Improvement of Orthopantography (OPG) Images using Texture Analysis

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Abstract: ***This paper presented an appropriate approach for the robust estimation of noise statistic in dental panoramic x-rays images. To achieve maximum image quality after denoising, a new, low order, local adaptive Gaussian Scale Mixture model is presented, which accomplishes nonlinearities from scattering. State of art methods use multi scale filtering of images to reduce the irrelevant part of information, based on generic estimation of noise. The usual assumption of a distribution of Gaussian and Poisson statistics only lead to overestimation of the noise variance in regions of low intensity (small photon counts), but to underestimation in regions of high intensity and therefore to non-optional results. The analysis approach is tested on 20 samples from a database of 50 panoramic X-rays images and the results are cross validated by medical experts. In this thesis, prominent constraints are firstly preservation of image's overall look; secondly preservation of the diagnostic content in the image and thirdly detection of small low contrast details in diagnostic content of the image. As shown in previously, state of the art methods provide non-convincing results. The new approach is funded on an attempt to interpret the problem from the view of blind source separation (BSS), thus to see the panoramic image as a simple mixture of (unwanted) background information, diagnostic information and noise.***

Keywords: Orthopantograph, Image processing, Enhancement, MatLab

1. Introduction

The "classic" 18-film intraoral radiograph examination of the teeth is relatively comfortable for the patient, and the overall radiation dose is generally acceptable; however, it is a time-consuming endeavor, and in some cases provides a less-than-optimum depiction of individual teeth. Nevertheless, it offers valuable information as a basis for treatment planning, is far superior to purely clinical observations, and often gives impetus for more extensive examination strategies. Finally, the 18-film"full series" exam provides a sense of security for both dentist and patient, and enhances confidence through communication. On the other hand, clear radiographic depiction of not only the teeth, but also the jaws, the temporomandibular joints, and the alveolar lobes of the maxillary sinuses will reduce the risk of an incomplete and possibly incorrect examination, which in the worst-case scenario could lead to malpractice. In this regard, the panoramic radiograph always leads to a broadening of horizons because it improves the dentist's knowledge of radiographic anatomy and thus improves her/his skill in distinguishing between and among normal and pathologic conditions. This, in conjunction with a better understanding of the interrelationships of systemic medical problems and dental/oral problems can open new avenues for treatment planning [1]. The question of whether the treating dentist her/himself actually takes the radiographs or delegates this task to auxiliary personnel is really a question of responsibility for the radiographic quality that is achieved, and the radiation dose that this requires. If, for whatever reason, this assignment is delegated, the person who bears the primary responsibility must see to it that the auxiliary personnel are well-trained and have received legal certification. They must not only become expert in the production of high-quality radiographs, but must also be knowledgeable regarding the dental indications and the procedures for protecting patients and staff from excessive radiation exposure. Auxiliary dental personnel who are given the responsibility of taking radiographs must remain current in all continuing education standards in order to insure high radiographic quality and the lowest possible radiation dose for every patient. This is critical. An image defined as it may be applied to a picture such as a photograph, a painting or a sketch which has a real physical existence. But it may be also being applied to an idea or concept which has a mental rather than physical existence. If asked to imagine an object such as apple, a mental image of an apple comes to mind. The existence of this visual image helps us to grasp the concept of an apple. Of course, a photograph of an apple represents only one aspect of an apple: its visual appearance. It provides no representation of the taste, smell or feel of the characteristics of an apple which we remember from past experiences [2][3][4]. There are two components are superimposed in the image. The presence of noise limits the amount of information which can be extended from image. In particular, the finer details of structure may be lost by being swamped by the effect of noise. Noise may see an unlikely term apply to a visual image which is silent. The use of the term probably originates from radio engineering, where the quality reception of radio signals is often impaired by background noise (i.e. hisses and whistles), particularly when the origin signal is rather weak and the radio receiver is being used with maximum amplification. The effect of such noise on the information communicated via a radio link is very similar to the effect of noise on the information carried by an image. Under optimum conditions the magnitude of the signal is very much greater than the magnitude of the noise. The signal-to-noise ratio is said to be high. Under adverse conditions the signal-to-noise ratio is law, and much information is lost. It is not uncommon for a radiographic image to be fogged, perhaps due to an accidental exposure to scattered radiation in X-ray room, or to poor conditions of storage. When such a radiograph is examined its image appears as viewed through a mist or fog. The information content of the image is reduced. Some information is lost entirely, whilst that which remains is more difficult to see. The fogging contains no information about the subject of radiograph. Such fogging is an example of one form of image noise. Another type of noise may be seen on a television image. In this case, the image appears as if viewed through a snowstorm. The screen display a very large number of small white specks which appear superimposed on the image. Again, the effect is to reduce the information content of the image. Such as appearance may be due to inferior design of the electronic circuitry employed, causing electronic noise. However, in many cases the basic is that the signal being displayed is too weak, and those speaks represent the absence of information, rather like the spaces left by missing pieces in a jigsaw puzzle. It is possible for a similar effect to occur in the image on a radiograph, expect that in this case the image appears to have a large number of very small black specks superimposed on it, giving it a grainy or mottled appearance commonly known as quantum mottle or quantum noise. To be able to identify a feature on an image, it must appear different its surroundings. On a radiograph, a structure must be of a different optical density (shade of grey) from adjacent structures. On television image, the structure must be of a different luminance (brightness). The term contrast is used to describe these differences are small; it is difficult to identify the structure will stand out well from its surroundings and it is said the contrast is high (good). If the differences are small, it is difficult to identify the structure against its background. The contrast is said to be low (poor) [6][7][8].

2. Methods and Materials

This study was conduct in College of Medical Radiological Sciences - Khartoum Dental Center and Elnasery Dental Clinic in period of December 2013 to March 2014. The target population amount for this study was 50 patients present at the area of the study. For panoramic images each film will scan using digitizer scanner then treat by using image processing program (MatLab), where the enhancement and contrast of the image was determined. The scanned image was saved in a TIFF file format to preserve the quality of the image. The data analyzed used to enhance the contrast within the soft tissues, the gray levels which can be redistributed both linearly and nonlinearly using the gray level frequencies and noise estimation of the original panoramic images. In Figure 1 explains the block diagram about the flow proposed research paper. Researchers use in this study a method for image preprocessing of X-ray radiographic images step by step process. This flow diagram explains the flow of work. Collecting the X-ray images from Govt. Hospitals and converting this image RGB into Gray color.

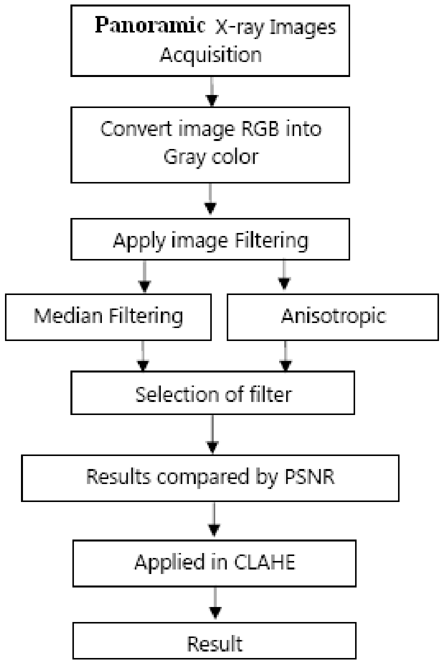

Figure 1: Flow chart of image analysis

Panoramic images were filtered by two different filtering algorithms. The filtering algorithms are used for anisotropic filtering and median filtering algorithm. The output results were compared in PSNR and MSE values. The output of filtering image applied for Image enhancement. That given image improves the subjective quality of contrast, noise reduction and edge sharpening. The targets for image enhancing are better contrast, sharpness of detail and visibility of features. Several algorithms are Histogram Equalization (CLAHE). Here researchers applied contrast limited adaptive histogram equalization algorithm. The best PSNR value of X-ray image output is given into input of Contrast Limited Adaptive Histogram Equalization (CLAHE). The data analyzed by using statistical package, Statistical Package for Social Studies (SPSS) under windows using t test to measure the significant difference between contrast within the soft tissues, the gray levels in both enhanced and unenhanced images and noise variance.

3. The results

In real X-rays images one can find a significant coherence of the noise with the image content. To illustrate the problem two panoramic image acquisitions are dedicated; one image (figure 2) form OPG scan technique and other image form another X-ray imaging (figure 3). The figure 3 shows an idealistic view of panoramic X-rays in figure 4, which needs to be enhanced and free from the mixture of noise. Pre-processing is to improve their quality of images. If these images are too nosy or blurred they should be filtered and sharpened. In image processing, filters are mainly used to suppress either the high frequencies in the image, i.e. smoothing the images or the low frequencies, i.e. enhancing or detecting edges in the image. Due to various factors the images are in general poor in contrast. Researcher applied image pre-processing to remove artefacts and degradations such as blurring and noise. A variety of smoothing filters have been developed that are not linear. While they cannot, in general, be submitted to Fourier analysis, their properties and domains of application have been studied extensively. For this reason researchers applied anisotropic filtering and median filtering. In study method anisotropic and median filtering algorithms were used. Anisotropic filter that smoothes noisy regions in the image while respecting edge boundaries. The another filter median used to reduce noise in an image, somewhat like the mean filter (it is a simple , intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images). The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. Like the mean filter, the median filter considers each pixel in the image in turn and looks at its nearby neighbours to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighbouring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighbourhood into numerical order and then replacing the pixel being considered with the middle pixel value. (If the neighbourhood under consideration contains an even number of pixels, the average of the two middle pixel values is used.) Figure 1 illustrates an example calculation.

80	81	79	79	79	80
80	81	79	79	79	80
80	81	79	79	79	80
79	79	77	77	78	78
79	79	79	79	80	80
79	79	80	80	81	81

Figure 2: Sample matrix value taken from figure 1.

Neighborhood values: 77,77,79,79,79,79,79.79,81
Median Value is: 79

Figure 2 calculating the median value of a pixel neighborhood. As can be seen, the central pixel value of 81 is rather unrepresentative of the surrounding pixels and is replaced with the median value: 79. A 3×3 square neighborhood is used here larger neighborhoods will produce more severe smoothing. Anisotropic Filtering and Median Filtering algorithms are applied in ten different X-ray images and calculated the equivalent MSE and PSNR values. The table-1 shows the value of MSE and PSNR. The original picture figure 3 RGP is changed into GRAY color Figure 4. This gray color image applied into anisotropic filtering method the output is in Figure 5 and also applied in median filtering algorithms the output is in Figure 6. Histogram equalization is a method in image processing of contrast adjustment using the image's histogram. This method usually increases the local contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast without affecting the global contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values. Given an image, improve the subjective quality of Contrast, Noise reduction and Edge sharpening. Fast implementation of Contrast Limited Adaptive Histogram Equalization (CLAHE) enhances the contrast of an image by transforming the pixel values of the image. It operates on small pixel regions (tiles), rather than the entire image. Each tile's contrast is enhanced, so that the histogram of the output region approximately matches the specified histogram. The neighbouring tiles are then combined using bilinear interpolation in order to eliminate artificially induced boundaries. The contrast, especially in homogeneous areas, can be limited in order to avoid amplifying the noise which might be present in the image.

Figure 3: Original OPG radiograph

Figure 4: Original OPG radiograph

Figure 5: The enhanced OPG radiograph

Figure 6: The Enhanced OPG radiograph

Figure 5 calculating the median value of a pixel neighborhood. As can be seen, the central pixel value of 81 is rather unrepresentative of the surrounding pixels and is replaced with the median value: 79. A 3×3 square neighborhood is used here larger neighborhoods will produce more severe smoothing. The original picture figure-5 RGP is changed into GRAY color Figure 4. This gray color image applied into median filtering method the output is in Figure 6 and also applied in median filtering algorithms the output is in Figure 7.

Figure 7: The enhanced OPG radiograph

Image analysis using different technique:

3.1 Stretchlim technique

A two-element vector of pixel values that specify lower and upper limits that could be used for contrast stretching image I. By default, values in LOW_HIGH specify the bottom 1% and the top 1% of all pixel values. The gray values returned can be used by the imadjust function to increase the contrast of an image.

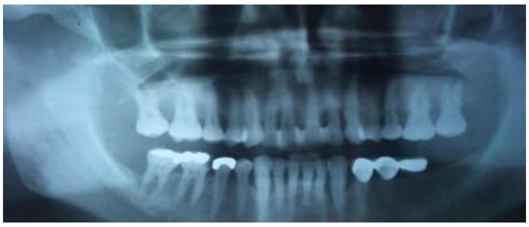

Figure 8: Original OPG radiograph

Figure 9: The enhanced image OPG radiograph using Stretchlim technique

3.2 Fspecial technique

h = fspecial(type) creates a two-dimensional filter h of the specified type. fspecial returns h as a correlation kernel, which is the appropriate form to use with imfilter. type is a string having one of these values.

Figure 10: Original OPG radiograph

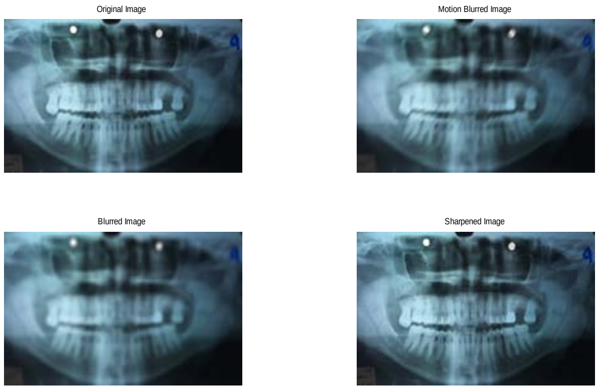

Figure 11: The enhanced images using f-special technique

3.3 Image addition technique

Add two images or add constant to image Z = imadd (X,Y) adds each element in array X with the corresponding element in array Y and returns the sum in the corresponding element of the output array Z. X and Y are real, nonsparse numeric arrays with the same size and class, or Y is a scalar double. Z has the same size and class as X, unless X is logical, in which case Z is double. If X and Y are integer arrays, elements in the output that exceed the range of the integer type are truncated, and fractional values are rounded

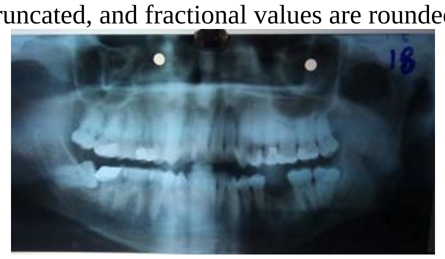

Figure 12: Original OPG radiograph

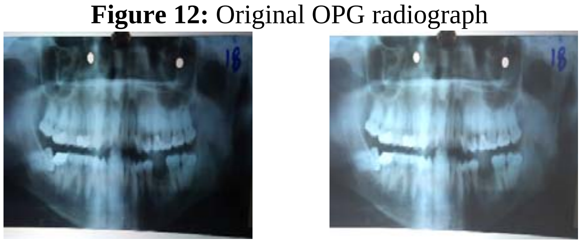

Figure 13: The enhanced OPG radiograph using image addition technique

4. Conclusions

Pre-processing is to improve their quality of images. If these images are too noisy or blurred they should be filtered and sharpened. In image processing, filters are mainly used to suppress either the high frequencies in the image, i.e. smoothing the images or the low frequencies, i.e. enhancing or detecting edges in the image. Due to various factors the images are in general poor in contrast. Researchers applied image pre-processing to remove artefacts and degradations such as blurring and noise. A variety of smoothing filters have been developed that are not linear. While they cannot, in general, be submitted to Fourier analysis, their properties and domains of application have been studied extensively. For this reason researchers applied anisotropic filtering and median filtering. In study method anisotropic and median filtering algorithms were used. The another filter median used to reduce noise in an image, somewhat like the mean filter (it is a simple , intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images). The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. Like the mean filter, the median filter considers each pixel in the image in turn and looks at its nearby neighbours to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighbouring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighbourhood into numerical order and then replacing the pixel being considered with the middle pixel value. (If the neighbourhood under consideration contains an even number of pixels, the average of the two middle pixel values is used.). A 3×3 square neighbourhood is used here larger neighbourhoods will produce more severe smoothing. The original picture figure 5 RGP is changed into GRAY colour Figure 4. This gray color image applied into anisotropic filtering method the output is in Figure 6 and also applied in median filtering algorithms the output is in Figure 7. Histogram equalization is a method in image processing of contrast adjustment using the image's histogram. This method usually increases the local contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast without affecting the global contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values. Given an image, improve the subjective quality of Contrast, Noise reduction and Edge sharpening. It operates on small pixel regions (tiles), rather than the entire image. Each tile's contrast is enhanced, so that the histogram of the output region approximately matches the specified histogram. The neighboring tiles are then combined using bilinear interpolation in order to eliminate artificially induced boundaries. The contrast, especially in homogeneous areas, can be limited in order to avoid amplifying the noise which might be present in the image. So conclusion of this research that the new approach is funded on an attempt to interpret the problem from the view of blind source separation (BSS), thus to see the panoramic image as a simple mixture of (unwanted) background information, diagnostic information and noise and filtered it. The detection of the noise is a complex procedure which is difficult to detect by naked eye so that image analysis should be performed by using powerful image processing.

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