Elimination of Gaussian Noise using Post Processing

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Abstract*—Image denoising is a noise elimination technique in digital image processing during transmission over the communication channel. Due to uneven illumination, image blurring, low contrast, image with poor quality is not useful for further application. Digital images are often degraded by Gaussian noise in order to obtain a better visual quality and mass communication signal-to-noise ratio than other several state-of-the-algorithms. The non-linear noise on digital images detected and reduced by RAISR algorithms and the internal parameter of the feed forward neural network are adaptively optimized by training for well-known images. The results are compared with other existing filters like sobel filter for performance evaluation. The proposed technique is shown better performance than other existing techniques in terms of edge and fine details preservation. The primary image is obtained to get extremely well executed image. The results are specified by white pixels because they are independent of variables.

***Keywords*—RAISR, FFNN, Gaussian noise, Pixels, Sobel filter**

I. INTRODUCTION

The term digital image refers to processing of a two-dimensional picture by a digital computer. In a broader context, it implies digital processing of any two-dimensional data. A digital image is an array of real or complex numbers represented by a finite number of bits. An image given in the form of a transparency, slide, photograph or an X-ray is first digitized and stored as a matrix of binary digits in computer memory. This digitized image can then be processed and/or displayed on a high-resolution television monitor. For display, the image is stored in a rapid-access buffer memory, which refreshes the monitor at a rate of 25 frames per second to produce a visually continuous display.

The first step in the process is image acquisition by an imaging sensor in conjunction with a digitizer to digitize the image. The next step is the preprocessing step where the image is improved being fed as an input to the other processes. Preprocessing typically deals with enhancing, removing noise, isolating regions, etc. Segmentation partitions an image into its constituent parts or objects. The output of segmentation is usually raw pixel data, which consists of either the boundary of the region or the pixels in the region themselves. Representation is the process of transforming the raw pixel data into a form useful for subsequent processing by the computer.

Description deals with extracting features that are basic in differentiating one class of objects from another. Recognition assigns a label to an object based on the information provided by its descriptors. Interpretation involves assigning meaning to an ensemble of recognized objects. The knowledge about a problem domain is incorporated into the knowledge base. The knowledge base guides the operation of each processing module and also controls the interaction between the modules. Not all modules need be necessarily present for a specific function. The composition of the image processing system depends on its application. The frame rate of the image processor is normally around 25 frames per second.

II. PROPOSED FILTER

The objective of our proposed work is to estimate the noise and remove the noise which may corrupt an image during its acquisition or transmission while sustaining its quality.

A.ProposedTechniques

- Rapid And Accuracy Image Super Resolution (RAISR)
- Feed Forward Neural Network (FFNN)

B.Gaussian noise

Within digital imaging, Gaussian noise occurs as a result of sensor limitations during image acquisition under low-light conditions, which make it difficult for the visible light sensors to efficiently capture details of the scene. Gaussian Noise is astatistical noise with a Gaussian (normal) distribution. It means that the noise values are distributed in a normal Gaussian way. An example of a normal(Gaussian) distribution. The Gaussian noise is added to the original image.

C. SOBEL FILTER

The Sobel filter is used for edge detection. It works by calculating the gradient of image intensity at each pixel within the image. It finds the direction of the largest increase from light to dark and the rate of change in that direction.

D. RAISR

The main idea of RAISR is to enhance the image quality by applying pre-learned filters on the image patches which are extracted from the initial upscaled low resolution (LR) image. The filters are learned based on the pairs of low resolution (LR) patches and high resolution (HR) pixels.

Since keeping the details in the image is preferable, the lost high frequency components are compensated by RAISR 1. The RAISR processing is performed on the image after Hard-Threshold processing using 216 learned filters to obtain the image G1. In the training phase of RAISR, the input image is an image denoised by Hard-Threshold processing, and the objective image is the Ground Truth. This inference generates the pre-estimated image G1 by recovering the missing high-frequency components of the image after HardThreshold processing.

E. MR Image

For MR simulation, we simulated T1-weighted MR images and the discrete images based on the BrainWeb database [24]. Each discrete image consists of 11 individual regions of the brain (gray matter, white matter, fat, muscle/skin, skull, vessels, connective, dura matter, bone marrow, cerebrospinal fluid and background). The matrix dimensions of the discrete MR images were 362 × 434 × 362 and that of the T1-weighted MR images were 256 × 256 × 181 with 1-mm isotropic voxel size [25]. Through image cropping, linear transformation, and partial slices extraction, the dimensions of discrete MR images were equal to the T1-weighted MR images while the structures of these were roughly matched.

F. Mathematical Analysis

To assess the performance of the proposed filters for removal of impulse noise and to evaluate their comparative Performance, standard performance indices are defined as follows:

- Type-I: Fixed input I, rolling guidance G, where
  G (n) = J (n−1)
  J (0) = G. J (n) = GVWA (I, G (n); θ)
- Type-II: Fixed guidance G, rolling input I, where
  I (n) = J (n−1)
  J (0) = I. J (n) = GVWA (I (n), G; θ)
- Type-III: Rolling input I and guidance G, where
  I (n) = G (n) = J (n−1) I (0) = I
  G (0) = G. J (n) = GVWA (I (n) G (n); θ)

G.Purpose of noise reduction

The purpose of noise reduction is to decrease the noise in natural images while minimizing the loss of original features and improving the signal-to-noise ratio (SNR). The major challenges for image denoising are as follows:

- flat areas should be smooth,
- edges should be protected without blurring,
- textures should be preserved, and
- new artifacts should not be generated.

H. Peak Signal to Noise Ratio (PSNR)

It is measured in decibel (dB) and for gray scale image it is defined as dB Where MSE is the mean square error between the original and the denoised image with size I×J.

I. Mean Square Error(MSE)

The mean squared error (MSE) is the most widely used and also the simplest full reference metric which is calculated by the squared intensity differences of distorted and reference image pixels and averaging them with the peak signal-to-noise ratio (PSNR) of the related quantity. It can be denoted by the equation as follows:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

J. Signal to Noise Ratio Improvement (SNRI)

SNRI in dB is defined as the difference between the Signal to Noise Ratio (SNR) of the restored image in dB and SNR of restored image in dB i.e.
SNRI (dB) = (SNR of restored image in dB- SNR of noisy image in dB)

K. Proposed work

In this work, we proposed a RAISR based joint filtering framework to improve the image quality of lowcount dynamic PET scanning. The main contributions of this work are as follows.

• The high-quality training label images were derived from the composited of all dynamic frames, and downsampled to obtain the network training inputs. This method of data acquisition only needs a single dynamic scanning of each patient.

• The network was pre-trained with simulated data and then the last two convolution layers were fine-tuned with clinical data. A similar idea was presented, where they used clinical data to fine-tune the last two convolution layers and the last residual block.

• The loss function was combined the L1-norm with the edge-preserving and structure-preserving features. Through minimizing the Manhattan distance and the gradient difference between labels and outputs, and maximizing the gradient of the result images, noise reduction and structural details preservation were achieved.

III.OBJECTIVE

The objective of our proposed work is to estimate the noise and remove the noise which may corrupt an image during its acquisition or transmission while sustaining its Quality.

As it had seen that noise elimination is a main concern in computer vision and image processing. Noise presence is manifested by undesirable information, not related to the scene under study, which perturbs the information relative to the form observable in the image.

It is translated to more or less severe vales, which are added (or) subtracted to the original values on a number of pixels. Noise is of many types.

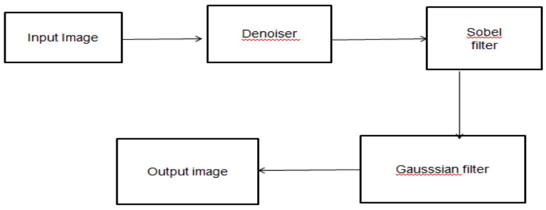


Figure.1:Block diagram of Denoising System

Thus, image noise can be Gaussian, Uniform or linear distribution. Here we will discuss about the, gaussian noise.For Gaussian noise, this implies that the filtered white noise can be represented by a sequence of independent, zero-mean, Gaussian random variables with variance of

$$\sigma^2 = N_o W$$

Note that the variance of the samples and the rate at which they are taken are related by

$$\sigma^2 = N_o f_s/2.$$

This Gaussian noise can be eliminated or the degraded image can be enhanced by the use of Gaussian filter. Due to certain disadvantages of linear filters, nonlinear method of filtering has been proposed in this paper. Nonlinear filter can be very effective in removing the Gaussian noise.

The sobel filter is the most popular order foe edge detection.It does not possess the drawbacks of linear filters and can effectively eliminate the effects of gaussian noise while preserving the edge information.

It replaces current pixel to be processed by PSNR value of a filtering window around the pixel. Normally, Gaussian noise has high or low magnitude and is isolated. When we sort pixels in the moving window, noise pixels are usually at the ends of the array.

Several techniques have been proposed which try to take the advantage of the averageprocess. Since the RAISR is the best image denoising technique, it is used for denoising. It enhance the image quality by applying pre-learned filters on the image patches which are extracted from the initial upscaled low resolution (LR) image.

As the result it produces primary image. Its underlying goal is to estimate the original image by suppressing noise from a noise-contaminated version of the image.

IV. RESULT AND DISCUSSION

A. PSNR Value

Typical values for the PSNR in lossy image are between 30 and 50 dB, provided the bit depth is 8 bits, where higher is better.

The higher the PSNR in the restored image, the better is its quality.

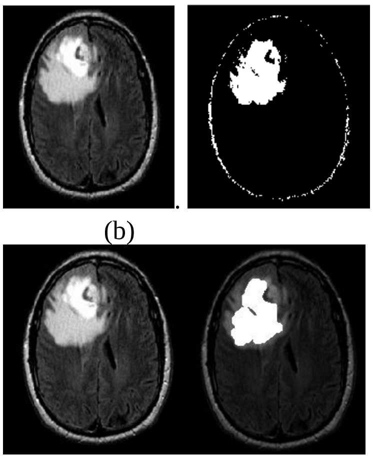
It is measured in decibel (dB) and for gray scale image it is defined as:

The PSNR (in dB) is defined as

$$\begin{aligned} PSNR &= 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \\ &= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE). \end{aligned}$$

The higher the PSNR in the restored image, the better is its quality.

We evaluated the proposed method in comparison with post filtering with Gaussian filter, and the RAISR trained with PSNR as loss function.The overall performance of all the test data was evaluated and were selected for visual comparison. The values of objective measures obtained by applying the filters on different test images contaminated with the impulse noise of various noise densities are summarized in and are illustrated graphically.



(a) (b) (c) (d)

Figure 2: Subjective performance illustration of the proposed filtering technique composed with existing technique a) Original image b) Imagecorrupted with Gausian with zero mean and σ^2= 200 c) Image denoisedusing FFNN d) Image denoisedusing proposed RAISR

Table 1: Performance of Corrupted images by denoising with FFNN and RAISR

Parameters	FFNN	RAISR
Gaussian noise with zero mean and σ^2=200	200	200
PSNR	29.01	30.02

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