IJETST- Volume||01||Issue||04||Pages 514-519||June||ISSN 2348-9480 2014

Open access Journal International journal of Emerging Trends in Science and Technology

Quality Enhancement of Various Diagnosed Medical Images Using Different Signal Processing Methods

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Abstract: *One of the most common degradations in medical images is their poor contrast quality and noise. Therefore, the image has to get under a process called image enhancement which contains an aggregation of techniques that look for improving the visual aspect of an image. Medical images are one of the fundamental images, because they are used in more sensitive field which is a medical field. Researchers made various attempts to enhance the biomedical images using various signal processing methods. Several techniques have been explored and reported for improving the quality of the medical images. Still, there is a scope of improvement in the area of quality enhancement of the medical scans. The basic objective of this study is to evaluate and discuss different techniques and approaches proposed in order to handle different medical imaging types. The paper provides a short overview of different methods presented in the prospect of medical image enhancement.*

Key words: *ULTRASOUND, Medical images, Brain, visualization, soft tissues, Tongue diagnosis. Computed Tomography (CT)*

1. Introduction

Medical imaging is an important source of diagnosing the malfunctions inside human body [1]. Some crucial medical imaging instruments are X-ray, Ultrasound, Computed Tomography (CT), and Magnetic Resonance Imaging (MRI). Medical image enhancement technologies have attracted much attention during the diagnosis process. Enhanced medical images are desired by a surgeon to help diagnosis and interpretation because medical image qualities are often deteriorated by artifacts. Nowadays, Medical imaging is the best techniques for monitoring the person's diagnosis process [2]. Most of the diseases are diagnosed by doctors using medical

imaging methods. One problem that physician encounter is because of the low quality of medical image. This low quality causes difficulty during the diagnosis. So it is necessary to improve the quality of the medical image.

2. Image Enhancement

Image enhancement operation improves the qualities of an image. They improve an image's contrast and brightness characteristics, reduce its noise content or sharpen its details. Image enhancement techniques may be grouped as either subjective enhancement or objective enhancement. The subjective enhancement technique may be repeatedly applied in various forms until the observer thinks that the image yields the detail necessary for a particular application. Objective image enhancement corrects an image for known degradations. Here distortions are known and enhancement is not applied arbitrarily. This enhancement is not repeatedly applied but applied once based on the measurements taken from the system. Image enhancement fall into two broad categories as below:

· Spatial domain technique
· Frequency domain technique

Spatial domain refers to the image plane itself and approaches in this categories are based on direct manipulation of pixels in an image. Frequency domain processing techniques are based on modifying the Fourier transform of an image. Spatial domain refers to the total of pixels comprising an image [2]. They operate directly on these pixels. Spatial domain processes will be denoted by the expression:

$$g(x, y) = T(F(x, y))$$

where f (x, y) is the input image, g (x, y) is the processed image, T is the function of F.

There are four steps involved in applying image enhancement process:

· The first step is image capturing of DICOM of body part of human being.
· Then, save the images under .jpg extension
· The third step is to select picture with three different types which is normal image, bright image and dark image. Three images are selected for each different type
·The last step is applying the proposed techniques to the selected images. There are so many methods for medical image enhancement to make a better perception from medical images. The basic purpose and theme of medical image processing is to diagnose and examine medical images in a more effective, accurate and efficient manner. This objective can be obtained through the process of image enhancement [3].

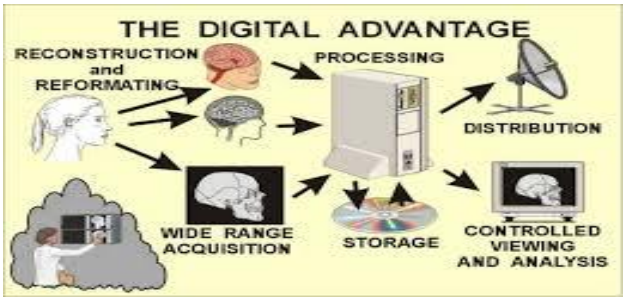

Fig1.Medical imaging methods

In this paper, we are mentioning below examples of image enhancement of various parts of human body.

3. Brain Image Enhancement

There are different methods of brain imaging:

1. Functional Magnetic Resonance Imaging (FMRI)
2. Computed Tomography (CT)
3. Electroencephalography (EEG)
4. Positron Emission Tomography (PET)
5. Magneto Encephalography (MEG)
6. Near Infrared Spectroscopy (NIRS)

3.1 Brain image enhancement of CT scanned image: The technique proposed in [10] is for enhancement of CT brain images by using the concept of wavelet. The purpose of this is to improve and boost the features dissimilarities between the standard and contaminated lung parenchyma with the intention of making consistent visual evaluation. The main work flow carried out involves the following steps: In order to eliminate the pulmonary vessels of the lungs the structural filtering i.e., wavelet decomposition is used. For that the region can be

classified into two different sub regions so that the difference of normality and abnormality can be detected. Next, feature localization is applied following image reconstruction step that aims to generate clean parenchyma intensity image on the basis of which quantification can be prepared [3]. At the end, to enhance the intensity dissimilarities between the normality and abnormality, structure enhancement and classification is applied. The conclusion of this technique was that it involves a variety of limitations that makes the system not much effective and efficient. The work done in [3] is an enhancement technique of CT images. The technique basically makes use of full range of grey scale values in the process of histogram equalization. Many histogram equalization techniques have been proposed in the prospect of image enhancement. Compared to other methods, this system involves very less amount of calculations with lesser complexity. The results commenced from the method show that the algorithm is not only efficient in enhancing the image but also produces faster computations as compared to other histogram equalization techniques. The similar work is done in [2]. The proposed solution is of enhancing CT images using a contrast based histogram equalization method. In this method the algorithm being proposed works in two steps. The first step works by taking two parameters i.e., the motion and sub block size. These parameters are used to calculate the local statistics. This step basically removes the artifacts present in the image together with reducing the calculation time. After this step the next action being taken is of histogram equalization that works on the altered local contrast extending operation. The system is tested on two sets of low dosage CT images. The outcomes showed that the process is efficient, reliable and flexible and has the ability to be utilized as a pre-processing device for low dosage CT images. Image enhancement in brain imaging is also applied on 3D images. This type of work is done in [10] on 3D bagging CT images. These types of images usually suffer from the problem of background noise with the presence of low contrast factor in the image. In order to deal with this problem order static decomposition along with computer simulations is applied. The technique is basically a parametric thresholding method. First of all image de-noising is done which involves image slicing together with the order statistical decomposition process, as a result of which object image and noise image are produced. The object image is then passed to order statistical decomposition process to produce the image slice of enhanced image resulting in enhanced 3D volume CT image. The results showed that the process is useful for cluttered images having minute targets. It also has the ability of object segmentation and recognition. Another method [3] of CT images enhancement is proposed. Multilevel image enhancement is obtained by using the wavelet transformation in different ways. In each step noise is removed and enhancement is improved.

4. Tongue Image Enhancement

Tongue analysis is one of the diagnosis processes in the patient management. In all traditional methods of diagnosis, tongue is an essential part for understanding the condition of the patient. Doctors ask the patient to open the mouth and show the tongue to extract the visual information [4]. Some of the areas of Doctor's interest are – 1)size and shape of the tongue 2) tip 3) width 4) thickness 5) color 6) texture 7) projections 8) fissures and cuts 9) coating or fur 10) swelling 11)bleeding 12) above conditions in different parts of the tongue, etc.. Based on this information and their knowledge and experience, Doctors try to understand the condition of the patient. But the problems faced by the Doctors are: 1) While the visual information that can be extracted from the patient's tongue is same, all Doctors do not have same level of knowledge and experience to analyze it.2) As the Doctors have to depend on their eye's perceivability to understand the tongue of patient, either because of old age or because of problem in their visual

capability or due to any other reason, Doctors can also make mistakes; it is false negative results that are likely to be more dangerous than false positive results because they usually lead to failure to provide appropriate treatment. 3) Even though some instruments are there like MRI, CT scan etc., they are very costly for procuring as well as diagnosing and as their main purpose is different, no Doctor advises his patient to diagnose the tongue with these costly equipments. In view of the above, there is a scope for the computer engineers to develop new model for the Tongue image analysis.

4.1 Sequential image enhancement method for tongue image analysis: The sequential process consists of extraction of the color feature, texture feature and so on [4]. We have developed a systematic approach for the efficient processing of the tongue image taken by a normal digital camera. The illustrated block diagram in figure 4

and 5 represents the step by step process we have undergone in our proposed method. There are two different methods followed in the processing of the image. First block diagram represents the process followed to derive the True colour and the white coating of the tongue image. Second block diagram describes the method followed to extract the cracks, pimples and buds in the tongue.

a) Colour and coating extraction

The color feature is extracted with help of intensity filtering methods. We extract the color of the tongue on the basis of the intensities presented in the different areas of the tongue. We apply this feature because intensity levels of different colours will be different for different areas of the tongue. So with help of this intensity method, we can extract the color feature, the coating and true colour of the tongue. We identify the white coating, true colour and dominant color of the tongue through this approach. The white coating may dominantly present in some tongues and in some others it will be less dominant.. The figure 3 shows the detection of white coating in the tongue. In the un processed image the coating is not pronounced and it got mixed up in the normal red colour of the tongue. In the procedcced image , the white coating can be clearly seen.

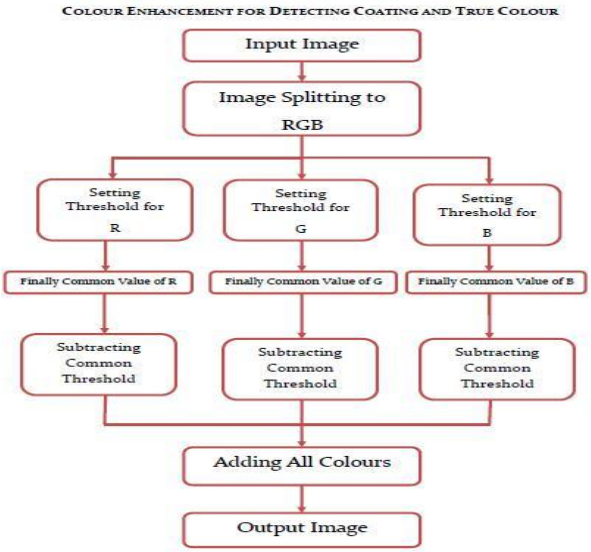

Fig 4: Colour and coating extraction

Fig 3: Detection Of Coating

b) Crack and Pimple Detection

For the detection of pimples in the tongue, We considered area in the tongue through some arithmetic calculation. Initially, we convert the color image in the gray scale image. Then, we find the different intensity in different areas of the tongue through the histogram method. After selecting the particular area we assign a threshold for detecting the pimples and cracks [6]. According to the value of threshold, the areas are selected on accordance with the

intensities. The areas with similar intensities are segmented So, those values that come below the threshold value are selected and after the complete process the pimples are highlighted. After plotting the histogram, the difference in intensity is identified then a threshold is applied.

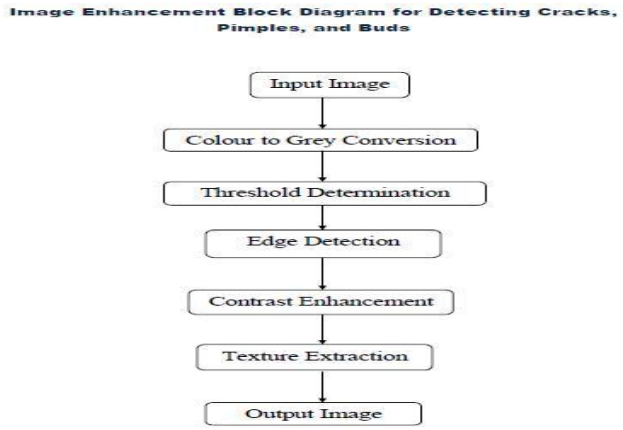

Fig 5. Crack and Pimple Detection

Fig 6. Detection of cracks

5. Image Enhancement of Dental X-Ray Images

Dental x-ray images usually taken with low radiation dosage are often presented as dark, low in contrast and noisy. These problems are usually solved with image enhancement techniques. However, choosing an appropriate technique is not an easy task especially for the purpose of disease diagnosis of periapical related lesion [7]. This research involves the collection of ten intra-oral dental x-ray images which were collected from the Faculty of Dentistry UiTM Shah Alam, Malaysia. Each of the enhancement methods is applied to every collected image. A dentist was then asked to do the evaluation using questionnaire. She graded the quality of the images and the diagnostic ability of the periapical pathology observed in the images. Subsequently the quantitative analysis using contrast improvement index (CII), signal to noise ratio (SNR) and root mean square error (RMSE) were done to investigate the characteristic of the images base on the dentist evaluation. The finding shows that the enhancement techniques managed to enhance the pathology slightly better than the original image. For each of the original images, four enhanced images namely, AHE, CLAHE, MAHE and SCLAHE were produced to make a total of sixty images for visual assessment by a dentist. AHE is used to improve contrast based on local histogram unlike the global contrast enhancement which uses the histogram for the entire image.

1. Adaptive Histogram Equalization (AHE): AHE divides the image into several non-overlapped sub-images and derives their histograms. Then, it modifies the histogram to enhance the contrast of the pixels within the sub-images.

2. Median Adaptive Histogram Equalization (MAHE): MAHE technique combines, median filtering and AHE methods. Median filter is introduced as one of its pre-processing technique to reduce noise and identify its impact towards the contrast of the dental images. This technique updates the pixel value in ascending order. The centre pixel in the 3 x 3 area is then replaced with the median value.

3. Sharp Contrast Adaptive Histogram Equalization (SCLAHE): SCLAHE consists of combination of image sharpening and contrast limited adaptive histogram equalization (CLAHE). The purpose of using the sharpening filters is to sharpen the outline of the periapical features. This work utilized Laplacian filter to

perform image sharpening process. Laplacian detects the outlines of the objects by convolving a mask with a matrix centered on a target pixel

4. Contrast Adaptive Histogram Equalization (CLAHE): CLAHE reduces the problem associated with AHE in relation to noise. This technique limits the slope associated with the pixel range to prevent saturation. CLAHE is to prevent the random noise introduced during local Histogram Equalization by limiting the maximum slope of the grayscale transform function [9]. The slope of the cumulative distribution function is determined by the bin counts. If a bin has a large count, it will result in more slopes. By thresholding (clipping) the maximum histogram count, we can ensure a limit on the slope Among all these methods, RMSE (root mean square error) with SCLAHE and CLAHE are found to be less as compared to other two methods

6. Conclusion and Future Work

In conclusion, our work support that image enhancement do contribute to the better appearance of the images, therefore improve the diagnostic ability in intra-oral digital images. The goal of the image enhancement technique is to improve a characteristic or quality of an image, such that the resulting image is better than the original image. One of the most common degradations in medical images are their poor contrast quality and noise. This study describes the method to improve the image quality of Digital Imaging and Communications in Medicine (DICOM) images It is observed from the analysis that huge work has been done in this regard but still there exists more space for further work.

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