Radiological Image Quality Enhancement and Analysis

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Abstract— Radiological medical imaging is a significant analytical tool for diagnosing various .The cannot be any compromise with the quality of the image as to be an important parameter in the radiological medical images. This paper confers a medical image enhancement mechanism for the improvement of quality of Computer Tomography (CT) medical images. This method of image quality enhancement is proposed to improvise the quality of radiological image. This method enhances the CT images which are low in brightness, contrast and affected by external noise in spatial domain. The experimental analysis shows that this method effectively enhances the details of scanned CT image of the patient by increasing the brightness, contrast and reducing the noise.

Keywords— Radiological images, CT images, Image quality

I. INTRODUCTION

Medical imaging is an important process to be carried after the scanning in order make the image readable and help in diagnosing the disease. There are several ways of medical image scanning for a very particular diagnosis using different technologies. Radiography is one of the widely used diagnosing. The degraded image can be improvised by various methods and image enhancement is one also one the method. In certain applications the high spatial resolution and contrast are demanded.

The image enhancement places an important role in order to rectify and improve the contrast as well as sharpness of the radiographic image resulting in the accurate interpretation of the medical CT image. There are two basic methods of image enhancement depending on the dominion specification they are: Spatial domain which calculates the image pixels and Frequency domain which calculates the Fourier Transform of the image. [1]. the spatial domain is the widely operable on real time applications. The algorithms that work on the image processing, pattern recognition and computer vision were not affected by the operation performed on the parameters of image. This method mainly focuses on clear edged objects-as there are blurred image they must be removed so that object can be viewed clearly and information by that object can obtained properly. This cleared image if further used for the processing and analysis. There are also several conventional enhancement techniques that adapt to global features such as global and fix-neighborhood techniques. The process of enhancing the image improves the quality of the image in fact its specifically approaches the interpretation of humans or machines. Spatial domain is the most approached processing method for image enhancement. The real time application are improvised by using the filters of frequency domain like smoothing and sharpening filters in order to sharpen the CT radiographed image [2].This paper discusses a method for pre-processing to remove speckle noise and filtering. The reason for the contrast enhancement is to refine the image noticeably into the image objects and its relative backgrounds by improving the variance of the image parameters. Hence, the image processing methods as applying filters results in improving the quality of the image [3].Henceforth , there are several contrast enhancement methods introduces to acquire the relatively required output image i.e. clearer image, object blurred image, etc [4].Similarly there are also few methods introduced to improve the low-contrast of CT images.

The paper is organized such that the section II has the image enhancement using spatial domain technique. And the section III holds the details of the proposed technique. In section IV, all the experimental results. Section V includes the conclusion of this paper.

II. SPATIAL DOMAIN TECHNIQUE FOR IMAGE ENHANCEMENT

Image enhancement techniques have a key value in medical image processing which qualifies the human interpretation (diagnosis). This whole paper revolves around the diagnosing and contrast enhancement techniques to improve the quality of the image. This project explores certain techniques that can be used to enhance medical images in the spatial domain using spatial filter [5]. The spatial is defined as the aggregate of pixels that composes the image with direct manipulation to these pixels. Result of this manipulation is expressed by the function

$$g(m,n) = T \mid f(m, n) \mid \ldots . (1)$$

Where f (m, n) is the input image, g (m, n) is output image, and T is an operator applied on input function defined over some neighborhood of (m, n). The enhancement operation (Smoothen or sharpen image) is achieved in this domain by selecting an appropriate mask to be applied on the image. Spatial domain techniques manipulates image pixels. The manipulated pixel value is the acquired value of pixel to get a desired enhancement. The techniques such as logarithmic transforms, power law transform, and histogram equalization

are direct pixel manipulation in the spatial domain. As spatial technique acts directly on pixels, it alters the pixel values that represent the gray level color code. Since the altercation applied on particular pixels is applied uniformly throughout the image hence providing an undesirable result.

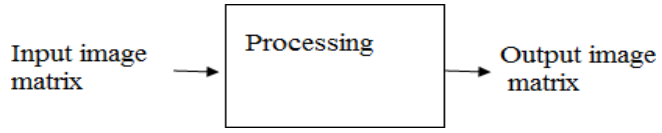


Fig.1. Simple spatial domain

In spatial domain technique operates directly on the image matrix as shown in fig.1.

III. PROPOSED TECHNIQUE

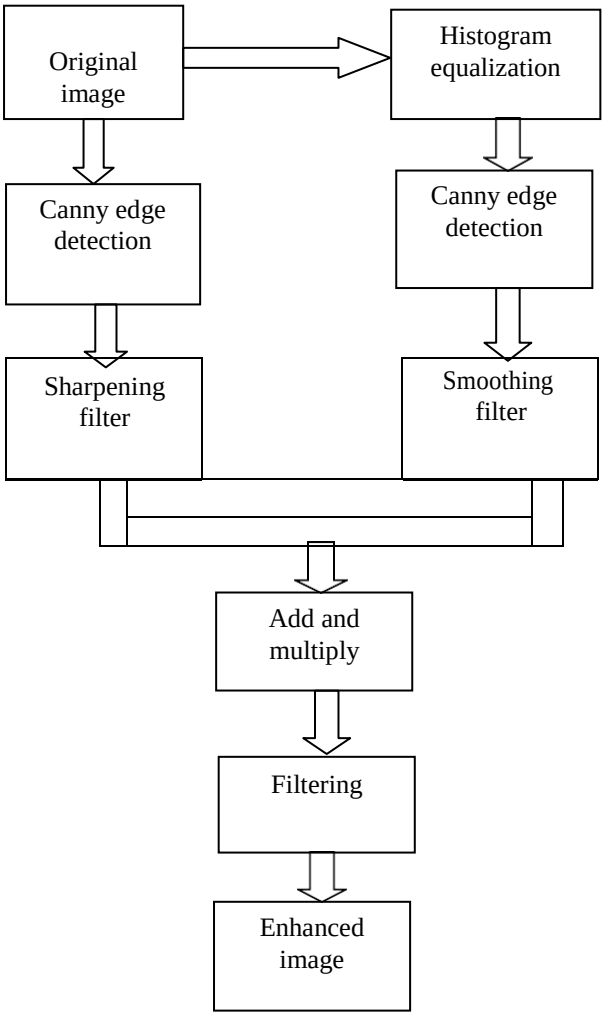


Fig.2. Block diagram of proposed technique

Image enhancement refines the quality of image in order of interpreting them with humans or machines. Implementation of spatial domain transformation for Image enhancement is the most preferred and suitable method of image processing. In this study, the sharpening of the image improves contrast to suite the CT radiograph image for study, and its implementation is shown in the block diagram in Fig.2. The proposed method contains various stages discussed as below.

Input Image: CT scan image of resolution 512*512 is given to the system for enhancement and removal of noise.

Histogram Equalization: Histogram is referred to be a graphical representation of image based on its intensity distribution with respect to the pixel value to the intensity. Hence, histogram equalization adjusts the contrast of image by altering the pixel values. If f is a function representing image whose pixels range is 0 to L-1[7]. Where L is be the probable intensity values, mostly 256 and p denotes the normalized histogram of f with an each possible intensity.

$$Pn=\frac{\text{number of pixels with intensity n}}{\text{total number of pixels}} \qquad n=0, 1\ldots L\text{-}1.$$

The histogram equalized image g is defined by

$$Qi,j= \text{floor}((L\text{-}1)\sum_{n=0}^{fi,j} pn) \quad \ldots . (2)$$

Canny detection: an image processing technique for finding the boundaries of objects within images is edge detection. It detects discontinuities in brightness. In areas such as image processing, computer vision, and machine vision, edge detection is used for image segmentation and data extraction [11]. A multi-step algorithm is used to detect the edges of the image as well as suppress the noise for the canny edge detected image. Reducing noise and unwanted details and textures is done by a Gaussian filter

$$g(m,n)= G_\sigma(m,n) * f(m,n) \ldots . (3)$$

$$\text{Where } G_\sigma=\frac{1}{\sqrt{2\pi\sigma^2}}\exp\left(-\frac{m2+n2}{2\sigma^2}\right). \ldots . (4)$$

Smoothing and sharpening: Smoothing and sharpening function use the pixels in an N * N neighborhood about each pixel to modify an image. For both smoothing and sharpening filters the larger the N * N neighborhood the stronger the smoothing or sharpening effect [6]. Smoothing and sharpening function can be either non-adaptive or adaptive to local statistics found in each N * N neighborhood of an image.

Filtering: The particular frequency components only need to be passed to avoid and remove all the unwanted frequency components. The mean filters are the most applicable filters. Consider an image of m*n and S_{xy} is the set of its coordinates centering at (x,y). Corrupted image is focused by the arithmetic mean filtering for computing the average value and in the defined image area it is considered as g(x, y) by S_{xy}. The computed arithmetic mean value is replaced as a pixel value with respect to the point (x,y) of image f i.e., restored image that region is computed by,

$$\hat{f}(x,y)=\frac{1}{mn}\sum_{(s,t)\epsilon Sxy} g(s,t) \ldots . (5)$$

Convolution mask is used to compute this operation where all of its coefficients have value 1/mn. The local variation found in image smoothened by local filter. The blurred image is rectified by decreasing the amount of noise in it.

IV. EXPERIMENTAL RESULTS

The proposed method is implemented on laptop having 1.8GHZ processor, 8GB RAM and Windows 7 operating system. This method is developed and analyzed using MATLAB 2013. Since, the medical CT image usually has

low brightness, low contrast and high noise, hence, it is necessary to enhance the brightness and contrast of the image in order to enhance the details, this process does not only enhances image but at times creates higher the noise amplification and over-enhancement problem. This paper works on comparison of spatial domain to the conventional algorithms to enhancement the parameters of image. The input given is a original CT image as shown in Fig.3 (a) this input image is converted into gray scale image. Fig 3(b) shows the pre-processing steps of low contrast image and There is a process called noise removal which removes the noise in an image. We have used spatial domain filter to enhance the image for further processing as shown in Fig 3(c). A CT scan is a detailed image of patient which holds the anatomical details of the internal organs that can be used for the medical diagnosis. Due to the complicated internal body structures the image to be captured from the patient body is always of the poor quality and has noises [3]. Whereas on other hand the quality of image is also poor due to blurring noise, low contrast, improper image enhancement and image restoration algorithms which degrade the captured image resulting into unreadable image. The Fig.3(d) and (e) sensory captured image of a patient for the medical report which is degraded and contains blurred pixels and noise. The noisy and blurred image results in low visibility and readability and also the image has low contrast as shown in Fig.3 (f). The input and output images as shown in fig4.

Fig.3(a). Original Input image

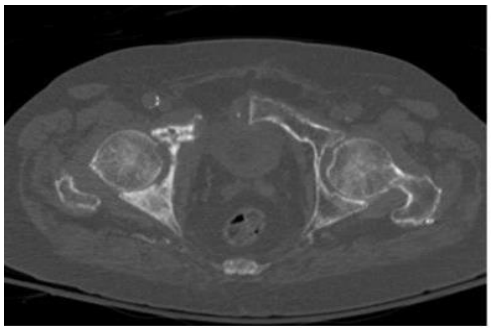


Fig.3(b). Low contrast image

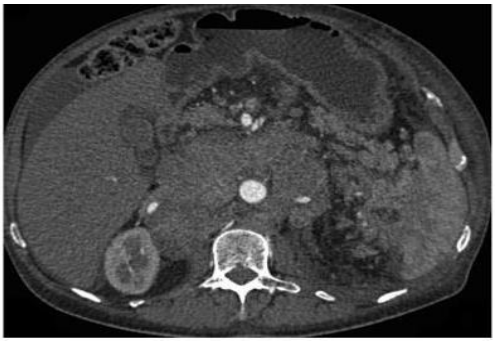


Fig.3(c).Noisy image

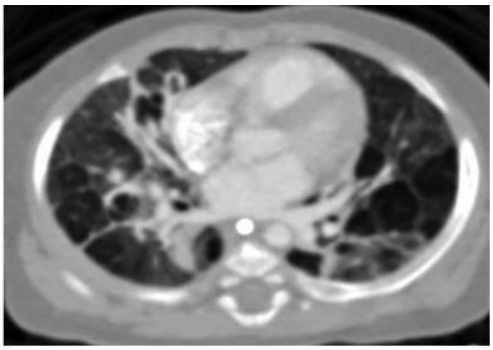


Fig.3(d).Blurry image

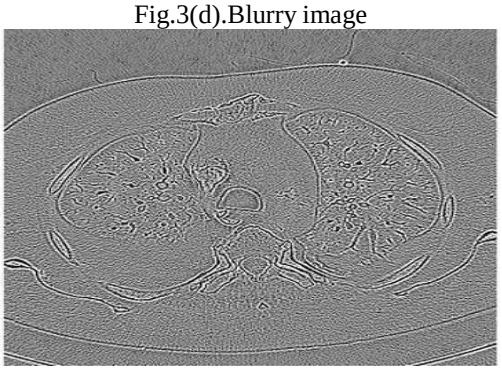


Fig.3(e). Spatial domain filtering

Fig.3(f).Output image

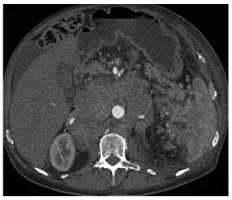
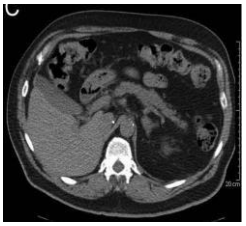
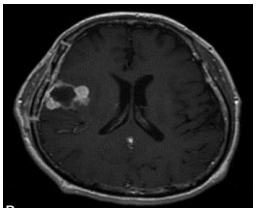
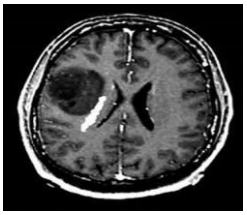
S.N	Input image	Output image
1.		
2.		
3.		

Fig.4. Experimental Results

V. CONCLUSION

In this paper, image quality enhancement method is proposed to improve the quality of the radiological images which are low in brightness, contrast and affected by external noise in spatial domain. From the experimental analysis, it can conclude that the proposed methods enhances by detailing the CT images by improving the brightness and contrast while reducing the noise. In future, this work is extended to analyze the contents of the CT images.

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