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Universal Impulse Noise Filter Based on Genetic Programming

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Abstract**—** This paper covers, a novel method of impulse noise filter construction, based on the switching scheme with two cascaded detectors and two corresponding estimators. Genetic programming as a supervised learning algorithm is employed for building two detectors with complementary characteristics. The first detector identifies the majority of noisy pixels. The second detector searches for the remaining noise missed by the first detector. Both detectors are based on the robust estimators of location and scale—median and MAD. The usage of a new impulse noise model—the mixed impulse noise, which is more realistic and harder to treat than existing impulse noise models. The proposed scheme is the combination of two noise models: salt-and-pepper and uniform impulse noise models.

Keywords**— Additive Gaussian Noise, Genetic Programming (GP), Impulse noise, linear filters, nonlinear filters.**

I. INTRODUCTION

Genetic Programming is a relatively recent technology which has been demonstrated as a versatile tool for Automatic Program Generation in a variety of applications. The use of Genetic Programming for pattern recognition, control, planning, and the generation of neural networks [2]. Genetic Programming (GP) to the development of a processing tree for the classification of features extracted from images, measurements from a set of input nodes are weighted and combined through linear and nonlinear operations to form an output response [1].

Impulse noise presents a frequent problem in image processing. It emerges as a result of noisy sensors or transmission errors. Impulse noise suppression is required pre-processing stage, which cannot be efficiently done by employing simple linear filters [3]. Therefore, a number of nonlinear and adaptive filtering techniques have been used for this purpose. Noise can be introduced into images during acquisition and transmission. The problem of image processing is to effectively remove noise from an image. The nature of the problem depends on the type of noise added to the image.

The two noise models can adequately represent most noise added to images such as: additive Gaussian noise and impulse noise. The way to remove noise from image data is to use the spatial filters. Spatial filters can be divided into non- linear and linear filters. The non-linear filters, the noise are removed without any attempts to explicitly identify it. Generally non-linear filters remove noise to a reasonable extent but at the cost of blurring images which in turn makes the edges in pictures invisible. The different types of nonlinear median type filters such as weighted median rank conditioned rank selection, and relaxed median. The linear filter for Gaussian noise in the sense of mean square error. Linear filters too tend to blur sharp edges, destroy lines and other fine image details, and perform poorly in the presence of signal-dependent noise. The example of linear filter is wiener filtering method [4].

II. PROPOSED SYSTEM ARCHITECTURE

A proposed scheme of universal impulse noise filter based on genetic programming is composed of two impulse noise models namely Dummy Impulse Noise Filter and Mixed Impulse Noise Model. An image containing impulse noise can be described as follows:

$$x_{ij} = \begin{cases} n_{ij,} \, with\ probability\ p \\ f_{ij,} \, with\ probability\ 1-p \end{cases} \quad (1)$$

Where x_{ij} denotes a noisy image pixel and f_{ij} denotes a noise free image pixel at the location (i, j). Also, $n_{ij} \in [L_{min,} L_{max}]$ is a noisy impulse at the location (i,j), where $[L_{min,} L_{max}]$ denote the lowest and the highest pixel luminance values within the dynamic range, respectively[5-7].

A. DUMMY IMPULSE NOISE FILTER

The dummy filter is based on a simple detection of all the pixels in the noisy image having values equal to minimal or maximal amplitude in the dynamic range, e.g., 0 and 255 in 8-bit gray scale image. All these pixels will be replaced by the median of their neighbourhood.

The below Fig.1 shows the dummy impulse noise filter. In this figure the 2D input image(Black & White) adds the noise in 50% & 100% standard deviation and then de-noised by the Gaussian by using the genetic algorithm, this is simulated by the 2D non-linear diffusion method and processed reactivated then we will get resultant output image.

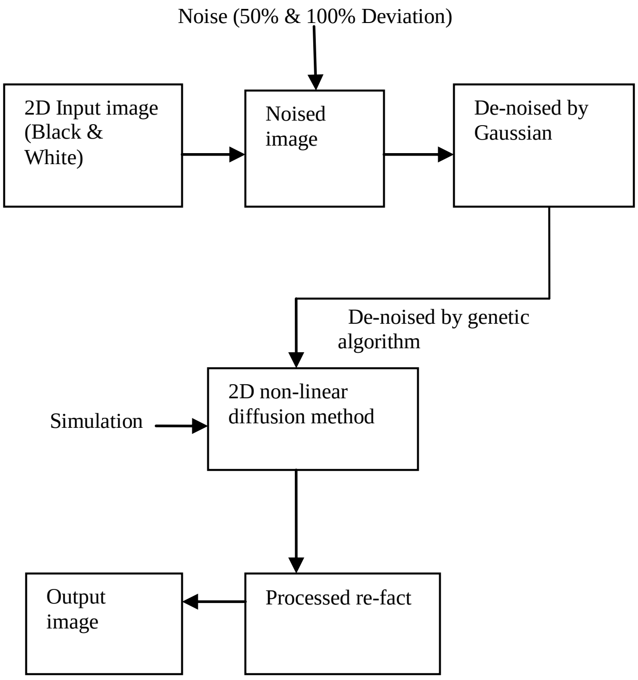

Fig.1 Dummy impulse noise filter

B. MIXED IMPULSE NOISE FILTER

/*Two impulse noise models are just the extreme cases and the real impulse noise is some mixture of them. Hence, an efficient impulse noise filter should perform well on both noise models. The new impulse noise model—mixed impulse noise, which combines models, the uniform and the salt-and-pepper.*/

An image containing mixed impulse noise is then given as follows:

$$x_{ij} = \begin{cases} n_{ij}^{unif}, & with\ probability\ \frac{p}{2} \\ n_{ij}^{snp}, & with\ probability\ \frac{p}{2} \\ f_{ij}, & with\ probability\ 1-p \end{cases} \quad (2)$$

Where $n_{ij}^{unif} \in [L_{min}, L_{max}]$ and $n_{ij}^{snp} \in \{L_{min}, L_{max}\}$. Also f_{ij}, denotes a noise-free image pixel at the location (i, j).

The Fig.2 shows the mixed impulse noise filter. In this figure the 3D input image(RGB) adds the noise in 50% & 100% standard deviation and then de-noised by the Gaussian by using the genetic algorithm after that simulation by the 3D non-linear diffusion method and in this method sub-divided into two parts one is called multi channel processing and another is called as single channel processing and processed the result and then we will get resultant output image.

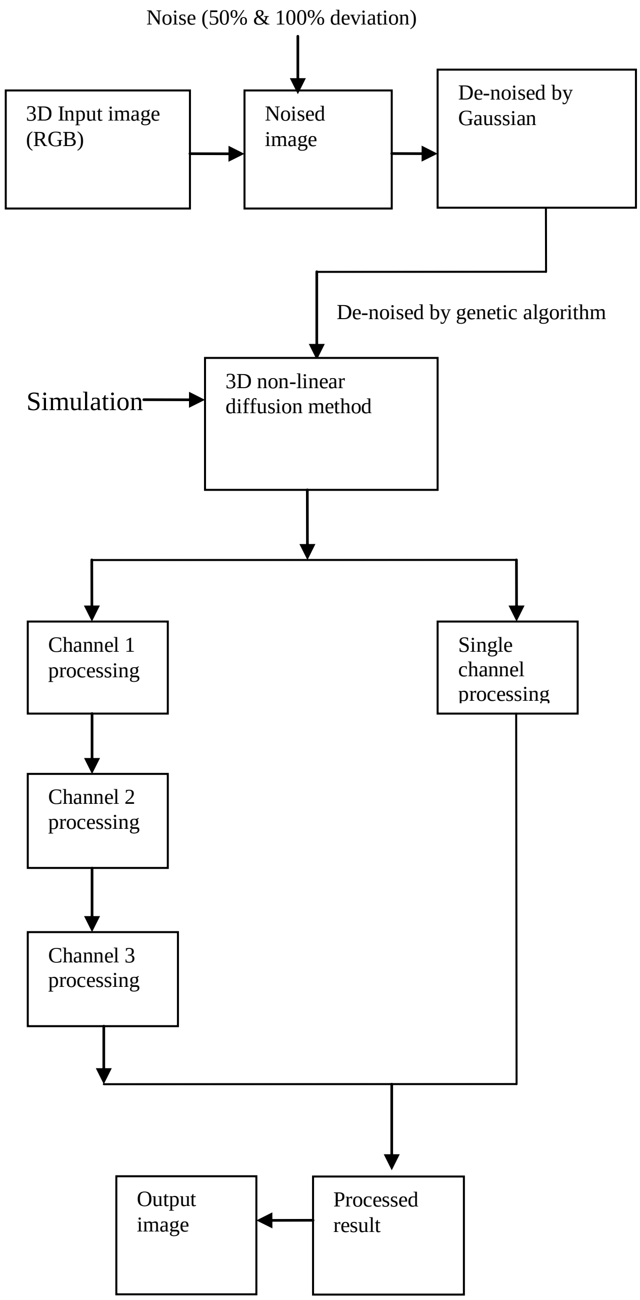

Fig.2 Mixed impulse noise filter

III. EXPERIMENTAL RESULTS

The original input image is embedded with non-linear diffusion method the resultant output image is as shown in Fig.3(a), Fig.3(b), Fig.3(c), Fig.4(a), Fig.4(b) and Fig.4(c) respectively.

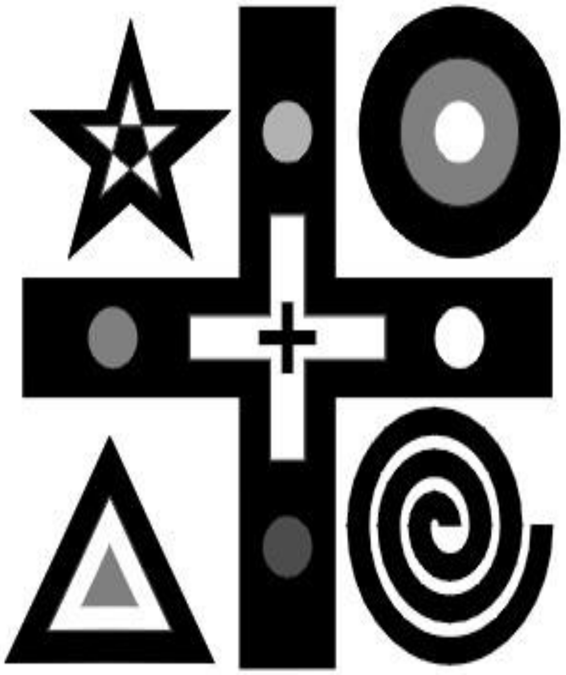

Fig. 3(a) Input image

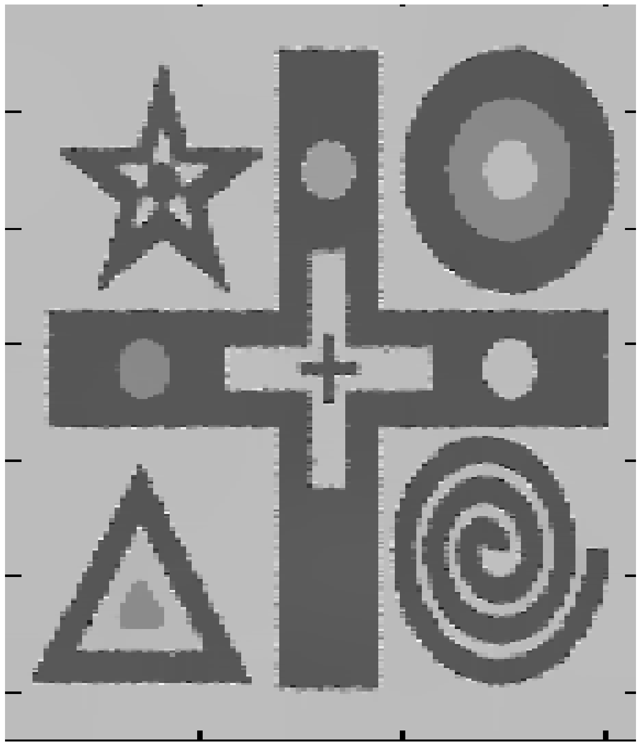

Fig. 3(c) Output image

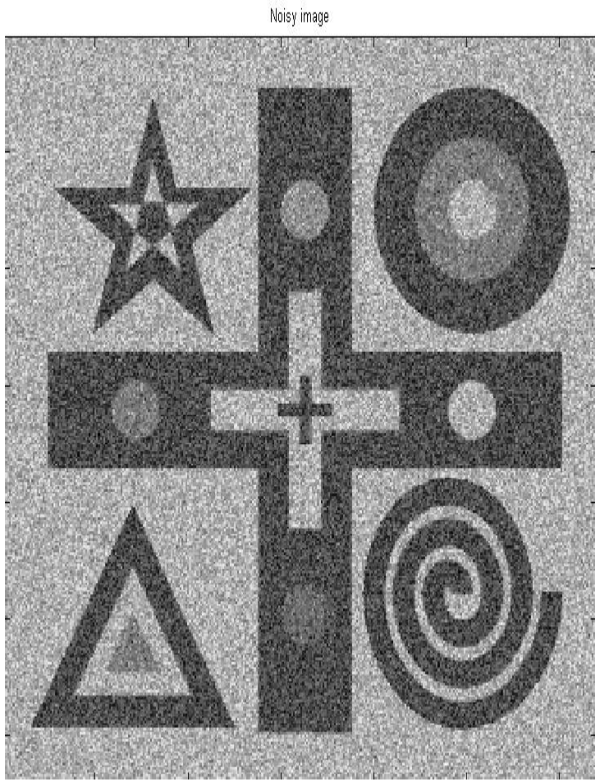

Fig. 3(b) Noisy Image

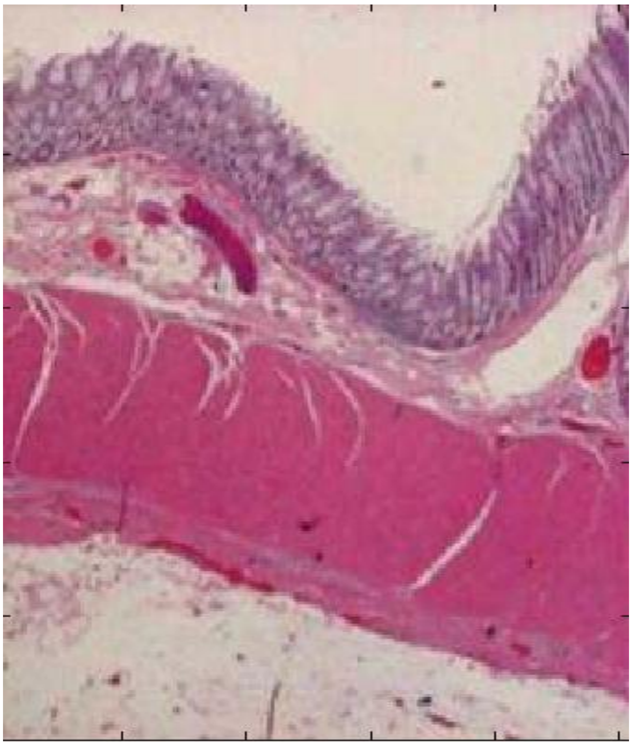

Fig. 4(a) Input image

Fig. 4(b) Noise remove image

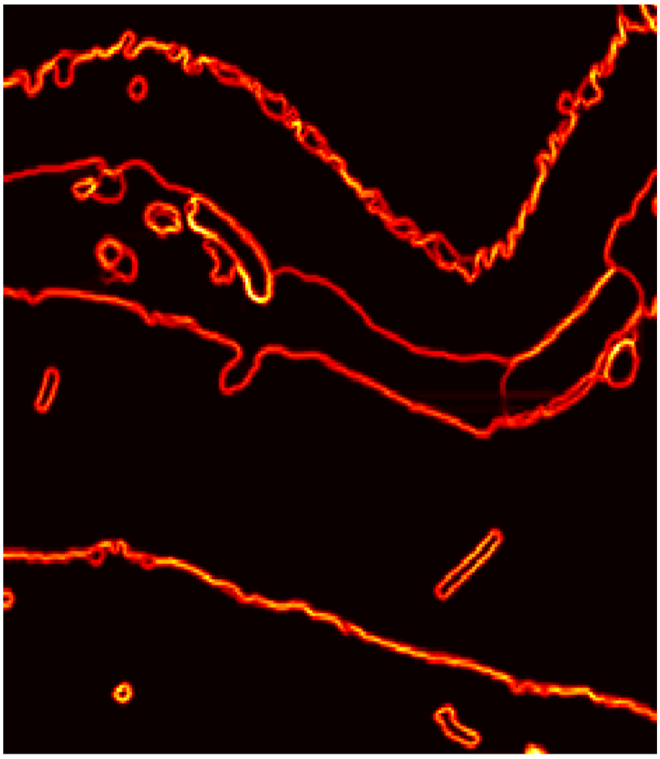

Fig.4(c) gradient magnitude image

The resultant output image returned from Fig.3 is used for Non –linear diffusion method. The original input image add the some amount of noise then apply 2D non-linear diffusion algorithm called as Perona-Malik diffusion and then we will get the final resultant output image..

In the Fig.4 is the genetic non-linear diffusion in colour images is calculated based on a norm of the gradients in each channel . this norm can be any p-norm. Including 'inf' norm

There two ways to diffuse colour images: one is the each channel diffused separately as if there were three different images and second is the gradient can be computed by a norm of the gradients in each channel ,so that same gradient and diffusivity are used for all channels at a time.

IV. CONCLUSION

In this paper, genetic algorithm is used to convert the original input image into resultant output image. Then we applied non-linear diffusion technique to de-noise the image in confidentiality of information and provide a means of communicating privately. The experiment results demonstrate that our proposed scheme produces the resultant image.

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