Calculating Contrast Stretching Variables in Order to Improve Dental Radiology Image Quality

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Abstract. Teeth are one of the body’s digestive tract that serves as a softener food that can be digested easily. One branch of science that was instrumental in the treatment and diagnosis of teeth is Dental Radiology. However, in reality many dental radiology images has low resolution, thus inhibiting in making diagnosis of dental disease perfectly. This research aims to improve low resolution dental radiology image using image processing techniques. This paper discussed the use of contrast stretching method to improve the dental radiology image quality, especially relating to the calculation of the variable contrast stretching method. The results showed that contrast stretching method is promising for use in improving the image quality in a simple but efficient.

Keyword: dental radiology, low resolution, contrast stretching, diagnose, image processing

1. Introduction
Teeth are one of the body’s digestive tract that serves as a softener food that can be digested easily. Histologically, the teeth and oral tissues derived from mesoderm and ectoderm, which has three main functions, namely, chewing (mastication), beauty (aesthetics), and speech (phonic). In the mouth, the teeth embedded in the jawbone and are protected by the gums, with different forms according to function. One branch of science that was instrumental in the treatment and diagnosis of teeth is Dental Radiology. The use of X-ray has long been known as a tool in the field of general medicine and dentistry were very helpful in diagnosing the disease and to determine the treatment plan. Image generated x-rays of a patient to a dentist is very important especially for the presence of abnormalities that are not visible can be seen clearly, so that will really help a dentist in determining the diagnosis and treatment plan.

It has more than a century dentistry profession using radiographic examination as a means to obtain diagnostic information cannot be obtained from the clinical examination and other tests before. Until now, dental radiography became one of the important tools used in the treatment of modern dentistry. Good dental radiographic projections shooting intra oral and extra-oral almost a common procedure performed by a dentist in assisting the management of a case. Dental Radiography usefulness of which is to: (i) Radio diagnosis / Rontgen diagnose: used for diagnosis as apical or per apical abnormalities that are not detected clinically, abnormalities in the jaw, fracture of the jaw or tooth root and hidden caries (at the proximal or root caries) secondary caries, caries incipient, the depth of caries and others.
(ii) Treatment Plan: assist in making or determining a treatment plan, such as the determination of the location of the pins or implants, root canal condition, determination of the type and technique (iii) Supporting Treatment: help facilitate the conduct of a treatment, such as post-operative complications, endodontic treatment (iv) Evaluation of Care: used to evaluate the success or progress or control treatment (v) Radiography is one of the medical record that is very important and also for (vi) Interest forensic [1]. Based on usability, it can be said that the Dental Radiography plays an important role in various matters in the field of dentistry. One of the tools commonly used in dental radiography is panoramic machine. Figure 1 shows the dental panoramic machine.

![Dental panoramic machine](http://www.dentistryiq.com/content/dam/etc/)

However, given the prominence of panoramic machine then the price is directly proportional to its superiority, i.e. the better image quality produced by more expensive the price of its panoramic machine. In fact, especially in developing countries, existing panoramic machine is a machine that has a low resolution. This research aims to improve the quality of the image generated by the low quality panoramic machine.

On the other hand, the current technological developments especially in the field of image processing is growing rapidly. Digital image processing according to Gonzales [2] is manipulation and interpretation of digital images using computer assistance. Digital image processing aims to (i) improve the quality of the image, seen from the aspect of radiometric and geometric aspects. Radiometric aspects consists of contrast enhancement, image restoration, and color transformation while the geometric aspect consists of the rotation, scale, translation, geometric transformations. (ii) The process of withdrawal of information or description of the object or the introduction of objects contained in the image (iii) perform image selection characteristics for analysis purposes. (iv) Compression or data reduction for the purpose of data storage, data transmission, and processing time data. According to functions and benefits of digital image processing techniques especially for supporting technology in medical field, there are some researchers that worked in the medical field using image processing techniques. Supriyanti et al [3][4][5] using image processing techniques in the application of medical technology for developing countries, especially for the detection of cataracts [3][5] and improve the quality of the ultrasound image of the uterus [4]. Kronfeld [6] conducted research on three-dimensional modeling on dental image. [6] Wu Kan [7] conducted research on dental segmentation using morphological algorithm approach framework. Shah et al [8] conducted research on dental segmentation using active contour method without using edge detection, because this technique focuses on the intensity of the overall area of the teeth. Wanat [9] conducted research on dental radiology segmentation for forensic interest. Kustra [10] conducted a research on the analysis and segmentation of the tooth surface using Dental Cast Segmentation method. Dighe [11]. In this paper we emphasize our discussion about improving quality of low resolution dental radiology image using contrast stretching method especially for calculating variable R1, S1, R2 and S2. Point (r1, s1)
and \((r_2, s_2)\) will determine the shape transformation, and can be set to determine the level of the spread of gray level of the image produced. If \(r_1 = r_2 = s_1\) and \(s_2\), then the transformation will be a straight line, which means there is no change in gray level of the image produced. It is generally assumed \(r_2 \leq r_1\) and \(s_1 \leq s_2\) so that the function will return a single value and its value will always go up.

2. Methods

2.1. Image Acquisition
As discussed in above, in this research we will improve image quality of low resolution dental radiology. Input images are taken from low resolution panoramic machine from Rumah Sakit Gigi dan Mulut Pendidikan Universitas Jenderal Soedirman. However, because this is a manual panoramic machine, therefore in order to convert to digital image, we have to scan this images manually. Figure 2 shows examples of dental radiology images using in this research.

![Figure 2. Examples of input images](image)

2.2. Contrast Stretching
Contrast stretching method is part of the point processing method, which means that the process is only dependent on the value of the intensity of one pixel, independent of other pixels around it. Here it is assumed that the image has a grey level range of 0 to 255. In order to change contrast from original pixels is using condition as described in Figure 3.

If the grey level value \(a_1 = a_2\) and \(b_1 = b_2\), the transformation will perform a straight line, no change in the grey level image produced. However, if it is assumed grey level value \(a_1 < a_2\) and \(b_1 < b_2\) so that the function produces a value. To calculate it can be made the following three functions as described in Equation 1 to Equation 3.

![Figure 3. Contrast Stretching function](image)

For \(0 \leq f_i(x, y) < a_1\), then :

\[
f_0(x, y) = f_i(x, y) \left( \frac{b_1}{a_1} \right) \]

\[\text{Equation 2.1}\]

For \(a_1 \leq f_i(x, y) < a_2\), then :
\[ f_0(x,y) = b_1 + (f_1(x,y) - a_1) \left( \frac{b_2 - b_1}{a_2 - a_1} \right) \]...... 2.2

For \( a_2 \leq f_1(x,y) \leq 255 \), then:
\[ f_0(x,y) = b_2 + (f_1(x,y) - a_2) \left( \frac{255-b_2}{255-a_2} \right) \]...... 2.3

2.3. *Image Histogram*

Image histogram is a graph that illustrates the spread of pixel intensity values of an image or a certain part in the image. From a histogram can be determined relative frequency of occurrence of intensity in the image. The histogram can also show a lot of things about the brightness and contrast of an image. Therefore, the histogram is a valuable tool in the execution of image processing both qualitatively and quantitatively. In order to obtain a good image, then the spread of intensity values to be changed. The purpose of smoothing the histogram is to obtain a uniform spread of the histogram, such that every degree of grey has almost the same number of pixels. In the histogram, low-contrast image has a narrow shape which indicates that the image has a low dynamic range, which means low contrast. High-contrast image shows that the grey level histogram is widespread. Although the histogram only shows a general nature and does not provide information about the contents of the image, but the shape of the histogram can provide information about the possibility for improvement of the image contrast.

3. *Results and Discussions*

As has been discussed above, the input image has a color format with layer composition Red, Green and Blue (RGB). Formats such as these have a fairly large data size and can slow down the subsequent processing. To overcome this, the image must first convert grayscale type, which has a color type 8 bits (2^8 = 256), i.e. from 0 to 255 so that the processing can be performed with contrast stretching method. After making a histogram of the gray scale image, it can be seen the distribution of light and dark pixels through the histogram display. If the image looks too dark grayscale, then the pixels will be concentrated or dominate the left side, and if it is too light to be concentrated on the right side. Table 1 describes some examples of histogram analysis. Formatted as follows:

| Input Image | Gray Image | Histogram | Histogram Region |
|-------------|------------|-----------|------------------|
| ![Image](image1.png) | ![Image](image2.png) | ![Histogram](histogram1.png) | **Dark** | **Bright** |
| ![Image](image3.png) | ![Image](image4.png) | ![Histogram](histogram2.png) | **V** | **V** |
| ![Image](image5.png) | ![Image](image6.png) | ![Histogram](histogram3.png) | **V** | **V** |
| ![Image](image7.png) | ![Image](image8.png) | ![Histogram](histogram4.png) | **V** | **V** |
| ![Image](image9.png) | ![Image](image10.png) | ![Histogram](histogram5.png) | **V** | **V** |
According to the results as described in Table 1, input images could be grouped into three classifications, namely: (1) concentration to the left (dark), (2) concentration to the right (bright), (3) concentration evenly to the left (dark) and right (bright).

Contrast Stretching is the last stage of the process of improving the quality of dental radiology image by taking a grayscale image data. This method is conducted to get the maximum dental radiology image better than the initial conditions. This is done because some dental radiology images have poor contrast, therefore the image becomes blurred, and that makes it difficult to obtain clear information in determining the condition of the patient's teeth. It is necessary for contrast stretching the histogram of original image so that the image looks clearer teeth.

Furthermore, based on equations 1-3 then we did calculation variables R1, S1, R2 and S2 to determine the scale of contrast stretching. Table 2 describes examples of variables calculation results.

| Histogram | VARIABLES |
|-----------|-----------|
|           | R1    | S1    | R2    | S2    |
| 37        | 40    | 167   | 186   |
| 40        | 5     | 200   | 240   |
| 15        | 2     | 231   | 252   |
| 70        | 65    | 210   | 220   |
According to Table 2, Bright histogram has grey spread that dominates the right side. In order for the deployment of pixels evenly, the value of S1 is smaller than R1. This is because the smaller the value of S1 can encourage new pixel layout changes leading to the left. Dark histogram has grey spread that dominates the left. In order for the deployment of pixels evenly then the value of S1 is greater than the R1. This is because the larger the value of S1 can encourage changes in new pixels to the right. Evenly histogram has fairly grey spread from left to right. Input value almost the same type of dark histogram which distinguishes only determine the approximate value with reference seeking input grey pixel intensities (peak) at the centre of the histogram therefore it can be seen balance grey spread clearly of the image histogram. Furthermore, by using the input value R1, S1, R2 and S2, it can be determined scale of contrast stretching as described in Table 3.

### Table 3. Example of Contrast Stretching Scale Area

| Histogram | Scale Area |
|-----------|------------|
|           | A1         | A2         | A3         |
| Bright    | 1.08108    | 1.12308    | 0.78409    |
| Dark      | 0.125      | 1.46875    | 0.272727   |
| Evenly    | 0.13333    | 1.15741    | 0.125      |
|            | 0.92857    | 1.10714    | 0.77778    |
According to Table 3, contrast stretching method has three areas, namely A1 (first area), A2 (second area) and A3 (third area). The area is an area stretching scaling based on the basic equations of contrast stretching. The area shows the value of a straight line gradient. If a straight line gradient is generating value $<1$, then the new pixel area will be narrowed, and the merger intensity values of the original pixels. Instead a straight line gradient $>1$ there will be a widening or stretching the pixel area. Improved image quality using Contrast Stretching method does not change the intensity values of an image.

4. Conclusions
Contrast stretching method is promising for improving low resolution dental radiology images. However, Image processing algorithms can be improved so as to obtain a grey value R1, S1, R2 and S2 automatically. Extensional area adds to the original three, into four or more areas so that the areas to be improved to be more focused. Combine several methods both before and after contrast stretching process in order to obtain the result of improved dental radiology image quality better than the results now.

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