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A Review of Various Digital Image Preprocessing Methods for Medical Image Analysis

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***Abstract*—** Image visibility improvement is a standout amongst the most vital assignments in digital image processing. It is a standout amongst the most mind-boggling and imperative undertakings in advanced image processing. Image visibility improvement procedures are utilized in enhancing the visual nature of images. Medicinal imaging is present as of late utilized in the greater part of the applications like Radiography, MRI, Ultrasound Imaging, Tomography, Cardiograph, and Fundus Imagery, etc. Contrast and Image quality are the serious issues in medicinal imaging. The image enhancement makes the image unmistakable for human discernment or machine vision. The procedure of image visibility improvement doesn't raise the inbuilt data substance of the information, yet can feature the highlights important to recognize the protests in a basic and productive way.

***Keywords*—** mammogram, medical image enhancement, image enhancement, X-ray, CT images.

I. INTRODUCTION

With the fast increment of the utilization of Digital imaging in the field of medicine, it has raised the requirement for the use of reasonable calculations for the handling of images in location, Screening, and grouping of infections. Medicinal images are influenced by noise, haziness and may endure because of poor contrast and sharpness which may result in false finding. image Enhancement is a significant undertaking of therapeutic image handling. There are diverse sorts of imaging strategies relying upon the application it serves.

1. X-ray methods of medical imaging include conventional X-ray, computed tomography (CT) and mammography.
2. Molecular imaging uses a variety of methods to visualize biological processes taking place in the cells of organisms.
3. Fundus imagery used to image the retina of eye in screening of Diseases like glaucoma and Diabetic Retinopathy.
4. Other types of medical imaging include Magnetic Resonance Imaging (MRI), Cardiograph and ultrasound imaging.

The organization of remaining part of this work is as follows: after providing a brief introduction of medical image processing in section-I, the section-II explains about the philosophy of digital image enhancement. The section-III explains some pre-processing methods for digital x-ray. Then section-IV explains some methods for pre-processing of x-ray mammography. The section-V explains about some pre-processing methods in the field of fundus imagery. In section-VI we have discussed our observations from this study. These observations are the key points for future research. At last the section-VII concludes the entire work.

II. IMAGE ENHANCEMENT

The principal objective of the enhancements techniques is to process the images so that the results are more suitable than the original images for a specific application. The image enhancement methods are problem specific. Which means that the best method for images of type-X will not work for images of type-Y [1]. Fig. 1: shows an example of medical image enhancement. Here the image in the left suffers from poor visibility and the image in the right is obtained from the left image by applying a suitable image enhancement method.

Fig. 1: An example of medical image enhancement.

A. Spatial Domain Methods

Spatial domain methods include methods that work directly on image plane. In these methods pixel values of the image are modified for performing certain type of operations. These methods include contrast stretching, histogram equalization, adaptive histogram equalization etc.

B. Transformed Domain Methods

In transformed domain methods the image is transformed from spatial domain to some other domain (often called a frequency domain) and then a certain type of processing is applied and the results are reverse transformed to the spatial domain. At this point, one may ask a question that when the end goal is to transform back the image into the spatial domain from the transformed domain. Then what is the need for transformation? The answer is because in a transformed domain more information about the features of the image can be easily accessed. Which is otherwise not possible in the spatial domain methods.

Two widely used examples of transformed domain methods are low-pass and high-pass filters.

III. PRE-PROCESSING OF DIGITAL X-RAY IMAGES

X-ray images are being utilized to image the inner structure of the human body. In X-rays, an X-ray bar goes through the body. When it goes through the body, the piece of the vitality of the X-ray shaft gets assimilated which is called attenuation [2]. At the opposite end, identifiers catch the lessened X-rays delivering a clinical image. The kinds of X-rays are Computed-Tomography (CT), mammography, and Angiography.

X-rays are one of the generally utilized analytic devices in prescription. They are utilized to check for the degree and kind of bone cracks and other obsessive related irregularities.

The principle Disadvantage with X-ray images is its low difference and they get ruined by added substance noise. Gaussian noise, Poisson noise is viewed as added substance noises [2] and denoising models are created based on these noise models. The explanation behind diminished difference and noise in X-ray images is because of the nearness of mass measure of fluid in the human body.

Pre-processing in X-ray images by and large mean the denoising of images. On the off chance that upgrade calculations are connected without denoising, they may extraordinarily enhance the noise and may cause loss of information in images. Thusly denoising might be performed utilizing appropriate filters.

Database

- ECLAP (CT-Chest Images) [3].
- VOLCANO'09 (Lung database) [4].
- LITFL (Radiology Image Databases) [5].

IV. PRE-PROCESSING OF DIGITAL X-RAY MAMMOGRAPHY

Mammography is one of the medical imaging advances that utilization low-portion X-ray to identify Breast malignant growths. Advanced mammograms are a standout amongst the most difficult regions in medicinal imaging. Image pre-handling is utilized in advanced mammographic images so as to recognize contrasts between tissue types because of the low image nature of mammogram images. Mammograms can recognize any anomalies with the least measure of the retained portion to the bosom. image nature of the mammogram images is influenced because of the nearness of obscure noise, poor image contrast, Homogeneity and poor boundaries.

Database

- DDSM (Digital Database for Screening Mammography) [6].
- OPTIMAM image mammography database [7].
- Mini-MIAS [8].

It is observed that 12.5% women prone to breast cancer in their lifetime. The mammography is a procedure used to create mammogram image from human breast. This procedure is too complex. Also the mammogram images are of low-contrast in nature. Hence image enhancement methods are used for enhancement of contrast in mammogram images. Few of the methods are discussed in [9]-[17].

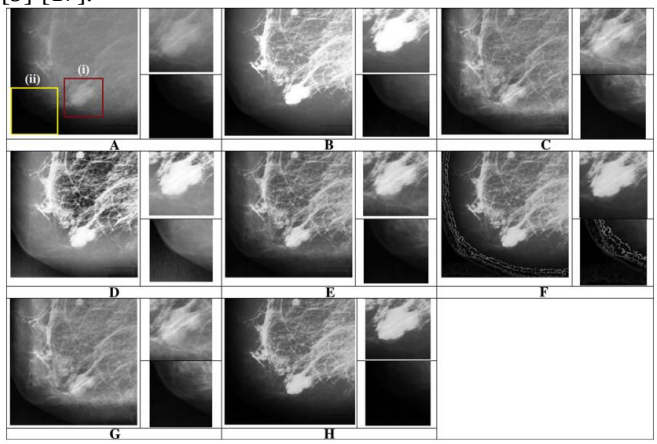

Fig. 2: Enhancement results for a mammogram image patch (cropped from fatty mammogram image mdb005) in this Fig. (A) is original mammogram image patch, (B) is result of HE, (C) is result of CLAHE, (D) is result of CLAHE', (E) is result of HM-CLAHE [12], (F) is result of HM-LCE [13] (G) is result of CLAHE-Median and (H) is result of HM-GRA methods (image source [11]).

From Fig. 2 (a mammogram image fix having a dangerous district and clear background. Dangerous district is set apart by square (i) and clear background is set apart by square (ii) in the first mammogram fix) we can see that proposed strategy delivers better outcomes on mammogram image patches, here unique image does not give clear data about the malignant district. Utilizing HE we can improve the contrast in a given mammogram image. The constraint of HE is that the mean brightness of the prepared image is constantly middle grey level (this issue is for the most part known as the "mean-shift" issue [11]). As such, there is a critical distinction in mean brightness of histogram adjusted image and the input image.

In spite of the fact that CLAHE, CLAHE', HM-CLAHE and CLAHE-Median can manage the 'mean-shift' issue, yet constraint of CLAHE, HM-CLAHE, and CLAHE' is that these techniques improve the background and frontal area at an equivalent level (see Fig. 1). This equivalent level of improvement prompts the upgrade of noise out of sight region and furthermore presents ancient rarity (ascent of false positive) in the background of the upgraded image. Likewise, HM-LCE gives some terrible outcomes out of sight district of the image. The HM-GRA technique delivers better outcomes when contrasted with consequences of other given strategies; as this strategy neither over improves the contrast of the image nor upgrades background and frontal area at equivalent grey level.

V. PRE-PROCESSING OF DIGITAL FUNDUS IMAGERY

Color fundus retinal imagery utilizes fundus cameras to record color images of the inside surface of the eye, for the procedure of recognition of quality of scatters and to screen their progressions after some time.

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Digital fundus images (DFIs) are utilized to image the retina, optic circle, macular districts and the back surface of an eye. These locales are utilized by ophthalmologists for diabetics screening for reviewing of diabetic retinopathy (DR). There are a couple of qualities in fundus images which are utilized in the portrayal of DR, for example, exudates, small scale aneurysms, hemorrhages, and veins. Recognition and evaluating of Diabetic Retinopathy depend on the ID of these highlights in fundus images. Ordinary diabetic eye screening is an essential advance in distinguishing and screening of DR.

Database

- DRIVE [18]
- STARE [19]
- MESSIDOR [20]
- DIARETDB0 [21]
- DIARETDB1 [22]

In Fig. 3: shows enhancement results by all methods on an image patch [20]. This clearly shows that the methods are capable of enhancing local details of the given color retina image without changing its color information. However, a careful observation tells that the method of Gupta et al. [24] is capable in enhancing sufficient contrast of the given image which is not possible by other methods. Structural information of the input image in terms of structural similarity is also maintained by the method of Gupta et al. [24].

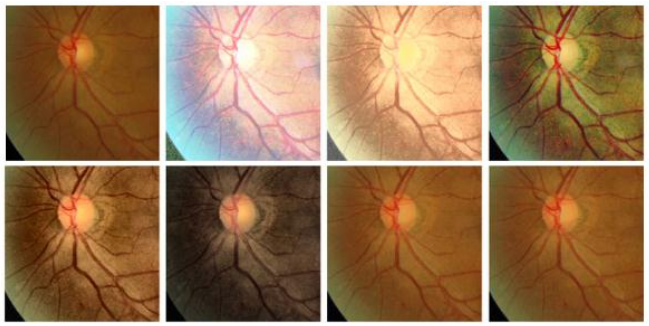

Fig. 3: Enhancement results by all methods on an image patch. Here from left to right and top to bottom input image, result of HE_{RGB}, result of HE_{Lab}, result of $CLAHE_{RGB}$, result of $CLAHE_{Lab}$, result of [23] method and result of [24] methods for q = 3 and q = 5 respectively have been shown (image source [24]).

VI. OBSERVATIONS FROM STUDY

We observe the following points about medical image enhancement methods.

1. The medical image enhancement methods are problem specific. Which means that the best method for images of type-X will not work for images of type-Y.
2. Medical image enhancement operation enhances noise in some visually important areas of the image.
3. Few medical image enhancement methods enhance information present in infected region and non-infected region of the image at same level. This rise false positive cases.
4. Different databases have been designed for different types of medical problems. Hence performance of the generalized medical image enhancement methods must be checked on all type of database. However methods dealing with specific problems must be checked with respective database only.
5. Enhancement of color medical images can be performed in Lab color space too.

VII. CONCLUSION AND FUTURE SCOPE

Medical analysis is conceivable just by methods for medicinal imaging. Life compromising sicknesses like disease are currently being treated just through medicinal examining images. A short review has been carried out on the pre-processing strategies of X-rays, mammogram and Fundus images. Each area has been explained with improvement methods utilized for the specific kind of image.

The review demonstrates that each image varies in the image quality and contrast relying upon the catching procedure. X-rays and mammogram images may require de-noising and enhancement while fundus images may require just improvement because of its exceedingly particular photographic strategies and the requirement for image data safeguarding. This paper can give a reasonable thought on pre-processing of images for the further strides on image pre-processing.

The points discussed in the section-VI can be used by other researchers during the development of medical image pre-processing algorithms. I am sure that by considering these points during the algorithm development will give good results.

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Authors Profile

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