# DIGITAL DENTAL X-RAY IMAGE SEGMENTATION AND FEATURE EXTRACTION USING EXPECTATION MAXIMIZATION TECHNIQUE

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## Abstract

***In the field of dental medicine science, one of the frequently and oldest used techniques for detecting teeth periapical lesions disease is X-Ray. It is important to analysis the dental x-ray images to extract features of image. The process of analysing X-Ray images is important to improve quantifies medical imaging systems. In this paper we present a technique for dental x-ray images segmentation and feature extraction. The proposed technique has been implemented by using expectation maximization (EM) technique for segmentation after image enhancement and remove noise. The extracted features techniques can use to obtain the teeth measurements for automatic dental systems such as dental diagnosis systems. The experimental result show the importance of the proposed technique to extract teeth features from an X-Ray image.***

**Keywords:** Dental x-ray image, Teeth periapical lesions disease segmentation, Feature extraction, and Expectation Maximization (EM) technique.

## 1. INTRODUCTION

Nowadays, a lot of experiment has been expanded in developing regular systems in the area ofbioinformatics and biomedical applications.A dental medical imaging system has been widely used in teeth periapicallesions disease applications such as ultra sound, orthopaedic and many more applications. The dental medical imaging is a process used for capturing the teeth image, for clinical purpose likephysiology, anatomy and diagnosis. There are different dental imaging technologies such as X-rayradiography,medical ultra-sonography, tactile imaging, endoscopy, magnetic resonance imaging and thermography are used to detect teeth diagnoses [1].

Dental X-ray image analysis can be used for many applications such as dental diagnosis system, dental treatment system [2], [3] and human identification system [4], [5]. Currently dental medical researcher'sfocuseson the applications of dental X-Ray images analysis but the important point of interest is which method will be the best one in most of the analysis cases. Computational techniques of dental image analysis and feature extraction must address several problems such as X-Ray segmentation of the image,extraction of features of image, and improve the quality of image that used in feature extraction systems. The X-Ray image segmentation problem is a difficult taskin image processing techniques and it performs an important role in image matching and pattern recognition [6].

Expectation Maximization (EM) is one of the most used algorithms for density estimation of data in an unsupervised setting [7]. Expectation Maximization (EM) algorithm is used for estimating the cattle image parameters; the resulting pixels clusters provide a segmentation of the image [8]. The EM algorithm was presented in [9] to use the homogeneities as a basic field of the image logarithm. This homogeneities algorithm has been applied for brain MR image segmentation [10]. The EM algorithm demonstrated greater sensitivity to initialization than the K-means algorithms [11].

The purpose of this paper is to automate the process of extracting texture feature of dental medical X-Ray images to use in classification and identification of teeth periapicallesions disease application. To obtain this purpose we need to automate the process of X-Ray image segmentation. The segmentation of X-Ray images may be difficult depending on the shape intensity variation, mean and variation within the same dental x-ray images and from one image to another. The segmentation term is a crucial process in dental X-Ray image processing. Image segmentation is a process of segment an important object from the whole image. This technique is used to divide a digital image into multiple segments. The result of X-Ray image segmentation is a set of pixels or segments that collectively form the entire image. These segments can use as image character like intensity, color, and texture.

The proposed model in this paper consists of two phases; namely preprocessing and feature extraction. Preprocessing techniques; average filter and median filter have been used to image enhancement and removing noise respectively. The proposed model uses Expectation

Maximization image segmentation (EM) for robust dental X-Ray matching.

The rest of the paper is organized as follows. Preliminaries are discussed in Section (2). Section (3) presents the proposed bovines classification models in detail. Experimental results are discussed in Section (4). Conclusions and future work are discussed in Section (4).

## 2. PRELIMINARIES

### 2.1Average filter algorithm

Average (or mean) filtering is a method of smooth images by reducing the amount of intensity variation between neighbouring pixels.The average filter works by moving through the image pixel by pixel, replacing each value with the average value of neighbouring pixels, including it.The Average filters smooth dental X-Ray image data toenhance image. Average filter performs spatial filtering on each individual pixel in an image using the grey level values in a square or rectangular surrounding each pixel. The average filter computes the sum of all pixels in the filter and divides the sum by the number of pixels in the filter area as in equation (1).

$$Filtered\ pixel = \sum (a_1 + a_2 + a_3 + \cdots a_n/9 \qquad (1)$$

The essential idea of average filter method is to replace grayscale value of the centre pixel by average value of neighborhood pixel grayscale. Its filter features are analysed as in

$$g(i,j) = f(i,j) + n(i,j) \qquad (2)$$

The image after neighbourhood smoothing is shown in equation (3)

$$g(i,j) = \frac{1}{M}\Sigma_{(i,j)\epsilon S} f(i,j) + \frac{1}{M}\Sigma_{(i,j)\epsilon S} n(i,j) \qquad (3)$$

Where, S is the neighborhood of point (i, j), M is the total points of the neighborhood [16].

### 2.2 Median filter algorithm

The median filter is a non-linear digital filtering technique; it used to remove noise from X-Ray images. It is mostly useful to reduce salt, noise and pepper noise. Median filter is edge preserving nature makes, it practical in cases where edge blurring is undesirable. Median filter has been introduced by in 1970 [12]. Median filter is a special case of non-linear filters used for smoothing images. Nowadays median filter is used in smoothing and reducing noise the dental X-Ray images. Hakan et al depend on using topological median filter to improve conventional median filter [13]. The Topological Median filters implements some new ideas on fuzzy connectedness to improve a conventional median filter extraction of edges in noise. A conventional median filter does perform better than a topological median filter in the reduction of the amplitude of noise.

We can define median filter in case of computing the output of using a median filter on dental X-Ray image, an odd number of sample values are ranked, and the median value is used as the filter output. It is acceptable to assume that the signal is of finite length, consisting of samples from $Y(0)$ to $Y(L-1)$. If the filter's window length is $N = 2k + 1$, the filtering procedure is given by

$$X(n) = med\,[Y(n-k), \ldots Y(n), \ldots, Y(n+k)] \qquad (4)$$

Where Y(n) and X(n) are the input and the output sequences, respectively. This is the non-recursive Median filter. It has been first shown that any sequence of length L is converted under repeated median filtering to the root signal after at most (L-2)/2 passes [14, 15].

### 2.3Expectation Maximization image segmentation (EM)

Expectation Maximization image segmentation can be applied to dental X-Ray image by treating segmentation as E-step, where the X-Ray image parts which belong to each object are assigned to it and X-Ray object analysis as M-step, where the model X-Ray image parameters are fit to data that is has occupied. To improve the accuracy of any classification model use the expectation maximization (EM) algorithm. EM can used to estimate the involved parameters during the iteration.

**Algorithm 4 " expectation maximization (EM) algorithm"**

1: estimate the missing information $\hat{z}$ given the current $\theta$ estimate.

2: use this missing information to form the complete muzzle data set $\{y, \hat{z}\}$

3: estimate the new $\theta$ by maximizing the expectation of the complete data log likelihood

4: The E-step calculate the conditional expectation by

$$Q(\theta|\theta^{(t)})\ \varepsilon[\log P(y,z|\theta)|\ y, \theta^{(t)}]$$

5: the M-step maximizes $Q(\theta|\theta^{(t)})$ to obtain the next value estimation by $\theta^{(t+1)} = argmax_\theta\ Q(\theta|\theta^{(t)})$.

6: let $\theta^{(t+1)} \longrightarrow \theta^{(t)}$ and repeat again from step 4.

## 3. PRELIMINARIES

The proposed model in this paperuseexpectation maximization (EM) technique for segmentation. This model consists of two phases; pre-processing phase which is the initial phase that contain Average filter to X-Ray image enhancement and Median filter to remove noise from X-Ray image, texture feature extraction is the second phase in which we use Expectation Maximization

International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org, editorijettcs@gmail.com
Volume 4, Issue 3, May-June 2015 ISSN 2278-6856

image segmentation (EM) that used to extract image colors and feature vector that reflect the content of each dental X-Ray image. This model with its phases are describe in detail in the following section with the steps involved and the characteristics for each phase and the overall architecture introduced system described in figure 1.

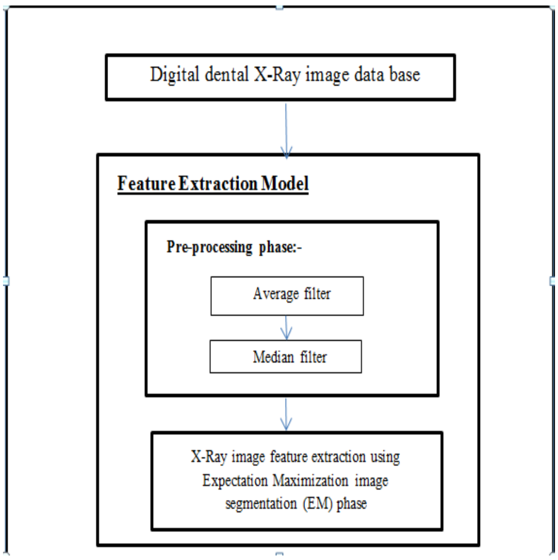


**Figure 1.**the proposed dental X-Ray image feature extraction model

### 3.1Pre-processing phase

Pre-processing phase is the first critical phase in the first classification model. This paper presents histogram equalization (HEQ) to increase image contrast and mathematical morphology filtering to remove noise from bovine muzzle image. HEQ based on distribute pixel intensity on each muzzle image and increase image contrast when it represented by close contrast values. Mathematical morphology filter depend on four operations dilation, open, close, and erosion. In this model first use dilation to maximize object values. So muzzle image after dilation operation will increase the intensity of image. Bovine muzzle image become darker than the original one because it thins the object. Erosion is the opposite of dilation. It's used to minimize object value. In this model after implementing histogram equalization on bovine muzzle image, the next step in this phase is to implement mathematical morphology filter on muzzle image in order to remove noise

### 3.2Texture feature extraction phase

The second and critical phase on this proposed model is bovine muzzle image texture feature extraction. This phase is still the challenging point in bovine muzzle classification because the accuracy of classifier model depends on number of feature extracted in the feature vector. We use Segmentation based Fractal Analysis algorithm (SFTA). SFTA feature vector contain eighteen element of bovine muzzle image feature and that help in increasing this accuracy of ANN.

## 4. EXPERIMENTAL RESULTS

The experimental results in this paper have been conducted using laptop with Intel® Core™ i5-4210U CPU running at 2.40 GHz, and 6 GB of RAM. The laptop is authorized by Matlab R2009b and Windows® 64-bit.

### 4.1Digital Dental X-Ray Image Database

The insufficiency of printed dental X-Ray database was the first critical challenge in this paper. Therefore, collecting an X-Ray dental images database was urgent and important step in order to start this work. A sample of dental X-Ray print images captured from different dental X-Ray images is shown in Figure 2. This database consists of 180 sample cases. A special care has been taken during capture dental X-Ray image to get on data base with high quality.

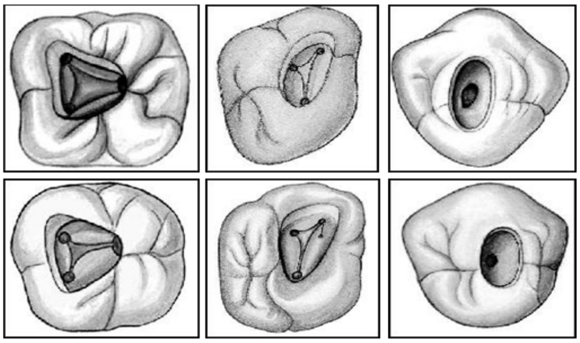

**Figure 2.**A sample of dental X-Ray images from live patients. This figure represented X-Ray print images have been taken from different patients

### 4.2Evaluation Results

After database collection step, we divide the image to k classes, and then we take the average, standard deviation and portion of each class as features from the x-ray image as in the following table.

**TABLE I.** At k=8, we divide the image into 8 parts and calculate the mean, variance and portion of each part, then we have three feature vectors for each image one for mean values, the second for variance and the third for portion, we can use these feature vectors in the classification .

| | | Class1 | Class2 | Class3 | Class4 |
|---|---|---|---|---|---|
| K=8 | Mean: | 143.412 | 179.11 | 182.57 | 170.24 |
| | Variance: | 66.6251 | 63.910 | 65.338 | 62.559 |
| | Portion: | 0.12 | 0.112 | 0.14 | 0.131 |
| K=16 | Mean: | 249.2 | 195.3 | 209.1 | 157.0 |
| | Variance: | 75.3 | 63.9 | 94.6 | 51.9 |
| | Portion: | 0.22 | 0.11 | 0.51 | 0.12 |

## 5. CONCLUSIONS AND FUTURE WORK

This paper has presented Expectation maximization (EM) model uses printed dental X-Ray image as input to Expectation Maximization image segmentation (EM) to extract features of each X-Ray image. The first step is to collect real-time dental X-ray image. Then in the first model using average filter to enhance the image contrast and median filter, in order to remove image noise. Second step use Expectation Maximization image segmentation (EM) in order to extract bovine muzzle texture feature.
Inthe future work, we tend to use one of classification algorithms to increase accuracy when we use large number of X-Ray images in case of classification.

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