology, large-scale transmission of image data has become possible, and the transmission speed has also been greatly improved. Image data transmission between two computers, between two factories, between two cities, and even between spaceships and the earth has become a common phenomenon. With the increasing demand for image data, the requirements for image quality have become higher and higher.However, since image data is often generated and transmitted by the environment or the system itself, therefore, The image data obtained by people cannot accurately reflect the actual information. This situation brings a lot of inconvenience to the actual production and life. In order to eliminate noise and obtain more accurate image data, many scholars have conducted in-depth research on various noise models.

The most commonly used spatial domain denoising filters are linear filters and nonlinear filters. Non-linear filters are mainly median filtering summer eggs. Linear filters mainly include mean filtering, linear weighted filtering, and reciprocal gradient weighted filtering. The median filter is used to remove impulse noise, while the mean filter is mainly suitable for removing Gaussian noise. The essence of the filters in the spatial domain are all operations based on the neighborhood of the pixels.By creating a desert plate centered on the pixel to be processed, and then panning the template across the entire image, the entire image is filtered. operating. So median filtering is to find the average value of all pixels in the window, and then assign it to the center pixel as the output of the filter. Obviously, this method blurs the image and destroys the details of the image while filtering the noise.

(2) Noise model

Noise in an image can be defined as an unwanted part of the image, or an unwanted part of the image. The noise may have some randomness, such as the salt and pepper noise on the TV screen, or there may be some regularity, such as the echo in the valley with only a certain delay. There are various reasons for the formation of noise, and their properties are also very different. The more common ones include thermal noise, flicker noise, emission noise and colored noise. Due to the influence of noise, the gray level of image pixels will change. The gray level of the noise itself can be regarded as a random variable, so its distribution can be described using a probability density function. According to the statistical characteristics of the noise probability density function, noise can be divided into Gaussian noise, salt and pepper noise, uniform noise, Poisson noise, Rayleigh noise, etc.For example, the probability density distribution of thermal noise belongs to Gaussian distribution, so it can be attributed to A Gaussian distribution noise. This division will bring a lot of convenience to the design of the denoising algorithm. Here are three important probability density functions:

Salt and pepper noise, the probability density function can be expressed as:

$$p(x)=\begin{cases} P_a & if x=a \\ P_b & if x=n \\ 0 & other \end{cases} \tag{1}$$

Among them, x represents the gray value of the pixel, and a and b represent the extreme gray in the image. When using an 8-bit image, a = 0, b = 2550. The effect of the wound gate reflected in the image is "black" and "white". "It looks like the pepper and salt particles are randomly scattered on the image, so it is called pepper and salt noise. Both emission noise and spike noise can be represented by this type of noise.

Gaussian noise, the probability density function can be expressed by Equation 2.

$$p(x)=\frac{1}{\sqrt{2\pi\sigma}}\exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right) \tag{2}$$

Among them, x represents the pixel gray value, $\mu$ is the average of x, and $\sigma$ is the standard deviation of x. The gray value of this noise is generally concentrated near the mean sound, and the degree of concentration is caused by. It was decided that as the distance from the mean increased, the number of distributions would decrease. Typical examples of this noise are noise from electronic equipment or noise from sensors. The Gaussian noise model is relatively easy to handle mathematically, so many noises with a distribution close to the Gaussian distribution are often approximated by the Gaussian noise model.

Even noise. The probability density function can be expressed by formula (3)

$$p(x)=\begin{cases} 1/(b-a) & if x\in[a,b] \\ 0 & other \end{cases} \tag{3}$$

Among them, x represents the pixel gray value, and a and b are given gray values, respectively. The average and variance of this noise are:

$$\mu=(a+b)/2 \tag{4}$$

$$\sigma^2=(b-a)^2/12 \tag{5}$$

This noise is balanced over a certain range and is often used as the basis for many random number generators.

## 2.2. Wavelet Denoising Principle

The main idea of image denoising in the wavelet transform domain is to select a suitable wavelet base to perform wavelet transform on a noisy image, and then to find the difference between noise and signal at different decomposition levels, use this difference to process the wavelet coefficients, and then The processed coefficients are subjected to inverse wavelet transform to obtain a denoised image.This process can be represented by Figure 1.

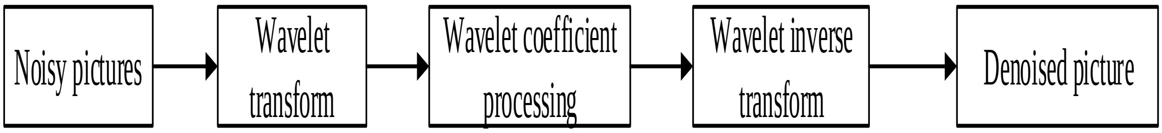


*Figure 1. General process of wavelet denoising method*

(1) Modular maximum filtering

Assuming that the observed noisy image is y, y can be expressed by equation (6):

$$y = x + n \tag{6}$$

In the formula, x is the original image without noise; n is zero mean because wavelet transform is a linear process, then:

$$Y = X + N \tag{7}$$

Where Y is the wavelet transform coefficient of y; X is the wavelet transform coefficient of x; N is the wavelet transform coefficient of noise n.

The basic idea of the modular maximal point filtering algorithm is: the modular maximal points after image wavelet decomposition contain important edge and detail information of the signal, and these points may also be caused by noise points, so by eliminating these Denoised images can be obtained by reconstructing the original image using the residual wavelet coefficients from the modulus maximum points generated by the noise.

(2) Spatial correlation filtering

After the noisy signal undergoes wavelet transform, the small coefficients corresponding to the signal and noise have great differences in spatial distribution: the wavelet coefficients corresponding to the signal have good propagation properties, and the wavelet coefficients corresponding to the signal at each scale have Good local properties, but the energy of the noise signal is only concentrated on a small scale. Therefore, the wavelet coefficients of the signal have good correlation on various scales, and the difference between the correlation is used to distinguish the noise from the signal point, so as to filter the noise.

(3) Wavelet threshold filtering

Wavelet threshold filtering is a simple and efficient wavelet domain filtering method. By comparing the amplitude of the wavelet coefficient with a specific threshold, if the amplitude of the wavelet coefficient is less than this threshold, the wavelet coefficient is set to 0; If the amplitude of the wavelet coefficient is greater than a threshold, the wavelet coefficient is retained or an appropriate correction is performed.

Threshold filtering is divided into two types: the hard threshold method (hard.threshold) shown in Equation 8, and the soft threshold method (soft-threshold) shown in Equation 9.

$$T_h = \begin{cases} 0 & |y| < T \\ y & |y| \geq T \end{cases} \tag{8}$$

$$T_s = \begin{cases} 0 & |y| < T \\ \operatorname{sgn}(y)(|y| - T) & |y| \geq T \end{cases} \tag{9}$$

Donohon strictly proved that the signal contaminated by additive Gaussian noise can be recovered by a nonlinear soft-threshold function in the wavelet domain, and theoretically shows that the method is progressively optimal. At the same time, he also gives the calculation method of the universal threshold (Universal Threshold) .This value is only related to the noise variance, as shown in the following Equation 10:

$$T_{univ} = \sigma_n \sqrt{2\ln(N)} \tag{10}$$

Practice has proved that the wavelet soft threshold filtering method proposed by Donohon can well filter the Gaussian noise contained in the image.

### 2.3. Improved Composite Denoising Method of Window Median Filtering and Wavelet Transform

This method first performs window-improved multilevel median filtering on images with noise, the purpose is to protect the linear characteristics of the original image, and then wavelet decomposition is performed on the multilevel filtered images, and the generated wavelet coefficients are subjected to window-improved multilevel again The median filtering process generates new wavelet coefficients, uses the new wavelet coefficients to reconstruct the image, and finally uses the wavelet threshold to denoise to generate a new denoised image. The specific algorithm is as follows:

(1) Multilevel median filtering using the algorithm in section 2.2 for images containing noise;

(2) Single-scale decomposition of the multi-level filtered image using Sym4 wavelet;

(3) Perform multi-level median filtering on the approximated coefficient A1, horizontal detail coefficient H1, vertical detail coefficient Vl, and diagonal detail coefficient D1 obtained by the decomposition, so as to obtain new wavelet coefficients;

(4) Reconstruction with new coefficients to obtain preliminary filtered images;

(5) Use the sv-n4 wavelet to perform 3 layers of decomposition on the above image again to obtain the detailed components and approximate components of each layer, and use the threshold value to choose;

(6) Reconstruction using each component to obtain the final denoised image.

The above-mentioned various filtering algorithms have been successful, but there are also many shortcomings and defects. Therefore, some scholars have tried to introduce more advanced mathematical tools into the field of image denoising to reduce noise; some scholars believe that a single denoising method does not It cannot achieve a good denoising effect.Only a combination of multiple cubes can better filter out noise and protect the details of the image. The main research trend is: apply the fractal mathematical theory in nonlinear mathematics to the image denoising research. Through the extraction of image features to protect the details and edges of the image, good results have been achieved in image denoising. The denoising method based on the combination of traditional methods and intelligent optimization algorithms improves the traditional method of discriminating all pixels in the traditional algorithm by first identifying the noisy and non-noise points in the image, and then targeting different situations Choose different processing methods to complete the filtering of noise. A denoising method based on independent variable analysis is used. ICA image noise reduction is also an image noise reduction method based on the transform domain. It is a data-adaptive transform. The transform is trained on data that does not contain noise. Accurate noise-free data is a hot topic of research. A theory of image processing proposed by the partial differential equation denoising technique. The advantage of the PDE method for denoising is that it has multi-scale and multi-directionality and can well protect image details. Yang's idea is to establish an image restoration model, which uses the idea of minimizing energy or directly based on the solution of partial differential equations The minimum solution of the equation is obtained, so the research hotspot is to obtain a partial differential equation model through various more suitable methods, which can remove the noise and better protect the details of the image.

## 3. Experiments

### 3.1. Experimental Data Set

Select the Lena image in the image standard database. The image source is http://decsai.ugr.es/~Javier/de-noise/test-images. In order to demonstrate the effectiveness and feasibility of the algorithm in this paper, Lena and Barbara images with Gaussian noise standard deviations of 30 and 50 were selected for experiments. At the same time, Gaussian noise with a variance of 0.02 and pepper and salt with a noise intensity of 0.02 were added to the original images of the experimental group. Noise to get an image with mixed noise. The control group is the image obtained after median denoising.

### 3.2. Experimental Environment

The algorithm in this article and the comparison algorithm are on a 64-bit Windows 10 operating system, the hardware platform is an Intel (R) Core (TM) processor, 8.00GB of memory, a computer with a 3.6GHz frequency, and the experimental software platform is Matlab 14a.

### 3.3. Experimental Steps

The specific steps of the image denoising method proposed in this research include:

(1) Perform two-dimensional median filtering on noise image, and the filtering window is 3 * 3;

(2) Decompose the image by one layer of wavelet decomposition, and extract the approximate coefficients of two-dimensional wavelet decomposition, which are the horizontal detail coefficient, vertical detail coefficient, and diagonal detail coefficient, respectively;

(3) The extracted approximate wavelet coefficients are processed separately using the median filtering principle to generate new coefficients;

(4) Image reconstruction using the newly generated wavelet coefficients to obtain a denoised image;

(5) The wavelet transform is used to decompose the above images to obtain the detailed components and approximate components under the 2-layer decomposition;

(6) Select appropriate Min value to choose the wavelet decomposition coefficient of each layer;

(7) Use the last layer approximation coefficient and each layer's detail coefficient to perform inverse image reconstruction to obtain the final denoised image.

## 4. Discussion

### 4.1. Experimental Results and Comparison

(1) In order to fully verify the effectiveness of the algorithm in this chapter, a series of algorithm performance analysis and comparative experiments were performed. In these experiments, two 512X512, 256-level grayscale images were used, as shown in Figure 2. For these two typical crop images, they contain different amounts of detailed information, so they are more persuasive. What needs to be explained here is that in order to facilitate the comparison of various denoising algorithms involved in this paper, these two crop images will also be used in the experiments to perform algorithm denoising performance experiments. The algorithm used a 5 * 5 filter window in the experiment.

*Table 1. Performance analysis of parameter adjustment methods*

| Input image | Ideal threshold | Actual threshold | Ideal MSE value | Actual MSE value |
|---|---|---|---|---|
| Image with 15% salt and pepper noise | 30 | 24 | 7.3573 | 7.3651 |
| Image with 25% salt and pepper noise | 24 | 16 | 68.7084 | 68.934 |
| Image with 45% salt and pepper noise | 18 | 9 | 16.0335 | 16.1299 |
| Image with 55% salt and pepper noise | 12 | 6 | 143.1117 | 143.1117 |

*Figure 2. Experimental benchmark image*

(2) In order to analyze the adaptability of the algorithm performance and the robustness to noise, here add 1% to 35% pepper and salt noise to each experimental image, use the algorithm in this chapter to perform denoising experiments, and calculate the corresponding denoised image. MSE value, while recording the corresponding optimal interpretation value, as shown in Figure 3, where the number in parentheses is the optimal value obtained by the parameter self-adjusting method.

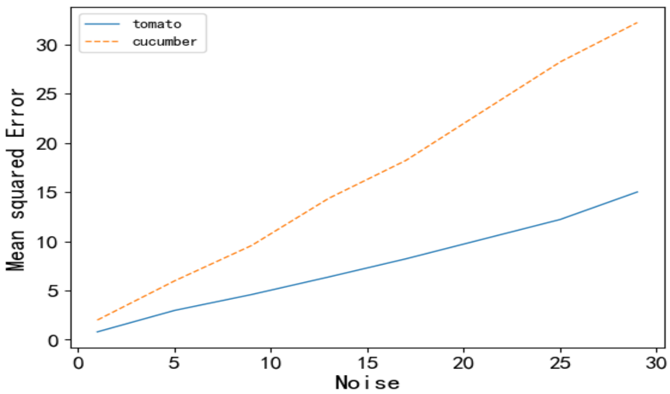


*Figure 3. MSE evaluation results of denoised images*

## 4.2. Experimental Results and Comparison of Crop Denoising Algorithms

(1)In order to verify the effectiveness of the algorithm, we compared the LS-SVM neighborhood threshold denoising algorithm with the BayesShrink threshold denoising algorithm and NeighShrink threshold denoising algorithm using the images provided in 4.1. Adding three kinds of Gaussian noise with different intensities, the noise variance is 20, 25, 30. Under the same conditions, the results obtained by three different denoising methods are shown in Table 2 and Figure 4 below.

*Table 2. Performance comparison of three different threshold denoising methods*

| Denoising method | S=20 | | S=25 | | S=30 | |
|---|---|---|---|---|---|---|
| | PSNR | MSE | PSNR | MSE | PSNR | MSE |
| LS-SVM | 27.54 | 112.12 | 26.42 | 145.23 | 24.22 | 142.34 |
| BayesShrink | 28.55 | 88.89 | 27.54 | 90.23 | 26.34 | 110.22 |
| NeighShrink | 28.45 | 59.23 | 28.10 | 78.29 | 26.75 | 103.25 |

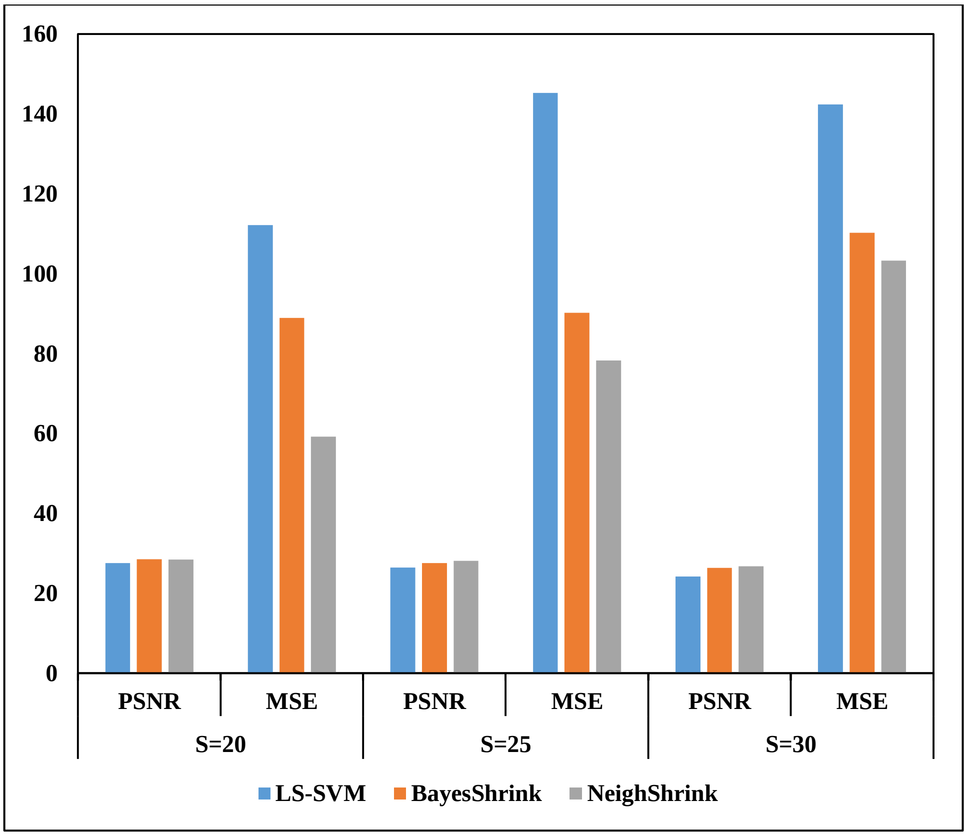


*Figure 4. Comparison of different threshold denoising methods*

(2)For tomato images with noise variances of 20, 25, and 30 (see Figure 2), the LS-SVM neighborhood threshold denoising algorithm is used, and the resulting denoised images are shown in Figure 5. From Table 2, we can see the superiority of the median filtering method based on wavelet transform, and the peak signal-to-noise ratio is relatively high.Therefore, no matter from the subjective image quality assessment criteria or the objective quality assessment criteria, the median filtering based on wavelet transform Method is an effective denoising method as shown in Figure 6.

*Figure 5. Image after adding noise and denoising*

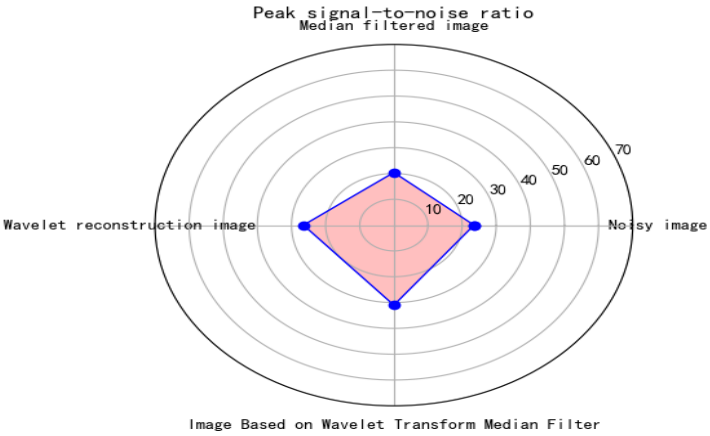


*Figure 6. Denoising advantages of wavelet variation median filtering*

## 5. Conclusion

By analyzing the data in parentheses, it can be seen that the optimal parameter value changes with the change of noise density and input picture, and the magnitude of the change is large, which indicates that the parameter is more sensitive to noise density and image type, so the parameter estimation The introduction of strategies is necessary. From the MSE evaluation data in the table, it can be seen that for the same image with different noises, the denoising performance of the algorithm in this chapter is relatively stable, and there is no serious performance degradation in the process of increasing noise, and the denoising results are all It is satisfactory, which shows that the algorithm in this chapter has good adaptability to different types of pictures, and is robust to pepper and salt noise with different densities.

With the development of agricultural informationization and modernization, image processing technology has been more and more widely used in the field of greenhouse monitoring. How to effectively remove image noise is a major problem in this field. This study analyzed the advantages and disadvantages of the median filtering algorithm, and based on this, combined with the wavelet transform principle, a new method with simple and practical algorithm was proposed, and it was successfully used in the process of tomato image processing. It provides a new method for image denoising of crops in greenhouse monitoring system. This paper analyzes the shortcomings of some classic filtering methods to remove impulse noise, such as the loss of image detail information and blurred image, etc.Aiming at such problems, a new two-stage impulse noise evaluation process is proposed to detect noise The new algorithm first determines the contours and noise points of the image by analyzing the local similarity of each pixel; then uses the neighborhood impulse noise evaluation method to detect the impulse noise points; finally, in the process of filtering the impulse noise, the local similarity is met Maximum principle, so that the gray value restoration of pixels polluted by pulse noise is more reasonable, and the accuracy of noise localization and detail protection is improved. It can be seen from the experimental results that compared with the classic median filtering algorithm and the minimum distance filtering algorithm The new algorithm proposed in this paper has a good effect in noise detection accuracy, objective distortion measurement, and visual effects, and has certain application value.

However, in the process of digitizing analog images, due to interference from electronic devices, the quality of the digital images after conversion is reduced, and there are problems such as varying levels of edge blurring and poor local or overall contrast. Need to enhance edges, improve contrast, and improve image quality. Wavelet has multi-resolution analysis capabilities. And the good locality in the time-frequency domain makes the wavelet transform have a "concentration" capability for certain signals. If the energy of a signal is concentrated on a small number of coefficients in the wavelet transform domain, then the values of these coefficients are larger than the wavelet coefficient values of the energy scattered on a large number of coefficients. In the wavelet transform domain, the energy of the signal is mainly concentrated on some bright lines, and most of the coefficient values are close to. The distribution of noise is opposite to the distribution of signals. Its coefficients are evenly distributed throughout the entire scale, and the amplitudes are not much different. Therefore, image denoising through wavelet transform has become an important research direction. Compared with traditional single wavelets, multiwavelets are wavelets generated by two or more functions as scale components, which have many advantages: such as symmetry and short support. Second-order hour moment loss and orthogonality. So multiwavelets are more advantageous than single wavelets in signal processing.

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## Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## Conflict of Interest

The author states that this article has no conflict of interest.

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