A Survey on Image Denoising methods

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Abstract – **Image denoising is general artifacts in digital image processing and it is hard to avoid. Image restoration or denoising is necessary to reduce noise from the image. Noise reduction is a fundamental operation of image processing in order to enhance, analyze & interpret the important information in an image. Edges are important to visual appearance of images, so to preserve important features like edges, corners during the denoising process. Noise reduction is still a challenging task, so this paper presents brief general classification of denoising methods.**

Key words – **Noise reduction, spatial filtering, image restoration**
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I. INTRODUCTION

Digital images surround us everywhere nowadays, with an increasing amount of devices capable of delivering, capturing and sharing multimedia sources. With increased interconnectivity it is easier to share experiences, often in form of an image or a video. Often this kind of media is shared on social network sites such as Facebook or twitter. More devices are being able to connect to the Internet so media can be shared from anywhere, at anytime.

Image Restoration is the process of taking a corrupt/noisy image and estimating the clean, original image. Corruption may occur in many forms such as, motion, blur and noise and camera misfocus. The purpose of image restoration techniques is to reduce noise and recover resolution loss. Image restoration is applied in every field where images have to be understood and analyzed. For example, medical image analysis, analysis of images from satellites, etc. Image processing techniques are performed either in the image spatial domain or the frequency domain.

Digital images can be corrupted by noise during the process of acquisition and transmission, so main challenge is to remove noise as much as possible without disposing the most representative characteristics of the image, such as edges, corners and other sharp structures[3]. To reduce undesirable effects, a variety of edge-preserving filtering techniques have been offered over the past few years. One of the edge-preserving filtering is non-linear filtering and can preserve the image details and local geometries while removing the undesirable noise. There are many techniques for handling such noise, called image filtering. Some of these filtering techniques are explained below[3].

II. CLASSIFICATION[3]

Denoising has two filtering domains:

A.   Spatial Domain filtering[4]:
Main goal of spatial filtering is to either remove, or isolate frequencies in the image. This method takes original noisy image into consideration and it is direct & high speed processing tool of images.

a.   Linear filtering:
Linear filtering like mean filter, wiener filter tend to blur sharp edges, destroy lines and other fine image details, and perform poorly in the presence of signal-dependent noise. Linear filters usually not only smoothes the noise but also blurs important structures along with noise.

Mean Filter:
Mean filter is windowed filter of linear class, that smoothes image[5]. The filter works as low pass one. It is simple & easy to implement. Idea behind mean filter is for any element of the image take an average across its neighborhood. Mean filter is simply replacing each pixel value in image with the mean value of its neighbor, including itself.

Wiener Filter:
Wiener filter is to compute a statistical estimate of an unknown signal using a related signal as an input and filtering that known signal to produce the estimate as an output.
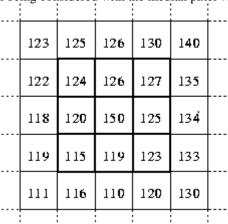
b.   Nonlinear filtering :
With non linear filters, the noise is reduced without any attempts to explicitly identify it. To resolve the issues raised with linear filters, a variety of non linear filters like median, weighted median, rank conditioned rank selection and relaxed median have been developed.

Median Filter:

Median filter is non linear digital filtering technique, often used to remove noise. It preserves edges while removing noise [8]. It considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with mean of neighboring pixel values, it replaces it with median of those values.

Median is calculated by first sorting all pixels values from surrounding neighboring hood into numeric order and then replacing the pixel being considered with the median pixel value.

123	125	126	130	140
122	124	126	127	135
118	120	150	125	134
119	115	119	123	133
111	116	110	120	130

Neighborhood values: 115, 119, 120, 123, 124, 125, 126, 127, 150
Median value: 124

Figure1. Median value

B. Transform domain filtering:

Filtering provides turn out a certain transformation of noisy image data and then applies the noise reduction process in the transformed image. Transform domain filtering methods are classified according to the choice of the base transformation functions which are adaptive data or non-adaptive data.

a. Data Adaptive:

Data adaptive filtering includes popular example of ICA method.

Independent Component Analysis:

Independent component analysis (ICA) is the decomposition of a random vector in linear components which are ''as independent as possible''. Here, 'independence' should be understood in its strong statistical sense: it goes beyond second order decorrelation and thus involves the non-gaussianity of the data [7]. The main drawback with ICA method is its computational cost.

b. Non data adaptive transform:

Non data adaptive transform is subdivided into two domains namely spatial-frequency domain and wavelet domain.

Spatial frequency transforms:

Filtering methods in spatial frequency domain refer use of low pass filtering by designing a frequency domain filter that passes all the frequencies lower than and attenuates all the frequencies greater than a cut-off frequency. It has different filtering methods such as, discrete cosine transform, discrete Fourier transforms, Hartley Transform etc.

Wavelet Transform:

A wavelet transform is the representation of a function by wavelets. A wavelet is a mathematical function used to divide a given function or continuous-time signal into different scale components. Wavelet transforms are classified into discrete wavelet transforms (DWTs) and continuous wavelet transforms (CWTs)[7]. The process of image denoising by wavelet thresholding, commonly called wavelet shrinkage, consists of the following main stages:

- Perform the discrete wavelet transform;
- Estimate a threshold;
- Apply the threshold according to a shrinkage rule;
- Perform the inverse wavelet transform using the threshold coefficients.

III. CONCLUSION

This paper summarized the image denoising techniques in the group of filtering and transform domain. The aim of this survey paper is to introduce available denoising techniques. This will help for the researchers who are trying to develop a new denoising technique for images restoration and to develop superior technique. Also from this survey, one can choose the best denoising method for further processes such as image classification, image segmentation and image registration.

IV. REFERENCES

[1] Ben Hamza, A., Luque, P., Martinez, J.,& Roman, R. (1999). Removing noise and preserving details with relaxed median filters. Journal of Matter Image and Visualization, 11(2), 161–177.

[2] Jain, A. K. (1989). Fundamentals of digital image processing. Upper Saddle River: Prentice-Hall.

[3] P. Jain, V. Tyagi "A survey of edge-preserving image denoising methods" Springer, 2014

[4] Snehal More, V.V.Hanchate, "A Survey on Magnetic Resonance Image Denoising Methods", IRJET, 2016

[5] http://homepages.inf.ed.ac.uk/rbf/HIPR2/mean.htm

[6] Priyanka S. Kole, Prof .S. N. Patil, "A Survey on Various Wavelet Domain Methods for Satellite Image Enhancement" IJESC,2016

[7] V. Roy, S. Shukla, "Image Denoising by Data Adaptive and Non-Data Adaptive Transform Domain Denoising Method Using EEG Signal" Springer 2013

[8] http://homepages.inf.ed.ac.uk/rbf/HIPR2/median.htm

[9] Gonzalez RC, Elwood's R (1993) Digital Image Processing. Addison-Wesley, MA