# Detecting and Probing the Distance Between Cemento-Enamel Junction (CEJ) and Alveolar Bone Crest (ABC) of Chronic Periodontitis with Radiographic Techniques

Arif Abdul Rahuman S, Anand,T and T.Sujatha

[1*]Department of Computer Science & Madha Engineering College, Kundrathur, Chennai-600069.

[2]Department of Information Technology, Madha Engineering College, Kundrathur, Chennai-600069.

## ABSTRACT

Diminished alveolar bone support is the major cause of tooth loss. This bone loss is most widely attributed to periodontal disease. The effects of periodontal disease are not fully understood although bacteria in dental plaque are known to be major contributors. It is extremely important to evaluate variations between the most used radiographs in dental practice, since minimum distortion on obtained images may change diagnosis, treatment plan, and prognosis for the patient. The radiograph can be a valuable aid in diagnosis of Periodontitis and determining its prognosis and evaluation of its treatment outcome. The aim of this study is to determine the distance between the Cemento-Enamel Junction (CEJ) and the Alveolar Bone Crest (ABC) on periapical, bitewing, and panoramic radiographs and compared among them. According to this study the mean distance between CEJ and ABC was compared among Bitewing, Periapical and Panoramic radiographs and the accuracy of three radiographic techniques were analyzed.

**Keywords**: Bitewing, Periapical and Panoramic radiographs

## INTRODUCTION

### Digital Image Processing

Image processing is a technique that improves unprocessed images received from digital camera/ sensors placed on satellites, space probes and aircrafts or pictures taken in normal day-to-day life for various applications (Juan *et al*., 1999). Now-a-days various image processing techniques are available. Most of the techniques are developed for improving images obtained from unmanned space crafts, space probes etc. Image processing systems are becoming very popular due to easy availability of powerful personnel computers, large size memory devices, graphics softwares etc. Image Processing is used in various applications such as: Remote Sensing Medical Imaging, Non-destructive Evaluation, Forensic

Studies, Textiles, Material Science, Military, Film industry, Document processing, Graphic arts, Printing Industry.

**Digital Image Processing Techniques**

Digital computers are used to process the image. The image will be transformed to digital form using a scanner – digitizer (KMM *et al.,* 1997) and then process it. The term digital image processing commonly refers to processing of a two-dimensional image by a digital computer (Anil *et al*., 1989). It is an array of real numbers represented by a limited number of bits. The principle advantage of Digital Image Processing methods is its flexibility, repeatability and the preservation of original data accuracy. The various Image Processing techniques are: Image representation, Image preprocessing, Image enhancement, Image restoration, Image analysis, Image reconstruction, Image data compression (Gonzalez Woods, 1992).

**Periodontal Disease**

Periodontal disease is the most common dental diseases in the world. The detection of Periodontitis, in an earliest stage is of most importance. Periodontal disease is a severe bacterial infection that affects the gums and bone supporting the teeth. It may affect one or more teeth (Ahmed Khocht *et al*., 2003). This disease starts when the bacterium in plaque (the sticky, colorless film that constantly forms on your teeth) causes the gums to become inflamed. The toxins encourage a chronic inflammatory response in which the body in essence turns on itself and the tissues and bone that support the teeth are broken down and destroyed (Moradi *et al*., 2010).

Gums divide from the teeth, forming pockets (spaces between the teeth and gums) that become infected. As the disease progresses, the pockets deepen and more gum tissue and bone are destroyed. Gingivitis is the mildest form of periodontal disease. If left untreated, bacteria associated with periodontal diseases can travel into the bloodstream and may result in other adverse health effects. Gum disease has been linked to heart disease, stroke, diabetes, cancer and preterm births. In order to determine the severity of periodontal disease and pocket depths around a tooth, periodontal probe, an instrument in dentistry usually a long, thin, and blunted at the end is used.

Based on the severity, the disease is characterized as:

**Slight periodontitis**: Periodontal destruction is generally considered slight when no more than 1 to 2 mm of clinical attachment loss has occurred.

**Moderate Periodontitis**: Periodontal destruction is generally considered moderate when 3 to 4 mm of clinical attachment loss has occurred.

**Severe (Chronic) Periodontitis**: Periodontal destruction is generally considered severe when 5 mm or more of clinical attachment loss has occurred.

Nowadays, different types of biomedical non-evasive imaging modalities such as X-ray, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound images, and many others, which are used in the medical field for disease diagnosis and treatment planning. These imaging modalities reflect the state of the internal anatomy and dynamic body functions.

Radiographs play a vital role in the assessment of periodontal diseases. They provide unique information about the status of the periodontium. Radiographs are used to detect the presence of alveolar bone loss and to assess the extent and severity of alveolar bone. Panoarmic, Bite wing and Periapical x-rays are useful in detecting the periodontal disease efficiently.

**Main Goal**

The main goal of the work presented is to extract alveolar bone loss in all the three dental X-ray images and determining the distance between Cemento Enamel Junction (CEJ) and Alveolar Bone Crest(ABC) which is useful to diagnose the severity of Periodontitis by the periodontist for further treatment planning. Also this work aims to compare the accuracy among three radiographs for the assessment of alveolar bone crest level.

# MODULES

**Module Description**

The steps have been implemented for this study includes:

**Inversion of Image**

The original images of tooth taken from Periapical, Bitewing and Panoramic radiographs are inverted to Binary images.

**Noise Filtering**

Noise filtering is used to filter the unnecessary information from an image. It is also used to remove various types of noises from the images. Mostly this feature is interactive. Various filters like low pass, high pass, mean, median etc., are available.

**Median Filter**

Median filter is a nonlinear filter mostly used to remove the impulsive noise from an image. It creates a 2-D mask that is applied to each pixel in the input image, by centering the mask in a pixel, evaluating which brightness value in the masked window is the median brightness value, and

replacing the pixel value by it. Furthermore, it is a more robust method than the traditional linear filtering, because it preserves sharp edges. Filtered images have usually strong changes in their statistics, due to noise removal by smoothing. Salient points depend on edges, so measurements should not be affected by this transformation, and visual appearance of the image should be improved (Flesia *et al*., 2011).

**Erosion**

In binary morphology, an image is viewed as a subset of a Euclidean space Rd or the integer grid Zd, for some dimension d. To probe an image with a simple, pre-defined shape, drawing conclusions on how this shape fits or misses the shapes in the image in binary morphology. This simple "probe" is called structuring element which is a binary image (i.e., a subset of the space or grid). Let E be a Euclidean space or an integer grid, and A a binary image in E (Dharmesh *et al.*, 2011). The erosion of the binary image A by the structuring element B is defined by:

$$A \ominus B = \{z \in E | B_z \subseteq A\}, \quad \text{..... (5)}$$

Where Bz is the translation of B by the vector z, i.e.

$$B_z = \{b + z | b \in B\}, \forall z \in E. \quad \text{..... (6)}$$

When the structuring element B has a center (e.g., a disk or a square), and this center is located on the origin of E, then the erosion of A by B can be understood as the locus of points reached by the center of B when B moves inside A. The erosion of A by B is also given by the expression:

$$A \ominus B = \bigcap_{b \in B} A_{-b} \quad \text{..... (7)}$$

**Region of Interest (ROI) definition**

The earliest stage is based in the statistical analysis of the sizes and positions of each component in each image, in order to define an initial region of interest. This eliminates non-useful information. Then created a mask for the region of interest and extracted the alveolar bone crest.

**Euclidean distance**

The Euclidean distance is the straight-line distance among two pixels. This distance can be calculated between CEJ and ABC using MATLAB distance tool.

**6. Mean, Variance and Standard deviation**

**Mean** yields the mean values of the elements along different dimensions of an array. This is obtained by summing the values and dividing by the number of values. The formula for calculating mean is:

$$\mu = \frac{1}{n}\sum_{i=1}^{n} f_i x_i = \sum_{i=1}^{n} p_i x_i$$

The mean is a measure of the *center* of the distribution.

**Variance (Second Moment)** of a data set is the arithmetic average of the squared differences between the values and the mean. The formula for calculating variance is:

**…….. (9)**

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n} f_i (x_i - \mu)^2 = \sum_{i=1}^{n} p_i (x_i - \mu)^2$$

**Standard deviation** is nothing but the square root of the variance.

**……..…….. (10)**

The variance and the standard deviation are $\sigma = \sqrt{\sigma^2}$ both processes of the spread of the distribution about the mean. Both measures of spread are useful.

In this study, the height of alveolar bone loss is extracted and the distances are calculated to find the mean, variance and standard deviation which are measured in millimeters. Finally the elapsed time is also calculated for mean, variance and standard deviation.

# RESULTS AND DISCUSSION

For this study, the dental x-ray images are taken from internet image data sets. Matlab, a high technical language is used to implement the algorithm. The three different images that we obtained are gray scale images. In the next step, these images are converted to binary images and apply logical NOT operation and convert white region into dark region and dark region into white. To remove some small artifacts we apply median filter on inverted image but still there are unwanted regions present between teeth. To remove unwanted regions we use morphological erosion operation on resultant image. For erosion we use disk type structuring element which is size of somewhat smaller than the object (Fig.1).

In the next step, we define the region of interest (ROI) and create a mask of the image. Then extract the alveolar bone crest from the created mask. In order to find the distance between Cemento enamel junction and Alveolar bone crest, Euclidean distance formula between two pixels are applied. Find 'n' number of pixel distances and calculate the mean, variance and standard deviation of the extracted images. Finally, the elapsed time for every mean, variance and standard deviation is calculated for each radiographs and compared. According to this study the mean distance between cemento enamel junction (CEJ) and Alveolar bone crest (ABC) was measured for periapical, Bitewing and Panoramic radiographs and are compared (Table 2) (Fig 2). Hence the panoramic technique is more accurate in the assessment of the alveolar bone crest level compared with the periadical and bitewing techniques (Fig. 3, 4&5).

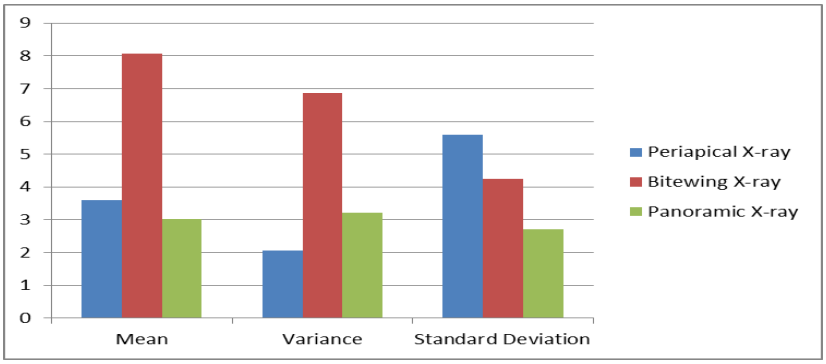


**Fig.1 Assessment of Alveolar Bone Crest Level**

| Type of Radiograph | | |
|---|---|---|
| Periapical X-ray | Bitewing X-ray | Panoramic X-ray |

| Elapsed Time (in seconds) | | | |
|---|---|---|---|
| Mean | 0.0017412 | 0.0022132 | 0.0014382 |
| Variance | 0.0013656 | 0.0016636 | 0.0011486 |
| Standard Deviation | 0.0008412 | 0.000911 | 0.0006018 |

Table 2: Elapsed time according to the type of radiograph for mean, variance, standard deviation values.

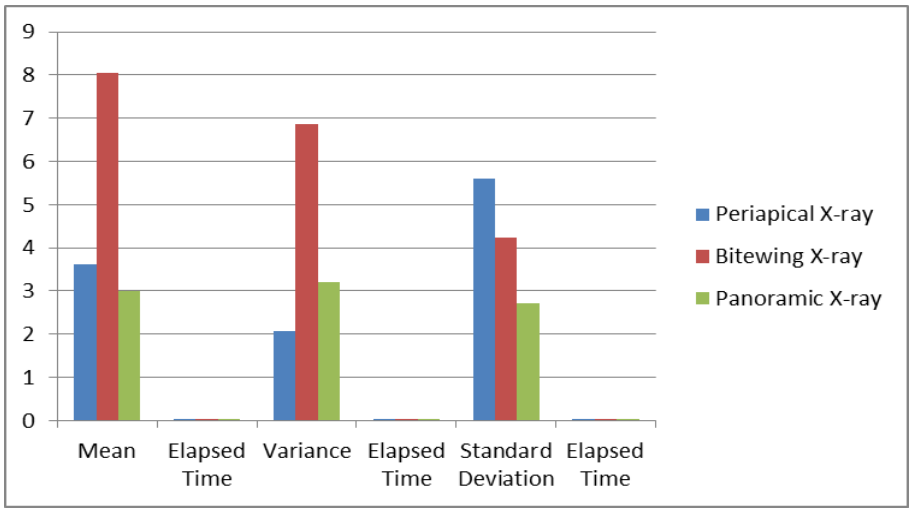


Fig. 2 Assessment of Elapsed time for various radiographs

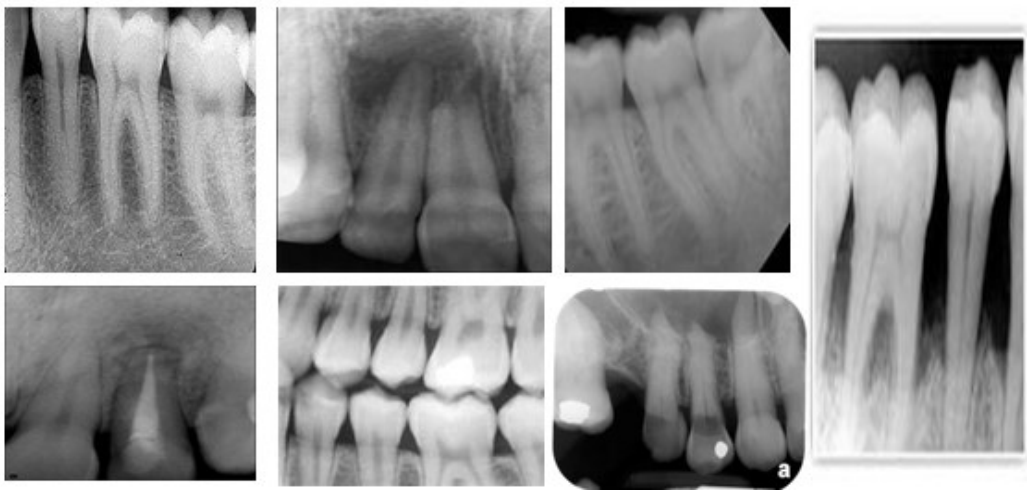

Fig. 3 Data set for analysis

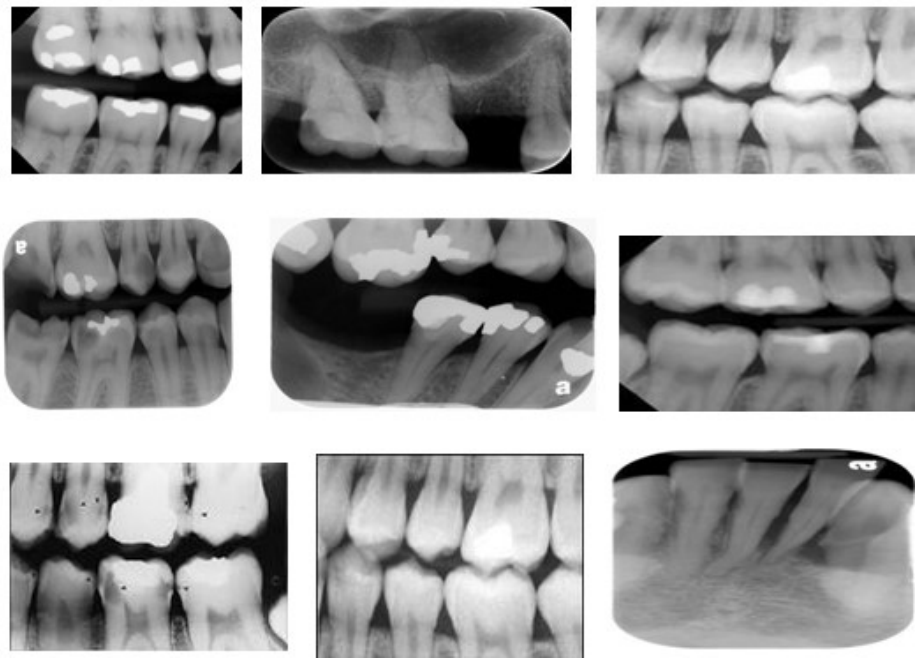

Fig 4: Examples of Periapical images of the Dental X-ray data set

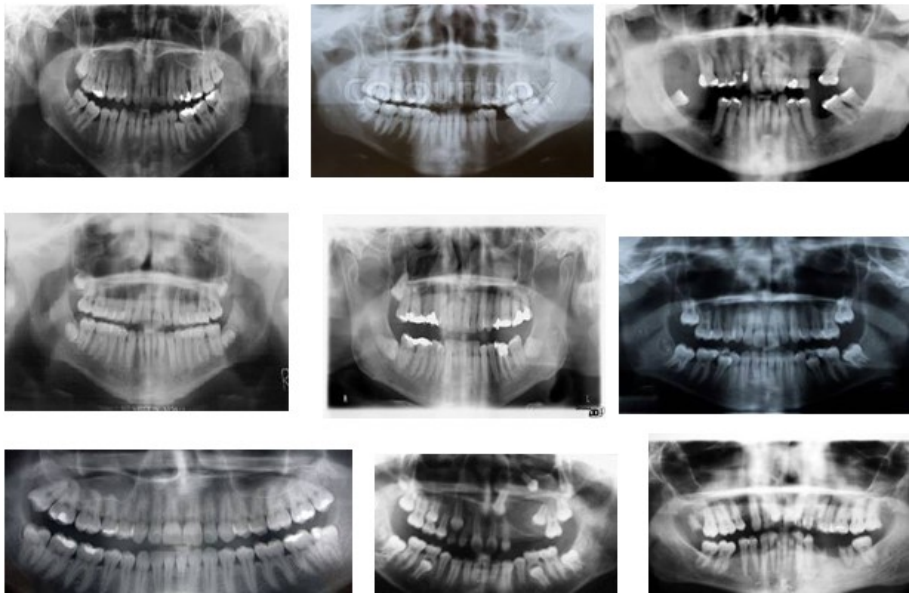

Fig.5 Examples of Panoramic images of the Dental X-ray data set

## SUMMARY AND CONCLUSION

In summary, the Android forensic reverse engineering in Quark for cyber security project aims to analyze the security of Android devices using reverse engineering techniques and the Quark tool. The project involves studying the Android architecture and components, understanding Android application components and security models, using ADB and other forensic tools, and applying reverse engineering techniques to identify potential security risks.

The use of Quark tool allows for the decompilation of Android applications, analyzing their behavior, and extracting data from the Android device. The project aims to provide a comprehensive understanding of Android forensic and reverse engineering techniques, and how they can be applied to improve the security of Android devices.

In conclusion, the project highlights the importance of understanding the security risks associated with Android devices and the need for effective forensic and reverse engineering techniques to identify and mitigate these risks. By applying these techniques and using tools such as Quark, it is possible to improve the security of Android devices and protect users from potential security threats.

## REFERENCES

Ahmed Khocht, Malvin Janal, Lynn Harasty, Kuang-Min Chang. Comparitive Study of Direct Digital and Conventional Intra Oral Bitewing Radiographs in Detecting Alveolar Bone Loss. J Am Dent Assoc. 2003 134(11):1468-75.

Anil K. Jain, Hall. Fundamentals of Digital Image Processing, Prentice- 1989.

Dharmesh B. Prajapati, Nirav P. Desai, Chintan K Modi. SIMPLE AND NOVEL FEATURE EXTRACTION TECHNIQUE FOR AM DENTAL RADIOGRAPHS. 2011, International Conference on Communication Systems and Network Technologies. 545-549.

Flesia J.G., Flesia A.G., "The influence of Digital processing in the accuracy of measurements In indirect digitalized intra-oral radiographic imaging "The Forensic Oral Pathology journal – FOPJ, 2011; 2(4):20-24.

Gonzalez Woods R.C. Addison Wesley. Digital Image Processing -1992.

Juan M C, M. Alcaniz, C. Monserrat, V.Grau, C.Knoll. Computer Aided Periodontal Disease Diagnosis using computer vision. Comput Med Imaging Graph. 1999; 23(4):209-217.

Kmm et al., Design and Fabrication of Color Scanner, Indian Journal of Technology, 1997, 15.

Moradi, J. Poorsafar, F. Khoshhal, M. Vafaei, F. Gholami, L. Comparison of two radiographic techniques to determine the distance between alveolar bone crest and cementoenamel junction in patients with chronic periodontitis. Avicenna J Dent Res. 2010;2(1): 70-73.