# Comparison Study of Gaussian and Histogram Equalization Filter on Dental Radiograph Segmentation For Labelling Dental Radiograph

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***Abstrakt*— More recently, the design and manufacture of Automated Dental Identification System (ADIS) for human identification using dental radiographs have been done, because the victim identification process is done manually requires a longer time. There are several stages for identification using ADIS. Preliminary and decisive is the phase separation and image classification teeth. With more accurate result of splitting image of the tooth, the more accurate the results of victim identification using dental image. The result of the separation of the teeth accurate image relies on pre-processing the image of dental radiographs. Therefore, we need a pre-processing effort to improve the image of dental radiographs prior to the process of image segmentation or separation of the teeth. This research will be carried out pre-processing on the image of dental radiographs using Gaussian Filtering and Histogram Equalization. Furthermore, the image of the results of the second pre-processing will be compared PSNR and validation labellingnya (classification of types of gear). From this comparison process can be known types of pre-processing is more suitable to be applied to the image of dental radiographs. Experiments using 28 images dental radiographs showed an average value using Gaussian Filtering PSNR of 32.21% and the average value of PSNR using the Histogram Equalization amounted to 22.52%. Average value of the validation labeling using Gaussian Filtering by 80.58% and the validation value using the Histogram Equalization labeling of 81.88%.***

***Keyword*— dental radiographi, Gaussian Filtering, Histogram Equalization,segmentation**

## I. INTRODUCTION

Human identification using dental data is commonly done in forensics. Dental chosen as the material for dental identification is part of the body that is usually intact, due to tooth structure is solid. More recently, the design and manufacture of Automated Dental Identification System (ADIS) for human identification using dental radiograph was performed. ADIS is a process automation system for postmortem identification that has been designed to achieve accurate and precise identification of time with minimum human interference[1]. There are several stages for identification using ADIS. Preliminary and decisive is the phase separation and image classification teeth. With more accurate result of splitting image of the tooth, the more accurate the results of victim identification using dental image[2]. The result of the separation of the teeth accurate image relies on pre-processing the image of dental radiographs. Therefore, we need a pre-processing effort to improve the image of dental radiographs prior to the process of image segmentation or separation of the teeth. This research will be carried out pre-processing on the image of dental radiographs using Gaussian Filtering and Histogram Equalization. Segmentation method used in this study is a watershed. Watershed transformation is one method that is good enough to get an object segmentation result. Furthermore, the image of the results of the second pre-processing will be compared PSNR and validation labelling (classification of types of gear). From this comparison process can be known types of pre-processing is more suitable to be applied to the image of dental radiographs.

## II. SYSTEM DESIGN

Diagram of system design can represent the whole system in order to obtain maximum results.

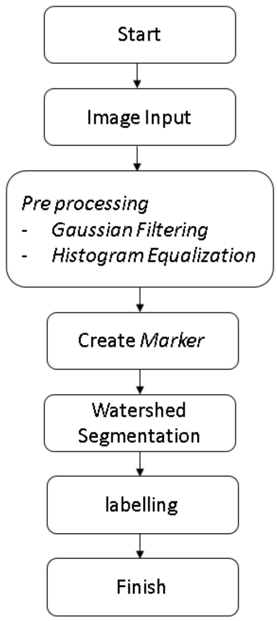



Fig 1. System Design

This system will be done offline. The first stage is the input image is performed dental radiography, radiographic images used in this study is a panoramic image with .bmp extension. The second stage is the pre processing the radiographic images to produce a better image segmentation, pre processing used in this study is Gaussian Filtering and Histogram Equalization. The third stage is to make the marker on radiographic image that has been in pre-processing. Make a marker intended to choose or select part of the object to be segmented. The fourth stage is the image segmentation using watershed. Phase segmentation aims to separate each tooth. After the tooth image segmentation successfully conducted last stage is labeled. At this stage, each of the teeth will be labeled according to its kind.

## III. PREPROCESSING

Preprocessing used in this study is Gaussian Filtering and Histogram Equalization.

### A. *Gaussian Filtering*

Gaussian filter is a linear filter that is usually used as more subtle. Gaussian filters are widely used in image processing. Gaussian filter aims to eliminate noise in an image and improve the quality of image detail. Gaussian filter is actually almost the same as the average filter only the weight values that are not flat like the filter on average, but follow a Gaussian function as follows

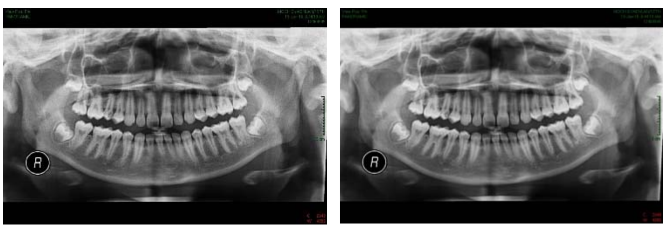
$$\mathbf{G(x,y)} = \frac{\mathbf{1}}{\sqrt[s]{\pi}} \mathbf{e}^{-((\mathbf{x}-\mathbf{m_x})^2+(\mathbf{y}-\mathbf{m_x})^2)} \quad \text{.................................(1)}$$

Information :
G (x,y) = 2-dimensional Gaussian
S = distribution and Gaussian function
$(mx,my)$ = Midpoint of the Gaussian function

Based on the formula of the gaussian function in Figure 2 for the 5x5 matrix will be obtained Gaussian filter kernel:

```
H = 0.0030 0.0133 0.0219 0.0133 0.0030
    0.0133 0.0596 0.0983 0.0596 0.0133
    0.0219 0.0983 0.1621 0.0983 0.0219
    0.0133 0.0596 0.0983 0.0596 0.0133
    0.0030 0.0133 0.0219 0.0133 0.0030
```

Fig 2. Kernel Gaussian filter for 5x5



(a) (b)

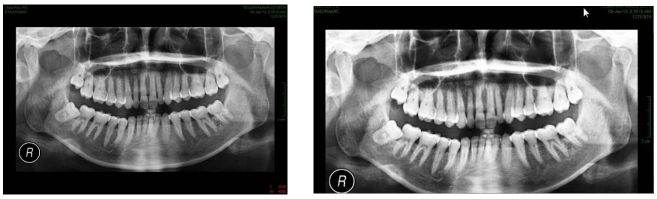
Fig 3. The comparison of original image and the result of Gaussian Filtering. (a) Original Image, (b) Gaussian Filtering

### B. *Histogram Equalization*

Histogram equalization is a process of flattening the histogram, where the distribution of the value of the degrees of gray in an image made flat. To be able to perform a histogram equalization is necessary which is the cumulative distribution function of the cumulative histogram. Histogram equalization is used to improve the quality of segmentation. Excessive segmentation is a major problem facing the segmentation using watershed algorithm because it needed a good pre-processing to avoid excessive segmentation. Value histogram equalization results are as follows:

$$\mathbf{w} = \frac{\mathbf{c_w} \cdot \mathbf{t_h}}{\mathbf{f_{lx}} \cdot \mathbf{f_{ly}}} \quad \text{.........................................................................(2)}$$

Information :
w = value of gray histogram results
c w = cumulative histogram of w
$t_h$ = threshold degrees of gray
$n_x$ and $n_y$ = size image



(a) (b)

Fig 4. The comparison of original image and the result of histogram equalization. (a) Original Image, (b) histogram equalization

### C. *Testing Gaussian Filtering*

Experiments done by providing pre-processing Gaussian Filtering on 28 image panoramic radiographs. Then each image sought PSNR value. PSNR or peak signal-to-noise ratio is the ratio between the maximum signal to noise affecting the image is used.

Table 1. Testing Gaussian Filtering

| No. | File Name | PSNR (dB) |
|---|---|---|
| 1 | Untu-01 | 31,948 |
| 2 | Untu-07 | 31,183 |
| 3 | Untu-09 | 32,692 |
| 4 | Untu-10 | 32,398 |
| 5 | Untu-12 | 32,422 |
| 6 | Untu-13 | 31,64 |
| 7 | Untu-16 | 32,011 |
| 8 | Untu-17 | 32,944 |
| 9 | Untu-18 | 30,872 |
| 10 | Untu-19 | 32,331 |
| 11 | Untu-20 | 31,9 |
| 12 | Untu-21 | 32,248 |
| 13 | Untu-22 | 32,43 |
| 14 | Untu-23 | 32,927 |

| | | |
|---|---|---|
| **15** | Untu-25 | 31,878 |
| **16** | Untu-30 | 31,693 |
| **17** | Untu-32 | 32,029 |
| **18** | Untu-35 | 32,514 |
| **19** | Untu-40 | 32,345 |
| **20** | Untu-42 | 32,416 |
| **21** | Untu-43 | 32,428 |
| **22** | Untu-44 | 32,714 |
| **23** | Untu-45 | 32,354 |
| **24** | Untu-51 | 32,003 |
| **25** | Untu-55 | 34,454 |
| **26** | Untu-56 | 32,43 |
| **27** | Untu-59 | 31,347 |
| **28** | Untu-60 | 31,548 |
| | average | 32,21 |

### *D. Testing Histogram Equalization*

Experiments done by providing pre-processing Histogram Equalization on 28 image panoramic radiographs. Then each image sought PSN value. PSNR or peak signal-to-noise ratio is the ratio between the maximum signal to noise affecting the image is used.

Table 2. Testing Histogram Equalization

| **No.** | **File Name** | **PSNR (dB)** |
|---|---|---|
| **1** | Untu-01 | 19,654 |
| **2** | Untu-07 | 23,269 |
| **3** | Untu-09 | 22,681 |
| **4** | Untu-10 | 23,86 |
| **5** | Untu-12 | 24,422 |
| **6** | Untu-13 | 20,339 |
| **7** | Untu-16 | 22,705 |
| **8** | Untu-17 | 23,557 |
| **9** | Untu-18 | 26,195 |
| **10** | Untu-19 | 27,137 |
| **11** | Untu-20 | 21,48 |
| **12** | Untu-21 | 26,795 |
| **13** | Untu-22 | 16,934 |
| **14** | Untu-23 | 22,125 |
| **15** | Untu-25 | 19,301 |
| **16** | Untu-30 | 22,705 |
| **17** | Untu-32 | 23,168 |
| **18** | Untu-35 | 28,469 |
| **19** | Untu-40 | 21,482 |
| **20** | Untu-42 | 22,309 |
| **21** | Untu-43 | 20,319 |
| **22** | Untu-44 | 20,161 |
| **23** | Untu-45 | 22,671 |
| **24** | Untu-51 | 20,051 |
| **25** | Untu-55 | 21,965 |
| **26** | Untu-56 | 24,333 |
| **27** | Untu-59 | 22,07 |
| **28** | Untu-60 | 20,628 |
| | average | 22,52 |

## IV. MAKE MARKER

This segmentation method is done semi automatic. All parts in segmentation processing is done by computer calculations except determine the parts to be segmented. In this section, the user is involved in determining the object of the gear to be in segmentation. Users give a sign or marker on the part of the tooth to be segmented. Marker that will be used to acquire the image of the watershed. Figure 5 is an example of how to create a marker on one of the panoramic image.


Fig 5. Creating marker

Markers will automatically be saved in the project file with the name "marker-filename." These markers will be used to get the image of the watershed. Reasons for using marker is because the system does not recognize the shape of the tooth so that the user should be involved in determining the object to be in segmentation. Figure 6 is a marker of stored images.

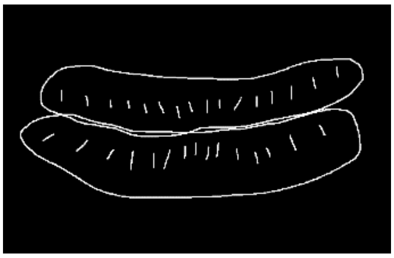


Fig 6. Marker saved

## V. WATERSHED SEGMENTATION

The segmentation process aims to separate the objects in the image. In this final tooth will be separated from the background and separated into each tooth.

Watershed change the image based on the intensity of the image into a topography consisting of mountains and valleys. Part of the mountain is a value that has a high intensity or close to white was part of the valley is a value that has a low intensity.

Marker is used to mark the topography of the area to be flooded, as if the marker is the fountain of the topography. The water sources in the region will be flooded valley topography based marker made.

Fig 7. Watershed image

## VI. LABELLING

Phase label on the tooth consists of several processes. Flowchart of stages labeling can be seen in Figure 8.

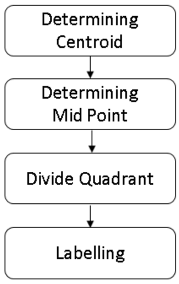



Fig 8. The flow chart label phase

To label each of the teeth according to type, there are several processes that must be done is to determine the centroid of teeth, determine the mid-point, dividing the quadrants and the last is labeled.

### *A. Determining Centroid*

Centroid is the central area of an object. In this final part of the centroid is the center area of each of the teeth or the midpoint of the tooth. Determining the tooth centroid aims to determine the mid-point (the midpoint of the mouth) and the location of the position label. Centroid value is a relation of

$$C_x = \frac{M_{10}}{M_{00}} \quad \text{.......(3)}$$

$$C_y = \frac{M_{01}}{M_{00}} \quad \text{.......(4)}$$

To find the value of $M_{10}$, $M_{01}$ and $M_{00}$ can use equations based on a scalar images (grayscale) with pixel intensities I (x, y). The equation can be:

$$M_{ij} = \sum_x \sum_y x^i y^j I(x, y) \quad \text{.......(5)}$$

Results watershed affect the value of the centroid. If the result of the segmentation is good, will get close countor broad area real teeth. The more accurate the spacious countour the more accurate the value of centroid. Because centroid, is the value of the central area of countour obtained from the segmentation process. Of the process of determining the centroid, it can know the number or centroid many teeth present in the image. Many centroid image is the number of teeth detected.

### *B. Determining Mid Point*

Mid point is the midpoint of the mouth, the purpose of determining the value of the mid-point is to divide the mouth into four quadrants. Each tooth has nillai centroid ($x_n$, $y_n$), the centroid of each tooth then calculated and divided by the number of teeth to get a mid-point value / midpoint of the mouth. Here is the equation for calculating the mid-point:

$$X_m = \frac{\sum_{x=n}^{x=1} X_n}{n} \quad \text{.......(6)}$$

$$Y_m = \frac{\sum_{y=n}^{y=1} Y_n}{n} \quad \text{.......(7)}$$

Information :
$X_m$ = point mid-point coordinates x
$Y_m$ = point mid-point coordinates y
$X_n$ = Centroid (coordinate x) to the -n
$Y_n$ = Centroid (the y coordinate) to the -n
n = number of teeth

Mid-point of the process depends on the number of teeth and tooth centroid distribution. If the complete gear 32 seed, the mid-point will be in the middle. Suppose there is a missing tooth on the lower right molar mid-point, the point will be shifted slightly to the upper left. If there is a missing tooth in the upper left molar, the centroid will be shifted slightly to the bottom right. Mid-point shift occurs when there is a missing tooth because of the determination of *the* mid-point is the accumulation of dental centroid divided by the number of teeth

### *C. Divide Quadrant*

The midpoint of the mouth or the midpoint ($X_m$, $Y_m$) is used to divide the mouth into four quadrants. In the Cartesian coordinate plane quadrant 1 is located on the upper right (positive x, y positive), but the image point 0,0 is in the upper left so the program behind the first quadrant to quadrant 4. Figure 9 is an illustration of the division of the quadrant

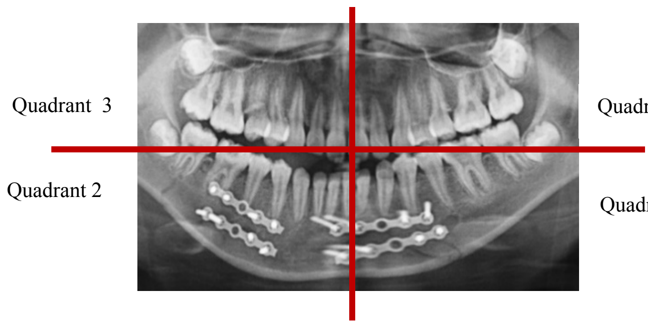



Fig 9. Dental Quadrant

The equation for dividing the quadrants:
$x > 0$ and $y > 0$ = quadrant 4
$x < 0$ and $y > 0$ = quadrant 3
$x < 0$ and $y < 0$ = quadrant 2
$x > 0$ and $y < 0$ = quadrant 1

Once in the quadrant, the next step is sorting by distance. Each tooth is calculated spacing or distance between the centroid of teeth with a mid-point. Then the value of the distance in descending or ascending disorting basis. Ordering the distance value is used to provide an index to the teeth. Index on the gear used to label at a later stage. The equation to find the distance can be:

$$Distance = \sqrt{(x^1 - x^2)^2 + (y^1 - y^2)^2} \quad \text{..............................(8)}$$

*D. Give Label*

Label tooth numbering system based on adult teeth. Label a tooth by tooth index obtained from sorting by distance in each quadrant. For the index value to the 1st and 2nd are incisors, for the index value of 3rd is the canine teeth, for the index value of 4th and 5th are the premolars and for the index value of the 6th, 7th, and 8th is the molar teeth. Figure 10 is a table division tooth.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | M | M | P | P | C | I | I | I | I | C | P | P | M | M | M |
| M | M | M | P | P | C | I | I | I | I | C | P | P | M | M | M |

Fig 10. The distribution of types of dental table

Information :
I = Incisivus
C = Caninus
P = Premolar
M = Molar

The label will be in the middle countour gear based on the centroid of each tooth. Figure 11 is an example image of the tooth that has been labeled..

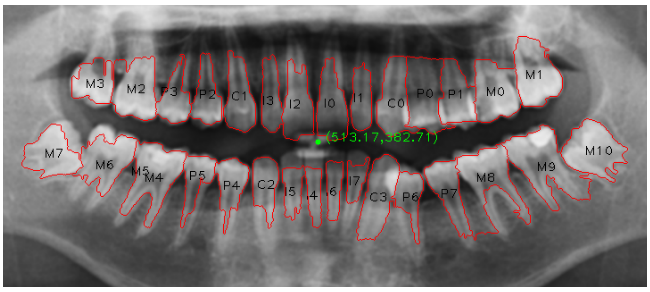


Fig 11. label with Gaussian

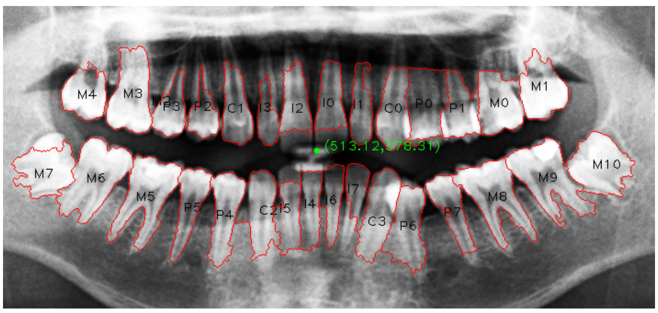


Fig 12. label with Histogram Equalization

Results labeling depends on the outcome of watershed segmentation. If the result of the segmentation is good, will get close countor broad area real teeth. The more accurate the spacious countour her the more accurate the centroid value and its mid-point. Accurate mid-point value will generate an index gear quadrant and accurate anyway.

## VII. TESTING

Tests labeling is done by comparing the image of the tooth that has been labeled by the system with the image of the tooth in the label manually and have been authenticated by the supervising doctor of the Hospital Dr Soetomo.

*A. Testing Labelling Gaussian Filtering*

Table 3 shows the results of testing with Gaussian Filtering labeling

Table 3. Tests labeling with Gaussian Filtering

| No. | Name | Error label / amount of teeth | Error (%) | Success (%) |
|---|---|---|---|---|
| 1 | Untu-01 | 9/31 | 29,03 | 70,97 |
| 2 | Untu-07 | 6/25 | 24 | 76 |
| 3 | Untu-09 | 10/31 | 32,25 | 67,75 |
| 4 | Untu-10 | 3/28 | 10,71 | 89,29 |
| 5 | Untu-12 | 5/29 | 17,24 | 82,76 |
| 6 | Untu-13 | 2/26 | 7,69 | 92,31 |
| 7 | Untu-16 | 4/32 | 12,5 | 87,5 |
| 8 | Untu-17 | 13/30 | 43,33 | 56,7 |
| 9 | Untu-18 | 10/24 | 41,67 | 58,33 |
| 10 | Untu-19 | 3/29 | 10,34 | 89,66 |
| 11 | Untu-20 | 3/32 | 9,37 | 90,63 |
| 12 | Untu-21 | 5/32 | 15,62 | 84,38 |
| 13 | Untu-22 | 5/30 | 16,67 | 83,33 |
| 14 | Untu-23 | 8/31 | 25,8 | 74,2 |
| 15 | Untu-25 | 6/28 | 21,42 | 78,58 |
| 16 | Untu-30 | 4/32 | 12,5 | 87,5 |
| 17 | Untu-32 | 6/25 | 24 | 76 |
| 18 | Untu-35 | 0/29 | 0 | 100 |
| 19 | Untu-40 | 11/25 | 44 | 56 |
| 20 | Untu-42 | 4/27 | 14,81 | 85,19 |
| 21 | Untu-43 | 12/26 | 46,15 | 53,85 |
| 22 | Untu-44 | 4/31 | 12,9 | 87,1 |
| 23 | Untu-45 | 7/29 | 24,13 | 75,87 |
| 24 | Untu-51 | 1/30 | 3,33 | 96,67 |
| 25 | Untu-55 | 6/32 | 18,75 | 81,25 |
| 26 | Untu-56 | 4/31 | 12,9 | 87,1 |
| 27 | Untu-59 | 0/32 | 0 | 100 |
| 28 | Untu-60 | 4/31 | 12,9 | 87,1 |
| | average | | 19,42 | 80,58 |

*B. Testing Labelling Histogram Equalization*

Table 4 shows the results of tests labeling with Histogram Equalization

Table 4. Test labeling with Histogram Equalization

| No. | Name | Error label/ amount of teeth | Error (%) | success (%) |
|---|---|---|---|---|
| 1 | Untu-01 | 2/31 | 6,45 | 93,55 |
| 2 | Untu-07 | 9/25 | 36 | 64 |
| 3 | Untu-09 | 0/31 | 0 | 100 |

| | | | | |
|---|---|---|---|---|
| **4** | Untu-10 | 0/28 | 0 | 100 |
| **5** | Untu-12 | 0/29 | 0 | 100 |
| **6** | Untu-13 | 0/26 | 0 | 100 |
| **7** | Untu-16 | 6/32 | 18,75 | 81,25 |
| **8** | Untu-17 | 6/30 | 20 | 80 |
| **9** | Untu-18 | 14/24 | 58,33 | 41,67 |
| **10** | Untu-19 | 5/29 | 17,24 | 82,76 |
| **11** | Untu-20 | 8/32 | 25 | 75 |
| **12** | Untu-21 | 5/32 | 15,62 | 84,38 |
| **13** | Untu-22 | 6/30 | 20 | 80 |
| **14** | Untu-23 | 12/31 | 38,7 | 61,3 |
| **15** | Untu-25 | 8/28 | 28,57 | 71,43 |
| **16** | Untu-30 | 9/32 | 28,12 | 71,8 |
| **17** | Untu-32 | 0/25 | 0 | 100 |
| **18** | Untu-35 | 1/29 | 3,44 | 96,56 |
| **19** | Untu-40 | 14/25 | 56 | 44 |
| **20** | Untu-42 | 0/27 | 0 | 100 |
| **21** | Untu-43 | 8/26 | 30,76 | 69,24 |
| **22** | Untu-44 | 8/31 | 25,8 | 74,2 |
| **23** | Untu-45 | 10/29 | 34,48 | 65,52 |
| **24** | Untu-51 | 0/30 | 0 | 100 |
| **25** | Untu-55 | 3/32 | 9,3 | 90,7 |
| **26** | Untu-56 | 0/31 | 0 | 100 |
| **27** | Untu-59 | 8/32 | 25 | 75 |
| **28** | Untu-60 | 3/31 | 9,67 | 90,33 |
| | average | | 18,12 | 81,88 |

From the above test can be seen success of the labelling system with pre-processing Gaussian amounted to 80.58% and the success of the labeling system with pre processing Histogram Equalization amounted to 81.88%. There is an error because the value of some of the teeth are not well segmented. Teeth are not segmented well as pictures of teeth that are less obvious, especially on the tooth root, pre-processing using the histogram equalization can clarify the teeth but not on the overall teeth, so there are teeth that are not well segmented. The clearer the object tooth it will be better the segmentation result using the watershed.

Results labeling depends on the outcome of watershed segmentation. If the result of the segmentation is good, will get close countor broad area real teeth. The more accurate the spacious countour the more accurate the centroid value and the mid-point. Accurate mid-point value will generate an index gear quadrant and accurate anyway. It can be concluded that the results of each process affects the outcome of the next process.

## VIII. CONCLUSION

1. Pre-processing affects the segmentation results. The clearer the object tooth it will be better the segmentation result using the watershed.
2. The average PSNR on image of Gaussian Filtering is 32.21% and the average PSNR on image histogram Equalization is 22.52%.
3. Results labeling depends on the outcome of watershed segmentation. If the result of the segmentation is good, will get close countor broad area real teeth. The more accurate the spacious countour her the more accurate the centroid value and its mid-point. Accurate mid-point value will generate an index gear quadrant and accurate anyway.
4. On image processing using the histogram equalization rosentase p value (%) error occurred on the image that the number of teeth is not complete, amounting to 58.33% in the untu-18.bmp image
5. On image processing use Gaussian filtering error value occurred on the untu-4.bmp image amounting to 46.15%.
6. Success the system labelling on image processing using Gaussian filtering is 80.58% and success the system labelling on image processing using the histogram equalization is 81.88%

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