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Identification of The Proximal Caries of Dental X-Ray Image with Multiple Morphology Gradient Method

Jufriadif Na`am[#], Johan Harlan[*1], Sarifuddin Madenda[*2], Eri Prasetio Wibowo[*3]

[#] *Computer Science Faculty, Putra Indonesia University, Padang, 25221, Indonesia*
E-mail: jufriadifnaam@gmail.com

** Computer Science Faculty, Gunadarma University, Jakarta, 16424, Indonesia*
E-mail: [1]harlan_johan@hotmail.com; [2]sarif@staff.gunadarma.ac.id; [3]prasetyo@u-bourgogne.fr

***Abstract*— This study aims to perform the sharpening of the dental x-ray image in the form of a panoramic dental x-ray. The method used in this study was segmentation morphology consisting of the dilation, erosion and gradient process. This study also developed a process of morphology gradient of subtracting morphology dilation results with the results of morphology erosion dilation in iterating basis. The results achieved indicate that the image enhancement process in each iteration stage can display caries objects clearly, making it easier to identify proximal caries. In this study have been compiled a looping morphology gradient algorithm which is called multiple morphology gradient.**

***Keywords*— Multiple Morphology Gradient; dilation; erosion; gradient; dental x-ray; cropping; histogram**

I. INTRODUCTION

Health problems in the teeth tend to be ignored, because it does not endanger human life [1]. If the bacteria that invade the teeth already inflamed to the gums, bacteria will release endotoxin (lipopolysaccharide). This endotoxin will pass through the blood circulation that can lead to heart disease and stroke [2]. About 80% of Indonesia's population has a broken tooth due to various reasons, but the most common was dental caries or cavities [3].

Spreading of caries starts from the email, dentin and to the pulp chamber that contains nerves and blood vessels, causing pain [4]. There are several types of caries, among which are proximal caries which is commonly found in the layer between the premolars and molars. The most difficult caries to detect is proximal caries [5]. This type can not be detected visually or manually using dental diagnostic tools. Proximal caries requires radiographic examination called a dental x-ray. Dental x-ray can observe areas of the teeth and determine how much of tooth decay [6], so that a radiographic examination is still being used for the most common approach to the proximal caries [7].

The examination dental x-rays produces images in soft copy. In order for image can be interpreted correctly by the human eye, it would require image processing [8],[9]. The objective of this study is to develop a processing system for detecting proximal caries on dental x-ray image of people with dental caries.

II. MATERIALS AND METHOD

In building a processing system for detecting proximal caries toward the image of dental x-ray of patients with dental caries is needed a research method comprising the steps of: image dental X-ray, pre-processing, morphology dilation, morphology erosion and Multiple Morphology Gradient (Fig. 1). The Multiple Morphology Gradient (mMG) is one stage which is a method developed as the contribution of this study.

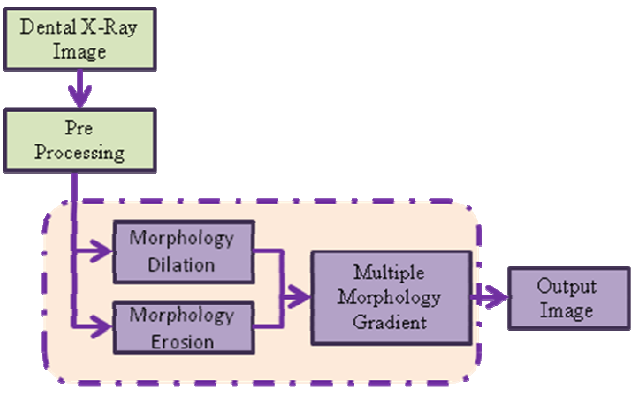


Fig. 1 Stages of processing

A. *Dental X-Ray Image*

Dental x-ray image is a panoramic image of dental x-ray of proximal caries patients on General Hospital of M. Djamil Padang, Indonesia. The first image was analyzed by a dentist to determine the position of the dental proximal caries.

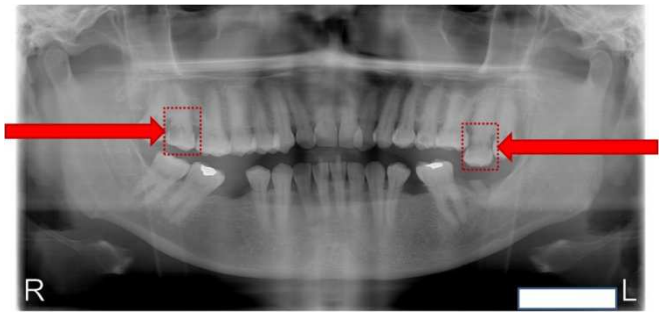


Fig.2 Dental x-ray image of the proximal caries patient

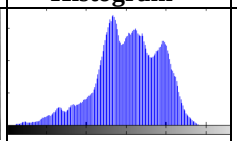
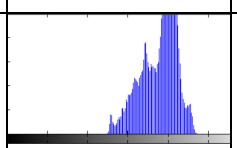
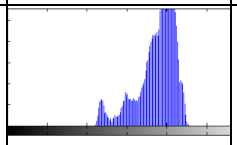
Fig. 2 shows the dental image of the proximal caries, which is tooth number 17 (the top right, position 7) and 27 (top left position 7) marked by the box appointed by arrows.

B. *Pre Processing*

The image of the panoramic dental x-rays showed the entire nose and jaw from ear to ear and not only the structure of the teeth which is extracted, it needs pre-processing of the image data of dental x-ray which aims to improve image quality by removing noise contained therein.

Difficulties in the process of removing noise in the image of dental x-ray image of the teeth is to separate it one by one, because there are teeth which overlapping with other teeth, so that the ends of the teeth can not be detected more accurately. Algorithm has been widely used, such as gradients, color, shape and others, but it is not suitable for this kind of panoramic dental x-ray [10], so the pre-processing that performed is the cropping process.

TABLE I
CROPPING RESULT

Cropping Image	Histogram	Teeth
		All
		**17**th
		**27**th

Cropping is the process of cutting the image to retrieve the observed object only. From these cuts we will get an area of interest so noise which was the outside area of observed object can be eliminated. Cropping method is the separation of object which is done horizontally and vertically [11,12].

The cutting process of part of the image (cropping) can be done by using two reference coordinates namely the initial coordinates of the upper-left corner as the initial coordinates for the image of the cuts and the coordinates of the bottom-right corner of the end which is the coordinate of the final image of the cuts. From this two-point coordinates it can be formed a rectangle shape as a size of the new image of the results of cropping process, in which there are all the items that will be processed. The result of cropping the image is shown in Table I.

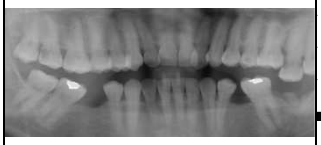
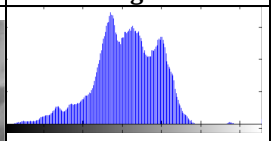
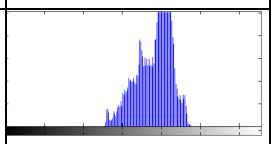
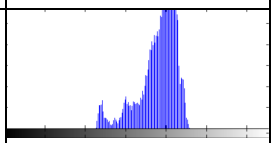
C. *Morphology Dilation*

Morphology dilation is defined as the process of "growing" or "thickening" object of image. Let A and B was the sets of pixels. Dilation of A by B is denoted by and defined by:

$$A \oplus B = \{z \mid (B)_z \cap A \neq 0\} \quad (1)$$

The result of dilation process towards cropping results is shown in Table II.

TABLE II
DILATION RESULT

Teeth	Cropping Image	Histogram
All		
17th		
27th		

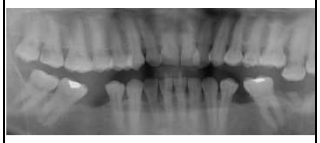
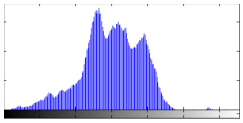
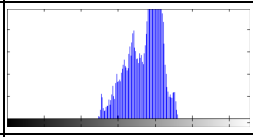
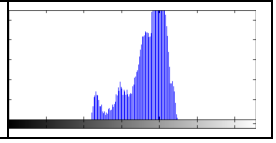
D. *Morphology Erosion*

Morphology erosion is the process of shrinking or diluting the image objects. Let A and B was the sets of pixels. Erosion A by B is denoted by A Θ B and is defined by:

$$A \Theta B = \{z \mid (B)_z \subseteq A\} \quad (2)$$

The result of the process of erosion on cropping results, shown in Table III.

TABLE III
EROSION RESULT

Teeth	Cropping Image	Histogram
All		
17th		
27th		

III. RESULT AND DISCUSSION

Morphology dilation process is intended to widen the area of the edges of the object, so that the area of teeth which is indicated as dental caries can be seen more clearly. Morphology erosion aimed to discourage or dilute the edges of the objects image area, so there will be differences in the area of each object when compared with the objects of dilation results. This result will simplify the next process in detecting the edges of caries objects and objects that exist in dental x-ray image.

Detecting the edges of objects in an object like dental caries, dental objects, or other objects can be performed by reducing the image of the morphology dilation result with the image of the morphology erosion result. The process of reduction dilation results to the results of erosion result repeatedly referred to as mMG. The notation is defined by:

$$mMG = \sum_{i=1}^{n} \{(A \oplus B) - (A \Theta B)\} \quad (3)$$

n is the value of the highest colour intensity which is defined as:

$$n = \frac{max(max((A \oplus B) - (A \Theta B)))}{w * 256} \quad (4)$$

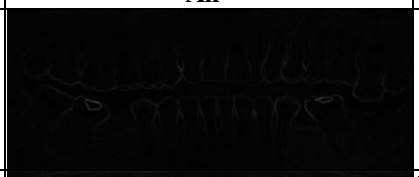
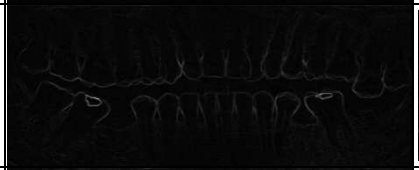
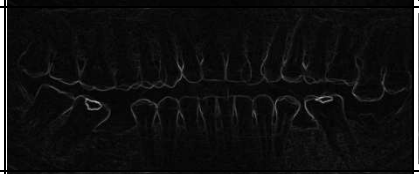
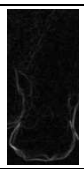
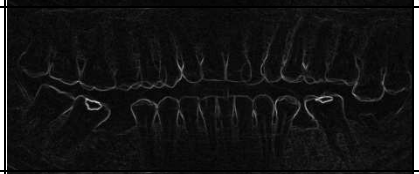
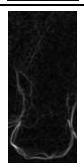
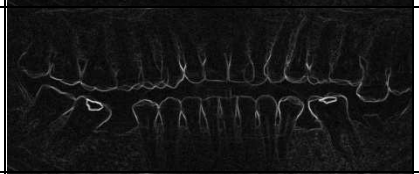
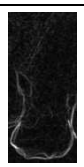
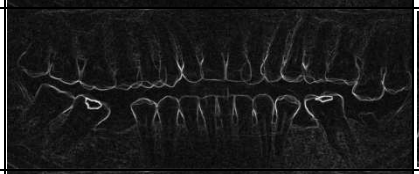
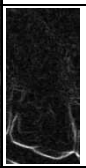
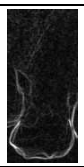
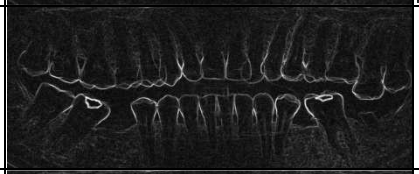
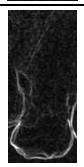
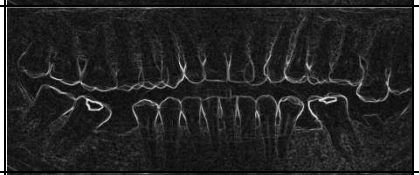
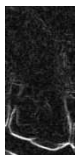
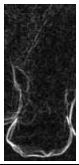
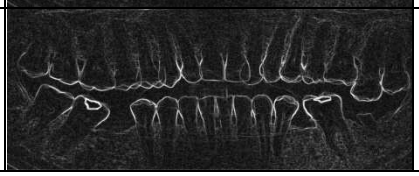
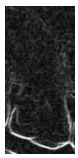
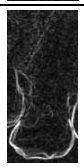
w is number of bits of image colour space.

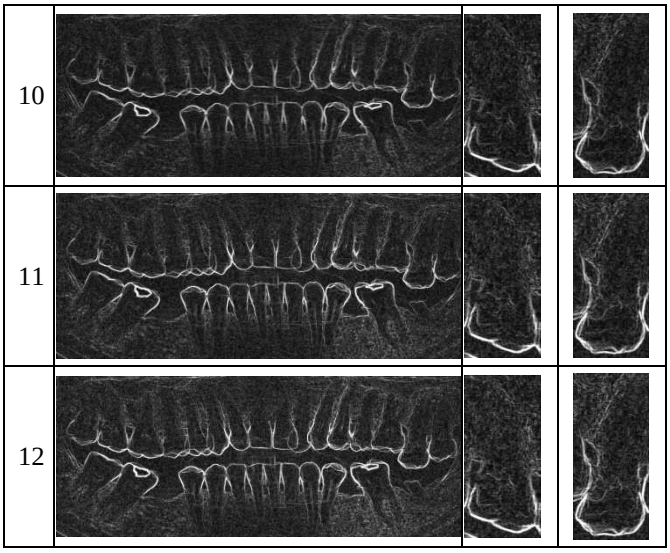
mMG algorithm

1. Read cropping image
2. Determine the elements that form the structure for morphological processes
2. Conduct morphology dilation process on cropping image
3. Conduct proses morphology erosion process on cropping image
4. Subtract the result of morphology dilation with morphology erosion repeatedly (multiple morphology gradient), where the highest color intensity values was 12 (n <= 12)
5. Show the image result

This repetitive process will produces the sharpening of the object, so existing proximal caries can be clearly seen by the human eye. The result of multiple morphology gradient process with the value of n = 12 is displayed in Table IV.

TABLE IV
RESULT OF MULTIPLE MORPHOLOGY GRADIENT (MMG)

i	All	17th	27th
1			
2			
3			
4			
5			
6			
7			
8			
9			



IV. Conclusions

This study was conducted to process the image of a panoramic dental x-ray in shaping the image so that the quality of proximal caries information contained in it can be interpreted correctly by the human eye. Mechanisms used in this study utilizes algorithms that are well known in the image processing such as cropping, morphology dilation and morphology erosion as well as developing multiple morphology gradient algorithm. Development of algorithms performed better clarify dental x-ray image, making it easier to identify proximal caries.

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