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SEGMENTATION AND COUNTING THE NUMBER OF TEETH PANORAMIC DENTAL IMAGE

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Abstract

In developing tooth separation system on radiography segmentation process is needed. Segmentation is the separation of teeth from the background and separation of each tooth. The purpose of this study, namely to separate dental images per tooth using integral projection. The expected benefits in this study can be used for the process of identifying unknown individuals based on panoramic radiographs. Where panoramic radiographs are thresholding, then the separation of the maxilla and lower jaw and also separating each tooth using integral projection. The process of separating teeth per tooth to calculate the number of teeth in a panoramic radiograph. The number of teeth is calculated based on the results of integral projection and the extraction of centroid point features. The thresholding accuracy value is 66.67%. Segmentation is done twice, namely: separating the upper and lower jaws, and separating each tooth. Separates the maxilla and lower jaw using a horizontal integral projection algorithm. Whereas to separate each tooth using vertical integral projection. In order for the separation process of each tooth to produce the best, panoramic radiographs are divided into three parts, namely: the left, right, and center. However, the separation process of each tooth produces an accuracy value of 33.33%.

Key words: Dental panoramic, segmentation, integral projection.

INTRODUCTION

Forensic Dentistry is a dental record in the form of a dental radiograph used for identification. Where dental radiographs are included in the dataset to automate the process of identifying victims using dental biometrics. The process of automation includes taking the features of dental contour, dental contour extraction, and matching recognition. The dataset used in Anil K. Jain's research, Hong Chen, was 100 radiographic images[1].

To make automatic tooth identification, classification and labeling of bitewing teeth is needed. The process of identifying individuals using dental radiographs requires preposesing and feature extraction stages. Where feature extraction is done is labeling or giving a number on a bitewing tooth image. Tooth classification and labeling algorithm, namely bayesian, for classifying premolar and molar teeth[2].

The process of identifying individuals based on teeth is needed by the forensic team. Because in a mass disaster or accident victims the teeth are resistant to hot weather. The process of classification and numbering of radiographic teeth based on dental contours, and tooth extraction. Stages in conducting classification, namely binaryization, extraction of dental contour features, molar classification and premolar with SVM algorithm (support vector machine)[3].

The aim of Hong Chen's research was to identify unknown victims. A system that is built automatically to assist the forensic team in identifying victims, with stages: extraction of dental contour features (parts of crowns and fillings), recording dental radiographs and labeling teeth and checking missing teeth, the last step is matching antemortem and postmortem data[4].

Research Diaa Eldin M. Nassar and Hany H. Ammar made an automatic identification system prototype based on teeth. A system built using radiographic images to identify unknown individuals[5][6].

An individual identification automation system using dental radiography has been developed, namely ADIS. The ADIS system is used to automate individual identification based on dental radiographs. The ADIS system can solve problems and enforce the law in the introduction of unknown victims[7].

The purpose of forensic dentistry is to identify individuals based on dental radiographs. The stages of developing identification systems based on dental radiology, namely: 1. Record antemortem dental radiographic data, 2. Extract tooth shape features, 3. Match between antemortem and postmortem radiographic teeth[8].

Identifying victims with decaying body conditions requires organs that are resistant to natural conditions, such as teeth. Dental biometrics can be used to identify victims by comparing antemortem (AM) data in postmortem datasets and data (PM). By building ADIS (Automatic Identification using Teeth)[9].

Identification of individuals dying from mass disasters and accident victims requires special attention. Dental forensic identification can help in matching unknown individuals. The identification automation process includes matching premolars, incisors, canines and molar teeth[10].

In the study Diaa Eldin M. Nassar and Hany H. Ammar made an individual identification system of dental radiographs. The identification process through matching antemortem and postmortem dental feature extraction. The algorithm proposed in the identification of individuals based on dental radiographs is backpropagation neural networks[11].

The purpose of this study was to separate each tooth on panoramic radiographs. The results of the separation of each tooth will be extracted to feature the centroid point of each tooth, then count the number of teeth. Expected benefits in this study, namely: to be able to use the identification process of

unknown individuals based on dental panoramic radiographs.

This study is expected to help in the identification of unknown individuals based on dental panoramic radiographs. In order to produce a good system, the thresholding process and segmentation of each tooth are carried out. Segmentation of each tooth uses integral projection, and in order to produce the right number of teeth, the dental radiographic image is divided into three parts, namely the left, right, and center.

MATERIAL AND METHODS

The data used in his research was taken directly through people. People who took 3 panoramic teech were photographed 2 times. The total data used was 6 panoramic teeth. Samples of panoramic teeth on behalf of Nur Nafiiyah, Hutami Endang, Yunianita, example in Dataset Table 1.

Dental biometric systems are the process of identifying individuals. Forensic dental biometrics matches antemortem (AM) radiographic data and individual postmortem (PM) data. The stages are: preparation of dental radiographic images, tooth segmentation, and matching[12].

To separate between the maxillary and mandibular image, this research used a horizontal integral projection (Equation 1).

$$HP_{(i)} = \sum_{j=1}^{n} f(i,j) \qquad (1)$$

Horizontal integral projection is the sum of the image matrix from row (m) to column (n). In other words, the sum of the image matrix with row direction. Horizontal integral projection aims to find the minimum or minimum global position of the line, the position of the line is used to create a dividing line between the upper jaw and the lower jaw.

To separate each tooth, the researchers used the same method of separation between the maxilla and the lower jaw. Separation of each tooth can be done using vertical integral projection (Equation 2).

$$VP_{(j)} = \sum_{i=1}^{m} f(i,j) \qquad (2)$$

Vertical integral projection is the sum of the image matrix from column (n) to row (m). In other words, the sum of the matrix of image from column direction. Things to be achieved on the vertical integral projection is the determination of the minimum local values in column summation curve.

The plot of this research is exposed in Figure 1. Which is part of the system design. System design is the stage to transform the various needs into the form of data and program architecture that will be implemented at the stage of system making later.

Figure 1 shows that the panoramic dental segmentation system consists of several processes, namely the separation of the image of the tooth and the background, the teeth separation process, the feature extraction process and the process of calculating the number of teeth.

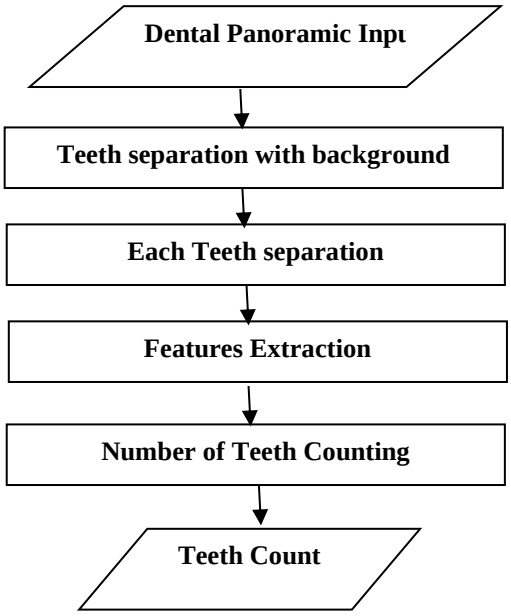


Figure 1. Research Stages

The process of separation of teeth with background is thresholding or binarization. Tooth separation process algorithm, namely iterative adaptive thresholding. And the process of teeth separation is separating the upper and lower jaw, the results of the separation of the maxilla and lower jaw

using the integral horizontal projection algorithm. And the algorithm for separating each tooth, namely: vertical integral projection. The feature extraction stage is to calculate the number of teeth using the centroid feature of each tooth.

The first process done in segmentation is image reading. After the process is done, the next step is the separation between the image of the tooth and the background. The purpose of this process is to separate the tooth from the background to facilitate the pattern recognition process. Input from this stage is a dental panoramic original image which is categorized as uint8 data type.

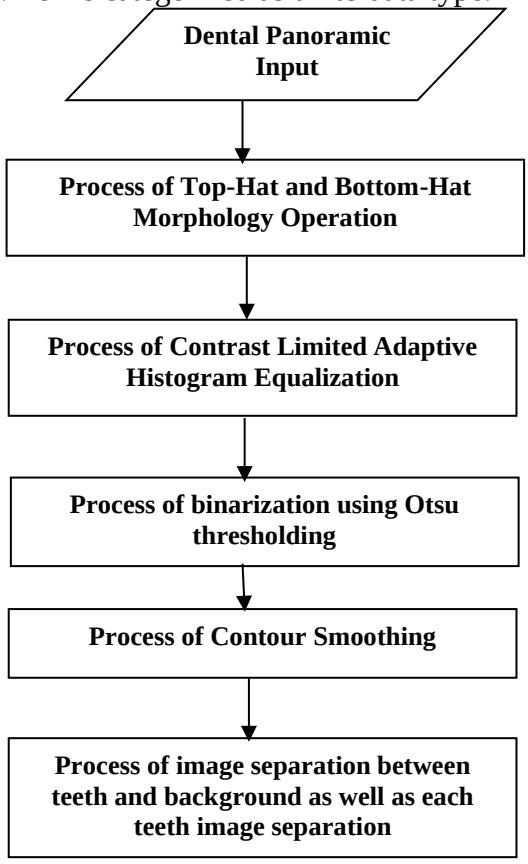


Figure 2. Teeth and Background Image Separation Process

Specifically, in the process of separating the image (teeth and background), the first step to do is morphological operation with top hat and bottom-hat operator to sharpen image contrast. This step is done by utilizing Contrast limited adaptive histogram equalization (CLAHE), dividing the image into small parts called tiles. The contrast, then, is fixed at the local level on each tile.

Next, the process to be done is binarization process of the image using otsu thresholding method. After the binarization process, contour smoothing is done as there will still be part of the image that is roughly contoured and has a lot of noise. The outcome of this process is a bright image that is ready for further processing (separation of the background and separation of each tooth) as found in figure 2.

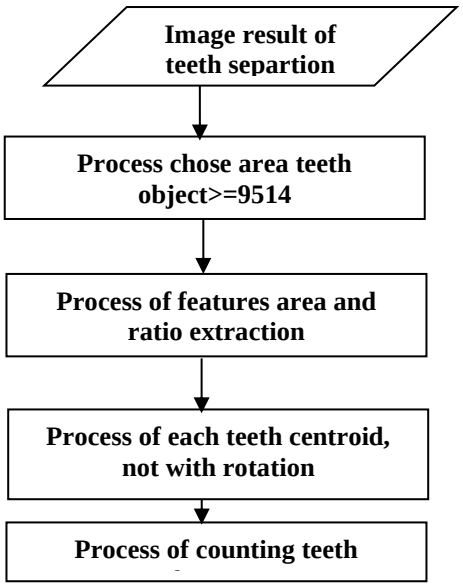
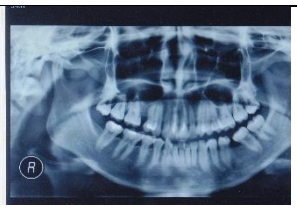
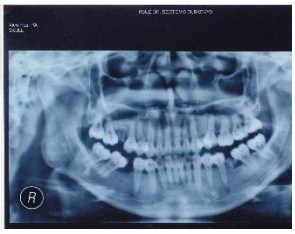
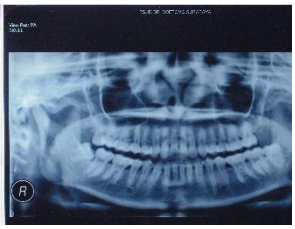


Figure 3. Proses of Teeth Separation

Back to the main research process, after the image separation process, the next process is the separation of each tooth image. this process is done to separate each tooth from its surroundings. There are two separate processes done to obtain isolated tooth objects. The first separation process is separating the upper and lower jaws by applying horizontal integral projection. The second separation process is separating each tooth from the surrounding by applying vertical integral projection.

After doing the processes elucidated before, as shown in figure 2, the next processes to be done are features extraction, number of teeth counting, and teeth count. Figure 3 depict the process of number of teeth counting.

Table 1. Dataset

No	Image Dental Panoramic	People
1		Image1
2		Image2
3		Image3

RESULT AND DISCUSSION

Before doing the thresholding process, the researchers prepare the necessary data first. The prepared data is stored in image and dental panoramic form obtained from the hospital as shown in Figure 4.

Next is the process of separation of teeth and background (thresholding). It is a process to distinguish between the image of a tooth and its background. This process has several stages, the first stage is data input (in the form of RGB image) which is, then, converted to grayscale. The next process is to do morphological operation with top hat and bottom-hat operation function to sharpen the contrast of the image.

After the second step above, contras limited adaptive histogram equalization (CLAHE) is done. it aims to improve the contrast by dividing the image into small parts called tiles. The contrast is, then, fixed at the local level on each tile.

The next step is to determine the threshold, the image is processed through binarization to separate the tooth image from the background, with the global thresholding (Otsu Thresholding Method). After that, the contour refinement is done as after the binarization process, there are parts of the tooth that have rough contour and a lot of noise.

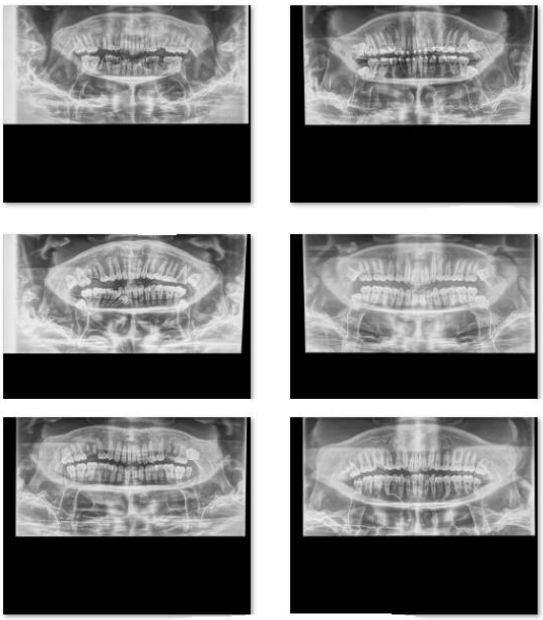


Figure 4. Example of Dental Panoramic Data

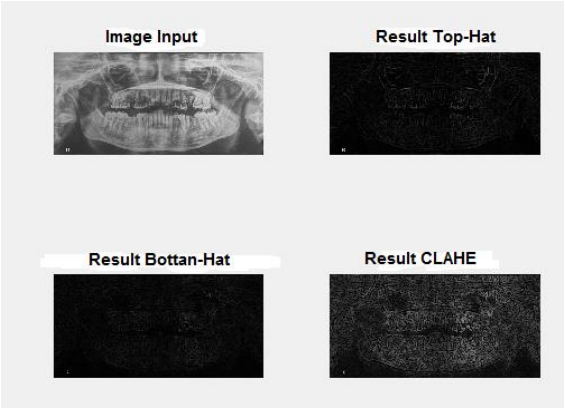


Figure 5. Result Top-hat and Bottom-hat Operation

Figure 6. Result of CLAHE

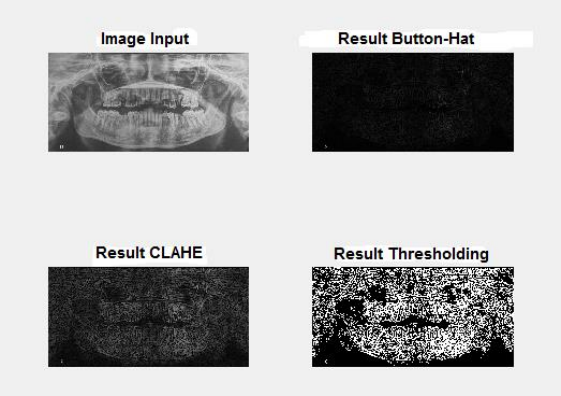


Figure 7. Result of Binerization

Next, the maxillary and mandibular image are separated, followed by separation of the image of each tooth later. In this process, dental panoramic image is divided into several parts, namely the left, right, and middle. this step is done with the aim to know the number of teeth. The cutting and binarization results can be seen in Figure 8.

The end result of this research is the separation between the image of the maxilla and the lower jaw, followed by the separation of each tooth with lines. From the lines pieces, we will know the number of teeth from humans, as shown in Figure 9.

The results of the separation of teeth and the background can be seen in Figure 8 where the panoramic teeth are divided into 3 parts, left, middle and right. However, if we compare with the results of the bitewing teeth thresholding, the result will appear as in figure 10.

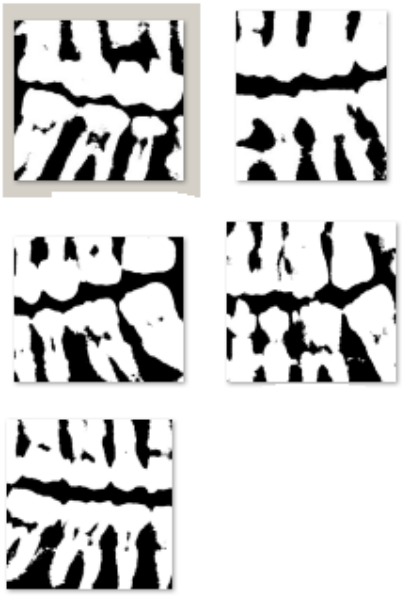


Figure 8. Result of Thresholding and Teeth Separation

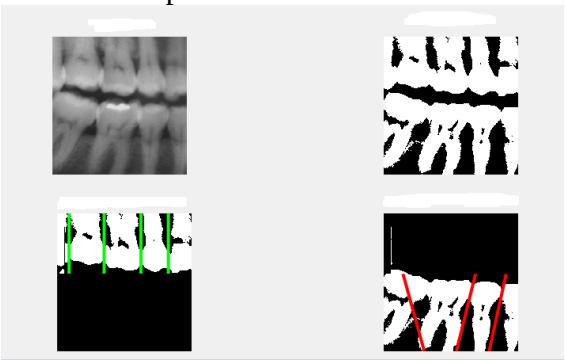


Figure 9. Result of Teeth Separation

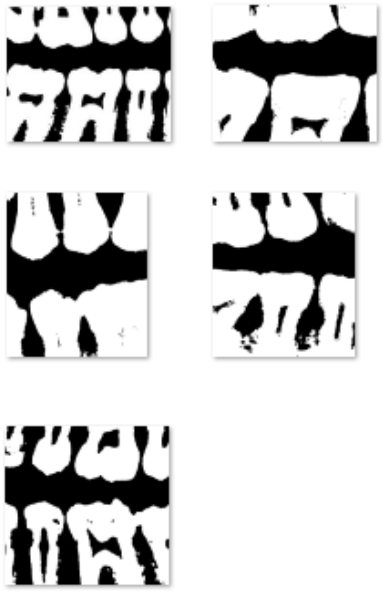


Figure 10. Result of Thresholding Bitewing

The accuracy results of the teeth and background separation process as well as teeth separation on dental panoramic image are shown in Table 2.

Table 2. Dental Panoramic Segmentation Results (level of accuracy)

No	Thresholding	Upper Jaw Separation	Lower Jaw Separation
1	30%	90%	30%
2	90%	90%	90%
3	30%	90%	90%
4	90%	90%	30%
5	30%	90%	90%
6	90%	90%	90%
7	90%	90%	90%
8	90%	90%	90%
9	90%	90%	90%

To measure the accuracy of this study, namely:

$$accuracy = \frac{total\_data\_correct}{total\_data} * 100\% \quad (3)$$

The result of dental panoramic segmentation, in the process of separation of teeth and background, shows that at 6 image the process was done well, whereas unfavorable results are found in 3 images. Hence, the accuracy value is $66{,}67\%$.

In the process of teeth separation, it shows that, in all image, the process can be performed well. Thus, the accuracy value is 100%. Meanwhile, for the separation of the lower jaw, there are only 7 images with a good process. Thus, the accuracy value is $77{,}78\%$.

The process of separating each tooth on a dental panoramic, where the image is divided into 3 parts (left, right, and middle), indicates that the results of each tooth separation on the maxilla has 6 images (out of 9 image) with good process. Hence, the accuracy value is $66{,}67\%$.

Meanwhile, the accuracy rate of separation of each tooth on the lower jaw is less successful due to the inequality of dental image, there are slanted image and there is straight image. Thus, the accuracy value is 0.

Next, the feature extraction result on dental panoramic results from the separation of the lines from each tooth and the calculation of the centroid value of the tooth. It is seen that the extraction of image feature with centroid is less successful as there are, sometimes, 2 centroids from the image of each tooth, whereas it should be only 1 centroid for each tooth image. The numbers of teeth calculation of dental panoramic (from the 3 sections: left, right, and middle) are shown in Table 3.

Table 3. Number of Teeth Calculation Result

No	Number of Real Teeth	Number of Teeth in Dental Systems	Results
1	29	30	Unequal
2	28	28	Equal
3	31	35	Unequal

As seen in the table above, the process of calculating the number of teeth can only be done correctly on 1 image only but not on 2 other images. This is because the process of dental panoramic cutting process (between the teeth) was not done well. it causes 2 times the calculation for image cut in the middle.

CONCLUSION

Based on the implementation and analysis of research results coupled with the supporting theories in the previous chapter,

it can be concluded that: (1) the process of separation of teeth and background with binarization has an accuracy rate of 66.67%. (2) The separation process between upper and lower jaws can be done with an accuracy rate of 77.78%. (3) the process of separation of each tooth in the upper jaw has an accuracy of 66.67%. (4) The process of separation of each tooth on the lower jaw was not successful with an accuracy rate of 0%. (5) There is only 1 good result on the calculation of the number of teeth, thus, the accuracy rate is 33.33%. Therefore, it can be said that the process in the segmentation and calculation of the number of teeth on dental panoramic is less successful. it is caused by the low quality of image, there is compression in the image. To overcome this problem, researchers have attempted to make improvements by dividing the image of the dental panoramic into 3 parts (left, right, and middle).

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