An Enhancement of Medical Images using Classical Unsharp Mask Filter and Log Gabor Filter

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Abstract- **In order to improve medical image visual quality, this paper presents a new method for unsharp masking for edge preservation and contrast enhancement of an image. Our approach employs a classical unsharp mask filter for the enhancement of the medical images, which will not only preserve the edge but also maintain the contrast that is suitable for body part. Image Enhancement transforms images to provide better representation of the subtle details. It is an indispensable tool for researchers in a wide variety of fields including medical imaging, art studies, forensics and atmospheric sciences.**

Keywords – Image enhancement, unsharp mask filter, PSNR, Standard deviation.

I.   INTRODUCTION

Image enhancement can be used with different modality of the images, unsharp mask filter plays vital role in medical images modalities. The dawn of the modern era of medical diagnosis can be traced to 1896, when the first x-ray has been captured by Wilhelm Roentgen, which was of his wife's hand. The development of radiology grew rapidly after that. Later, modern x-ray techniques have been developed to significantly improve both the contrast detail and the spatial resolution. Better image details let the smaller places diagnosis of pathology than may be discovered by older technologies. Radioscopy is a flow of medical science that treats with medical modalities. X-ray devices or other such radiation machines are utilized for imaging purpose. Radiology also includes techniques that do not require radiation, such as ultrasound and MRI. Radiology can be divided into two streams which are diagnostic radiology and therapeutic radiology. Diagnostic radiology is interested with using different imaging modalities to serve in disease diagnosis. Diagnostic radiology can be further divided into multiple sub-specialty domains. Interventional radiology is one of the sub-specialty areas which use the imaging modalities of diagnostic radiology to guide minimally invasive surgical procedures. On the other hand, Therapeutic radiology, also named radiation oncology uses radiation to treat diseases like cancer. Some of the popular imaging modalities are general radiography, CT scanning, sonography, magnetic resonance imaging. Image Enhancement (IE) is essentially improving the perception or interpretation of image information for supplying better input data for other image processing techniques. Image enhancement can be used with different modality of the images. Enhancement of contrast and sharpness of an image is required in many medical applications. There has been continuous research into the development of new algorithms [1]. Unsharp mask filter plays vital role in medical images modalities. Medical image enhancement processing can provide more rich clinically diagnostic information for doctors which can help clinicians to exam disease especially find early lesion very significantly [2]. So Unsharp masking is a classical tool for sharpness [1].In this paper, other more advanced Log gabor filter is used. Gabor filters are commonly recognized as one of the best choices for obtaining localized frequency information. They offer the best simultaneous localization of spatial and frequency information . There are two important characteristics of log gabor filter. Firstly, Log-Gabor functions, always have no DC component, which contributes to improve the contrast ridges and edges of images. Secondly, the transfer function of the Log-Gabor function has an extended tail at the high frequency end, which enables to obtain wide spectral information with localized spatial extent and consequently helps to preserve true ridge structures of images [3].

II.   RELATED WORK

In this section, we first briefly review previous works which are directly related to our work. These related works include unsharp masking and its variants, histogram equalization, retinex and dehazing algorithms, and generalized linear systems.

1) **Sharpness and Contrast Enhancement**: The classical unsharp masking algorithm can be described by the equation: $v = y + \gamma (x-y)$ where x is the input image, y is the result of a linear low-pass filter, and the gain $\gamma(\gamma>0)$ is a real scaling factor. The signal $d=x-y$ is usually amplified ($\gamma>1$) to increase the sharpness. However, the signal contains 1) de- tails of the image, 2) noise, and 3) over-shoots and under-shoots in areas of sharp edges due to the smoothing of edges. While the enhancement of noise is clearly undesirable, the enhancement of the under-shoot and over-shoot creates the visually un- pleasant halo effect. Ideally, the algorithm should only enhance the image details. This requires that the filter is not sensitive to noise and does not smooth sharp edges. These issues have been studied by many researchers. Contrast is a basic perceptual attribute of an image [4]. It is difficult to see the details in a low contrast   image. Adaptive histogram equalization [5], [6] is frequently used for contrast enhancement. The retinex algorithm, first proposed by Land [7], has been recently studied by many researchers for manipulating contrast, sharpness, and dynamic range of digital images. The retinex algorithm is based upon the imaging model in which the observed image is formed by the product of scene reflectance and illuminance. An important issue associated with the unsharp masking and retinex type of algorithm is that the result is usually out of the range of the image [8], [9-11]. For example, for an 8-bit image, the range is [0, 255]. A careful rescaling process is usually needed for each image. A histogram-based rescaling process and a number of internal scaling processes are used in the retinex algorithm presented in [11].

2) **Generalized Linear System and the Log-Ratio Approach**: In his classic book, Marr [12] has pointed out that to develop an effective computer vision technique one must consider: 1) why the particular operations are used, 2) how the signal can be rep- resented, 3) what implementation structure can be used. Myers [13] has also pointed out that there is no reason to persist with particular operations such as the usual addition and multiplication, if via abstract analysis, more easily implemented and more generalized or abstract versions of mathematical operations can be created for digital signal processing. Consequently, abstract analysis may show new ways of creating systems with desirable properties. Following these ideas, the generalized linear system, shown in Fig. 1, is developed.
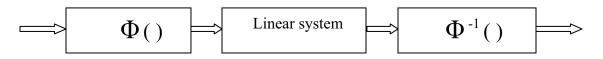

Fig1: Block diagram of a generalized linear system, where $\Phi(\ )$ is usually a nonlinear function.

III.   OUTLINE OF THE PROPOSED ALGORITHM

The proposed algorithm is based upon the previous image model and generalizes the classical unsharp masking algorithm. Digital images have applications in medical images such as Digital Radiography and in areas of research and technology including GIS (Geo-graphical Information System). Datasets collected by image sensors are generally contaminated by noise and noise can be introduced by transmission errors and compression. The problem of image is to recover an image that is cleaner and more informative than its raw observation. Thus, Enhancement in the image is an important technology in image analysis and the first step to be taken before images are analyzed. Although unsharp mask filter have efficient enhancement ability, still have problems on an Edge preservation and Contrast adjustment. In this approach, investigate the problem of image enhancement when the source image is formed with raw data which is a valid assumption for images obtained through transmitting, scanning or compression. A simple and efficient algorithm is proposed based on the Log Gabor filter and predefined contrast level for body part selected. It will enhance the functionality of Unsharp Mask filter. In this method, an input is given as a medical image to the filter and frequencies are normalized with the help of Log Gabor filter. A look up table is prepared   that have different contrast adjustment parameter according to body part selected. Using Adaptive gain control (ADC), the process is combined for the Unsharp mask filter.

IV. CONCLUSION

In medical images, especially digital x-ray images for lower extremity and spine when raw image is processed there is chance of false edge making and also contrast is not suitable according to exam done. In this approach not only the contrast is maintain but also edges are preserved by giving an enhancement to classical unsharp mask filter that would resolve this problem.

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