Available online at www.sciencedirect.com

SciVerse ScienceDirect

AASRI Procedia 1 (2012) 68 – 73

AASRI Procedia

www.elsevier.com/locate/procedia

2012 AASRI Conference on Computational Intelligence and Bioinformatics

An Improved Algorithm for Impulse Noise by Median Filter

Hanglin Zeng[a*], Yuan-zhong Liu[a], Yu-mei Fan[a], Xuefei Tang[b]

[a]College of auto. and Electr . Eng.， SiChuan University of Technology and Engineering，ZiGong, 643000，China
[b]College of Computer.，University of Electr Science and Tech of China,，Chengdu, 610054， China

Abstract

This paper proposes an algorithm to improve image processing for impulse noise by median filter. Isolate noise points in an image are detected by way of indiscernibility on rough sets. The improved algorithm enhances the detection capability of the single element of an image. Impulse noise is removed by a method of improvement of choice of threshold and filtering templates of median filter. Experiment simulation showed that the method of image enhancement proposed is superior to the traditional method in effectively improving image degradation and image clarity.

Keywords：Image processing; Median filter; Impulse noise; Edge detection

1. Introduction

A principal thrust of image processing is the utilization of methodologies that facilitate knowledge processing on state-of-the-art scientific exploration，manufacture, transportation, communication, etc.. There are urgent needs for developing a new method of improvement quality of degradation image.

Image degradation is generally caused by Gaussian noise and impulse noise. For example, images collected with a camera contain Gaussian noise due to the characteristics of physical devices and electronic systems and pictures taken contain pulses noise caused by the external environment interference.

Denoising of image is realized by way of image filtering which can be divided into spatial domain, frequency domain and wavelet domain [1-3]. The most common spatial domain filtering has two kinds of linear filters and nonlinear filters. Linear filters include linear average filter, inverse gradient weighted filter, etc. Nonlinear filter is mainly used by median filter to remove impulse noise [4-7].

doi:10.1016/j.aasri.2012.06.014

Choice of threshold and filtering templates of median filter to determine impulse noise is key operation. This article is intended to improve image processing for median filter of impulse noise. Isolate noise points in an image are detected by idea of indiscernibility on rough sets. Impulse noise is removed by a method of improvement of choice of threshold and filtering templates of median filter.

2. Detection of Isolate Noise Points in an Image by Way of Indiscernibility on Rough Sets

$S=(U,A,V,f)$ is a collected database of the gray value of pixels of an image. U is a non-empty universe defined on a finite set; for any object $x \in U$, $A=C \bigcup D$ is a non-empty set where C and D respectively are set of condition attributes and decision attribute contained noise. Where $U\left|C=\left(X_1,\ldots,X_n\right)\right.$ is referred as indiscernibility which denotes the equivalence classes of U classified on the set of condition attributes C, where X_j denotes an equivalence class based on condition attributes, and $U\left|D=\left(Y_1,\ldots,Y_m\right)\right.$ denotes the equivalence classes of U classified on the set of decision D, where Y_i denotes an equivalence class based on decision attributes, and $U\left|R_i\right.$ denotes the equivalence classes of U classified on a qualitative attribute $R_i \in C, i=1,\ldots,n$. V is a set of the gray value of pixels of an image. $f: U \times A \rightarrow V$ is an information function.

Definition 1: For $S=(U,A,V,f)$, based on rough set [8], r_1 is a set of all the noise on $U \mid C$, r_2 is a set of all the information pixels of an image on $U \mid D$, it will be satisfied with:

$$r_1=\{(i,j) \mid \min(mean(|I(i,j)-I(x,y)|))>M\} \tag{1}$$

$$r_2=\{(i,j) \mid \min(mean(|I(i,j)-I(x,y)|)) \leq M\} \tag{2}$$

Where $I(i,j)$ denotes the gray value of centre pixel of an image of a filter template. $I(x,y)$ denotes the gray value of pixel (x,y) of an image of a filter template. $mean$ denotes average gray level difference operator. $\min$ denotes minimum operator. M denotes the threshold value of noise.

To distinguish between edges and noise with median filter, 5×5 window filter template is taken as an example shown in Figure 1.

i) If the current centre pixels for flat area pixel, then it around 24 pixel grayscale values most very close. So even if there are a few noise points, but the pixels absolute value which these pixel points and the centre of grey value of the difference is greater than some threshold number M would not more than 5.

ii) If the current centre pixel points are the image edge points, then it around 24 pixels grayscale value about half very close, the others will have big difference. So they and the centre of the difference between the pixels grey value absolute value is greater than some threshold number M would have 12 or so.

iii) If the current centre pixel is noise points, so its most grayscale value which around the current centre pixel have big difference with it, So they and the centre of the difference between the pixels grey value absolute value is greater than some threshold number M would be more than 18 or above. Thus, we can draw:

If $cnt \leq 5$ we think the current point is flat area point;

If $5 < cnt < 18$ we think the current point is image edge point;

If $cnt \geq 5$ the current point is image noise point;

cnt for the centre with its pixel around 24 pixel grayscale value difference of the absolute value greater than some threshold of number of M.

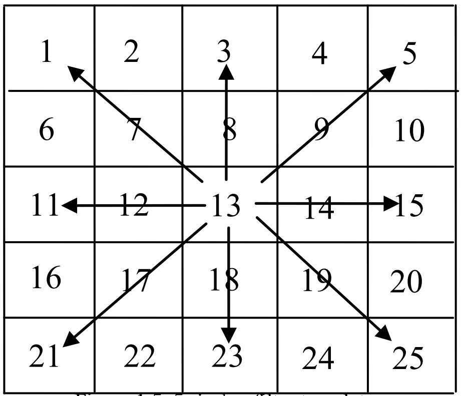

Figure 1 5x5window filter template

3 An Improved Algorithm for Impulse Noise By Median Filtering

Median filter is constructed with an odd number of points of a sliding filter window, the window in the gray value of each point the value of the centre of the window instead of the gray value of pixels. Specific operation is as follows:

1） Take a $m \times m$ window template, m is odd. Graph window template will roam a pixel position coinciding with the template center and read the gray value of each pixel corresponding to f_{ij} in the template.

2） Gray values of all pixels from small to large order to generate monotonic data sequence $\{f_{ij}\}$, and to find the middle of a $median\{f_{ij}\}$.

3） The value of $median\{f_{ij}\}$ is assigned to the middle of the center of the pixel corresponding to the template.

The image detail ambiguity caused by linear filters and filter out glitches and grain noise can be overcome by this way. But for some more details (special points, lines, spire) of the image should not be used median filtering method.

A threshold M is defined to judge noise in a median filter. If the difference of the centre pixel and around centre pixels is greater than M, then the current pixel is judged as a noise point.

Consider as shown in figure 1 shows the templates, we will centre around 13 pixels and 24 neighbourhood pixels, for a vector b, a definition is given as following:

$$\Delta(i,j) = (b(4)+b(5)+b(6)+b(7))/4 \tag{3}$$

Where $b(4), b(5), b(6), b(7)$ is the value of vector b from the fourth element to the seventh element. Each pixel will have a $\Delta(i,j)$, and an image of a template form a Δ matrix. A mean and variance of an image of a template is defined as:

$$\overline{\Delta} = \frac{1}{M \times N} \sum_{i=1}^{M} \sum_{j=1}^{N} \Delta(i, j) \tag{4}$$

$$\sigma^2 = \frac{1}{M \times N} \sum_{i=1}^{M} \sum_{j=1}^{N} \left(\Delta(i, j) - \overline{\Delta}\right)^2 \tag{5}$$

A threshold of an image of a template can be defined as:

$$M = \overline{\Delta} + \sigma \tag{6}$$

If meet $\Delta(i, j) > M$, we can judge the current centre pixel is noise points.

In order to improve judge impulse noise, an image of a template is divided into 8 direction as four groups, respectively is: 0^0 、 45^0 、 90^0 、 135^0 、 180^0 、 225^0 、 270^0 、 315^0 is shown as Fig.1. When the number of impulse noise is more than 18, even if the absolute difference value of around the pixel is greater than the threshold value, but the absolute grey value of the centre pixel of a group of above four groups is no more than the threshold, it is not regarded as noise point.

4 Experiment Results and Analysis

An experiment simulation of image processing for impulse noise by median filter is realized by normal median filter， adaptive median filter，impulse noise median filter, and improved median filter in this paper with an image Lena of adding chili and salt noise in a 5 x5 window. In order to compare the improving image degradation and image clarity by method proposed in this article and with other median filter methods [2,4,8,10].

The simulation results in Matlab7.8 is shown in Figure 2. Some comparison results of the signal-to-noise ratio are given in the Table 1.

TABLE 1 comparison of the signal-to-noise ratio by median filter

Filtering method	SNR
Noise image	18.45dB
Normal median filter	30.84dB
Adaptive median filter	33.42dB
impulse noise median filter	35.92dB
improved median filter	37.32dB

It is shown that signal-to-noise ratio of an image is improved by normal median filter than linear filter, but the whole image edge details is lost, image vision is blurred; Adaptive threshold median filter is of obvious enhancement effect, but a part of edge pixel is incorrectly judged to noise. Impulse noise median filter enhances image edge to become clearly. But from the noise image we can see, it is a part of wired pixel edge was judged to noise. The improved median filter proposed here will reduce the effect of the image edge, and increase the signal-to-noise ratio in effectively improving image degradation and image clarity.

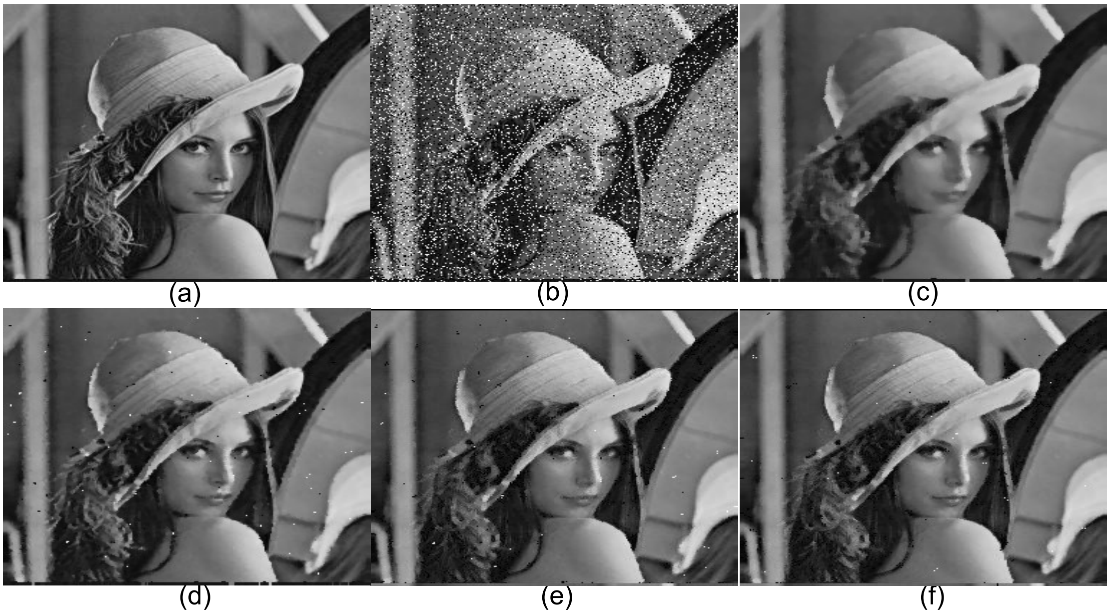

Figure 2 comparison of filtering noise

(a) An original image (b) noise image (c) normal median filtering (d) adaptive median filtering (e) impulse noise median filtering (f) improved median filtering

5 Conclusions

The main issue what we are interested is effective improvement of image processing for impulse noise by median filter. The main works completed in this paper are that a way of detection of isolate noise points in an image is proposed by way of indiscernibility on rough sets. A choice of threshold and filtering templates of median filter is suggested to remove impulse noise. An improved algorithm enhances the detection capability of the single element of an image. The feasibility of the proposed approaches of improvement of image processing for impulse noise by median filter is supported by some of examples.

Acknowledgements

This work was supported by a grant from Foundation of major applied science project of Science and Technology Department of Sichuan Province under No. 2011JY0051 and Foundation of major special project of Key Laboratory of Sichuan Province of Liquors and Biotechnology under No. NJ2010-01

References

[1] YAO Min etc., Digital image processing [M], Beijing: mechanical industry press, 2006
[2] GUO Hai-Xia, XIE Kai, An improved adaptive median filtering algorithm [J], China journal of image and graphics, 2007.7:1185 ~ 1188
[3] YAN Jin-Wen, Digital image processing (MATLAB edition) (M), Beijing: defense industry press, 2007
[4] LIU Zhu-Hua, ZOU Dao-Wen, DENG Cheng-Zhi, WANG Sheng-Qian, A new detection based on noise points of impulse noise denoising algorithm (J), Computer engineering and application, 2005.15: 41- 43
[5] RUAN Qiu-Qi, Digital image processing learning [M] (second edition), Beijing: publishing house of electronics industry, 2004.180-304
[6] HUANG Xiaoli , ZENG Huanglin. Face Blind Separation Using Wavelet Packet Independent Component Analysis[C], Proceeding of 2010 International Conference on Image Analysis and Signal Processing, 2010, 680–685
[7] ZENG Huanglin, XU Zeng-wei, Industrial Sewage Evaluation Based on Fuzzy Neural Network[C], Procedia Environmental Sciences, , Available online at www.sciencedirect.com, ELSEVIER, 2011,771-776
[8] FEI Gao , YANG Ping-Xian, SUN Xing-Bo, Based on wavelet transform and threshold shrinkage of image enhancement denoising[J], Journal of Sichuan University of Sciene & Engineering, 2006,19(2), 8-10
[9] RAFAEL C. Gonzalez, Digital Image proccessing in MATLAB[M], BeiJing: Publishing House of Electronics Inustry, 2003,78-125
[10] GANG Li, HE Shi-Wen, LU Yu-Ron etc., Wavelet modulus maxima multi-scale edge detection algorithm analysis [J], Journal of Sichuan University of Sciene & Engineering, 2010, 21(5) , 65-68