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An Effective Denoising and Enhancement Strategy for Medical Image Using Rl-Gl-Caputo Method

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Abstract. At present, fractional differential is the effective mathematical approach which deals with the factual problems. This projected technique employs the fractional derivatives definitions Riemann-Liouville (R-L), Grunwald-Letnikov (G-L) and the caputo technique for denoising medical image. The presented method based on fractional derivative which in turn improves the quality of image. The input image is processed on integer order method such as pre-processing operation, image conversion and noise image. The fractional differential mask method is to be applied with the help of Riemann Liouville, and Caputo algorithm. After denoising the medical image enhanced using Anisotropic diffusion process and the result is analyzed to finally get denoised and predicted image.

Keywords. Medical image, denoising, enhancement, Riemann-Liouville (R-L), caputo, Grunwald-Letnikov (G-L), anisotropic diffusion.

1. Introduction

In image processing systems, image denoising, and image enhancement is an indispensable problem however it is not easy to examine. The effectual means of making a convolution mask which is fractional-dependent will be based on image denoising and image enhancement mechanism which is capable of recognizing edges quite significantly in detail [1]. The fractional derivatives benefits are obvious in engineering correspondence that covers automatic manipulate, biomedical programs, finite impulse reaction filter designs, and in lots of other fields [2, 3]. Noise is signified as any unwanted signal which in turn contaminates an image.

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Image denoising inside the fractional area has lately obtained extensive research attention [4, 5]. Several algorithms on fractional calculus for image denoising were proposed[6, 7]. On the contrary the property of integral differential, the constant fractional differential is non-zero, while their integral differential should be a zero one [8, 9]. Fractional differential be capable of enhancing the intricate textural information of images nonlinearly[10, 11]. Here in this method a fractional differential mask approach using RL-SG method was implemented. Riemann liouville and SavitzkyGolay algorithm helps to develop the sense of the fractional operators. It helps to evaluate the numerical derivatives which are also known as digital smoothing polynomial filter. This method helps to reduce the noise effect and it should be helps to apply the particular region by the separation of the whole area. The residual part of the manuscript is systematized as shown: the section II is a depiction of several presented method that is employed so far. Section III is the narration of projected method. The performance outcome of the projected system is shown in section IV. At last, the conclusion of proposed system is offered in section V.

2. Related Works

(12)deliberated a novel hybrid method for despeckling, depending on Undecimated Dual-Tree Complex Wavelet Transform 5 (UDT-CWT) with the use of MAP (maximum a posteriori) estimator and non-local Principal Component Analysis (PCA)-based filtering by the local pixel grouping (LPG-PCA). DT-CWT is a newly formed transform which offer both near shift invariance and enhanced properties of directional selectivity. [13] considered an effective method of Discrete Wavelet Transform (DWT) for the analysis of EEG time-frequency and were employed for detection of seizure in the daily monitoring systems of healthcare. DTDWT might conquer those drawback however might augment redundancy of information [14].At present, the image denoising depending on sparse representation has a superior outcome [15]. a new framework of wavelet denoising depending on sparse depiction was presented. This technique offers an optimal resolution in assured circumstances through orthogonal matching pursuit (OMP), the algorithm of steepest descent, or else the algorithm of conjugate gradient. [16] proposed an algorithm to enhance vessels which is based on Hessian matrix. In this work, to improve the detection of arteries on coronary angiograms a variation in an algorithm. [3] proposed algorithm utilizes the fractional derivatives (R-L) and (G-L) definitions in the estimation of two direction areas and enhancement of image in the course of first run. As per this, new Gabor filter mask fractional derivative is intended.

3. Proposed work

This part offers the comprehensive representation of proposed methodology.The overall flow of the projected system is shown below:

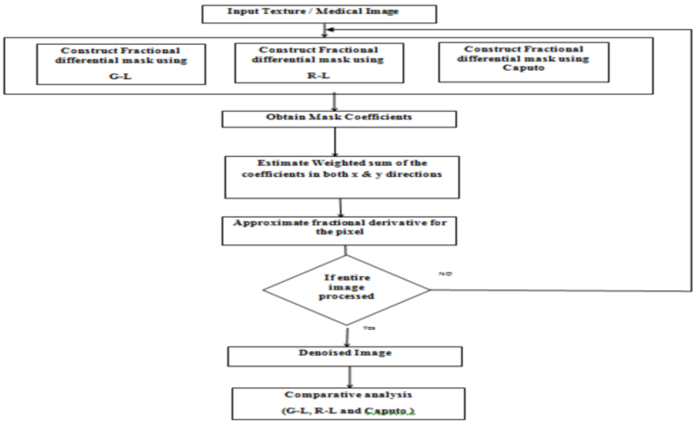

Figure 1. Flow of proposed system

3.1 Fractional differential mask

A convolution mask that is fractional-dependent having the application to the edge analysis of the image was being made. The mask was made depending on derivative Riemann-Liouville fractional that was considered as a particular Srivastava-Owa operator form. The fractional differential known as RL, and GL, six fractional differential masks were presented and offered the parameters and structures of all cover on the direction of positive x-coordinate, negative x-coordinate, negative y-coordinate, positive y-coordinate, right downward diagonal, right upward diagonal, left downward diagonal, and left upward diagonal correspondingly.

The coefficient of the fractional differential operator mask is provided by:

$$\begin{cases} C_{s0} = 1 \\ C_{s1} = -v \\ \vdots \\ C_{sk} = \frac{\Gamma(k-v)}{k!\Gamma(-v)} \\ \vdots \\ C_{s_{n-1}} = \frac{\Gamma(n-v-1)}{(n-1)!\Gamma(-v)} \\ C_{s_n} = \frac{\Gamma(n-v)}{n!\Gamma(-v)} \end{cases} \tag{1}$$

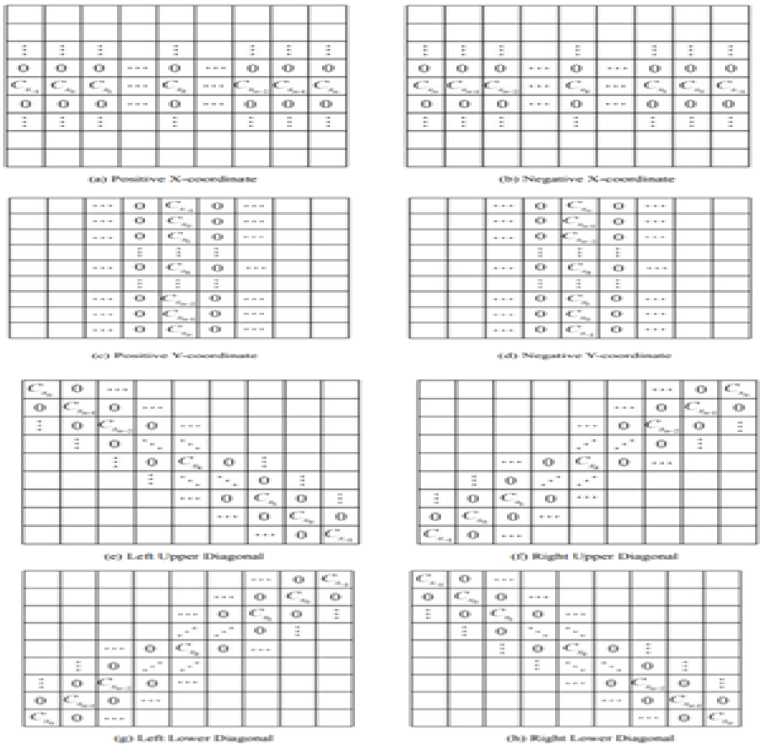

Figure 2. Fractional differential mask on the eight directions

The fractional differential is the normally used one for enhancing the edge and texture details of medical image in the digital image processing. RL – GL-Caputo methodin turn associated with a real function $f : R \rightarrow R$ another function Iαf of the correlated kind in support of the entire parameter value $\alpha > 0$. The integral is a generality behavior of the recurring anti-derivative of f for positive integer values of α, Iαf was an anti-derivative iteration of f of the order α. Three popular designation of fractional operators calculus are specified by G-L, Caputo, and R-L. Among these, G-L and R-L are the most admired designation employed in processing digital image.

The G-L significance of $\alpha > 0$ fractional order derivative is characterized as:

$$ {}_a\mathrm{D}_t^{\alpha} = \lim_{h \to 0} h^{-\alpha} \sum_{j=0}^{\left[\frac{t-a}{h}\right]} (-1)^j \binom{\alpha}{j} f(t - jh), \quad (2)$$

Where, the binomial coefficients are αj.

The Riemann – Liouville integral is defined by,

$$I^{\alpha} f(x) = \frac{1}{\Gamma(\alpha)} \int_{a}^{x} f(t)(x-t)^{\alpha-1}\, dt \quad (3)$$

where Γ is Gamma function and *a* is the arbitrary however base point that is fixed.

Obviously $I^1 f$ is the anti-derivative of f (of first order), and on behalf of positive integer values of α, $I^{\alpha} f$ was an anti derivative of order α through formula Cauchy meant for frequent integration.

The area of the incidence rectangle in lower bound is given by,

$$\text{Lower (par, func)} = m_1(x_1 - x_0) + m_2(x_2 - x_1) + \cdots + m_3(x_3 - x_2) = \sum_{j=1}^{m} m_j(x_j - x_{j-1}) \quad (4)$$

The area of the incidence rectangle in upper bound is given by,

$$\text{Upper (par, func)} = m_1(x_1 - x_0) + m_2(x_2 - x_1) + \cdots + m_3(x_3 - x_2) = \sum_{j=1}^{n} m_j(x_j - x_{j-1}) \quad (5)$$

Here, Par is the partition, func is the function, Inferimum is denoted as m_j, superimum is denoted as M_j.
A standard approach is to utilize diffusion for image smoothing is anisotropic diffusion . After that, process of linear isotropic diffusion might be well-defined through the below equation

$$\frac{\partial L}{\partial t} = \nabla.(c\nabla L) = c\nabla^2 L. \quad (6)$$

Let $L(x,y)$ signify a grayscale noisy input image and $L(x,y;t)$ be an image evolving at t scale , initialized by $L(x,y;0)=L(x,y)$.

4. Performance Analysis

In fact, in acquisition of image, one will frequently suppose that the resultant image might be contaminated by a number of unrestrained features. Be that as it may, evidently an ability of algorithms for handling these features will make them invariant and robust creation of their implementation useful.

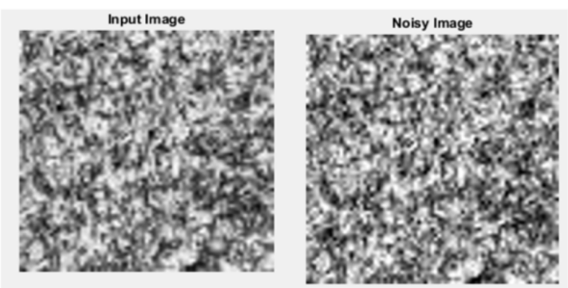

Figure 3. Input image **Figure 4.** Noisy image

Figure 3 and figure 4 is the representation of input image and noisy image which is added to get better result.

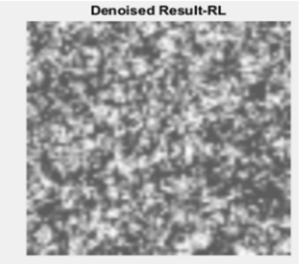

Figure 5. GL-Fractional differential masks **Figure 6**. Denoised Result-RL

Figure 5 is the depiction of GL-Fractional differential masks which is attained by the use of GL method at the noisy image.Figure 6 is the denoised result attained on the use of RL method. The noisy image is denoised using RL method.

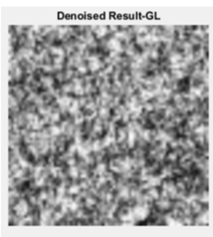

Figure 7. Denoised Result-GL **Figure 8.** Denoised Result-Caputo

Figure 7 is the denoised result attained on the use of GL method. Figure 8 is the denoised result attained on the use of Caputo method.

5. Conclusion

A new medical image denoising and method of enhancement was presented using RL-GL-Caputo method. After denoising the image is enhanced using anisotropic diffusion enhancement technique. The projected technique considered the neighboring information (like the image edge, texture information and clarity) and structural features of various pixels, in addition to the directional derivative of all pixel in the construction of masks. By means of presenting this process, it not only can enhance the information of high frequency, however also enhance the information of low frequency of the image. Eventually, this in turn augments the information regarding texture of the medical image.

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