

# Optical Tomography: A New Filter Technique for Post Processing Image

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**Abstract**—Filtering process is important to make sure the resultant image is free from noise. This paper introduces a new filtering technique for optical tomography to reduce the noise or called a smearing effect. With this technique, it also can increase the Peak Signal to Noise Ratio (PSNR). This smearing effect is resultant from Linear Back Projection (LBP) algorithm that is applied in image reconstruction process. To solve the smearing effect, a new technique that use a threshold value is introduced which is called Averaging Grouping Colour (AGC) bar. The result shows that the AGC bar type 5 is the most suitable technique to be implemented in this system.

**Index Terms**—Optical tomography, Averaging Grouping Color, PSNR, LBP

## I. INTRODUCTION

In tomography, image is the interpretation of the flow inside the pipe. It brings along useful information to be used by the researcher or the employees to enhance the process control system in the industry that used a pipeline for material transportation. With a good image, it solve the problem that exist in the system such as a blockage or wrong flow pattern that affect the production outcome.

Filtering is a technique to process the image and there are many type of image filtering that is applied in the image world. One of the popular technique is used a threshold way. In general, threshold method can be classified into bi-level threshold [1], [2] and multilevel threshold [3] - [7] techniques.

Donoho has proposes two well-known threshold-based denoising method in [8] and [9], which are performed

in wavelet transform. The Hard-Thresholding (HT) [8] is a bi-level threshold-based denoising method. It utilizes a global threshold value to threshold the wavelet coefficients.

By using the multilevel threshold, information can be extracted from a more detailed level. Another threshold-based denoising method proposed by Donoho in [9], the Soft- Thresholding (ST), utilizes multilevel threshold. The ST has better performance compared to the HT. These two methods have been reported to be a robust estimator in the wavelet domain. However, its computational complexity is increased because it is employed in the transform domain.

A more recent multilevel threshold-based denoising method is proposed in [10], called the Pixel Value Based Division (PVBD). In the PVBD, the threshold is divided equally for different levels by fixed parameters. However fixed parameters are not adapted to each different image conditions.

Fazalul Rahiman used a threshold value [11] also, but they set the number using a fix concept where it is got from  $\frac{3}{4}$  of the highest number of pixel that exist in the image. The disadvantage of this method is, if the highest number is a noise, the threshold value that they applied will give a wrong value. We implement an average technique using averaging grouping color bar where in this method, if the highest value is a noise, it will not affect the result. This is because we applied an average concept that give the average value from the overall pixel amount. The technique will be explained later in section 2.

In this paper, we propose a multilevel threshold technique, Averaging Grouping Color (AGC), which could provide a more accurate threshold to be used in tomography. To our knowledge, filtering methods performed in tomography that exploit the color bar has not yet been proposed.

## II. AVERAGING GROUPING COLOR (AGC)

FBP algorithm is currently being used in almost all applications of straight ray tomography (Kak and Slaney, 1998). In this study, the filtering process is done by setting a threshold value where there are eight techniques to select the threshold value. This technique is called Average Grouping Color (AGC) bar. The objective is to select the threshold value after averaging has taken place in the group selected. A threshold value is selected to separate the object from the background. This procedure is appropriate for two phase flow imaging (Plaskowski *et al.*, 1995).

The colour bar is divided to eight sections. 0-63, 64-127, 128-191, 192-255, 256-319, 320-383, 384-447 and 448-511. The darker area usually represents the location of the solid, however, the image from real time measurement cannot be predicted as it depend on the system measurement whether it can detect the solid with the darker, moderate or light colour. Therefore, the distribution of each of the pixels will be averaged and the average value will be set as its threshold value. To get the average threshold value there are eight techniques that will be used in this research which is FBP using AGC bar: Type 1, Type 2, Type 3, Type 4, Type 5, Type 6, Type 7 and Type 8.

Figure 1 shows the flow chart that simplify this algorithm. All of the techniques can be expressed mathematically using equation (1). Its explanation is shown in equation (2) or (3) FBP using AGC Bar Type 1 will choose the highest group that exists in the tomogram. If the darkest group is the eighth group that represents the value from 448 to 511, therefore the distribution of this group will be averaged and the average value will be selected as the threshold value. However, if the highest group that exists is seventh group, all the values in this range will be averaged.

FBP using AGC Bar Type 2 selects two highest groups that exist in the tomogram. Every group will be averaged and the sum of two average values will be divided by two to get the threshold value. For FBP using AGC Bar Type 3, the threshold value is selected by choosing the three highest groups in the tomogram. Every group will be averaged and all the averaged values from every group will be summed up and divided by three.

Calculation for other types of FBP using AGC Bar such as Type 4, 5, 6, 7 and 8 using the same concept as explained above.

$$\text{Threshold}_{\text{Type}n} = \frac{\text{Threshold}_{1^{\text{st}}\text{Group}} + \dots + \text{Threshold}_{n^{\text{th}}\text{Group}}}{n} \quad (1)$$

$$\text{Threshold}_{n^{\text{th}}\text{ group}} = \sum_{x=0}^{63} \sum_{y=0}^{63} \frac{B(x, y)}{m} \quad \begin{cases} f(x, y) = f(x, y) & ; t \geq \text{Lower limit} \\ f(x, y) = 0 & ; t < \text{Lower limit} \end{cases} \quad (2)$$

$$\text{Threshold}_{n^{\text{th}}\text{ group}} = \sum_{x=0}^{63} \sum_{y=0}^{63} \frac{B(x, y)}{m} \quad \begin{cases} f(x, y) = f(x, y) & ; \text{Lower limit} \leq t \leq \text{Higher limit} \\ f(x, y) = 0 & ; \text{Lower limit} > t > \text{Higher limit} \end{cases} \quad (3)$$

where,

$f(x, y)$  = Voltage distribution obtained using LBP algorithm

$B(x, y)$  = Summation of all voltage distribution in the range

$t$  = Voltage distribution value in each pixel

$m$  = The number of voltage distribution that exist in the range

$n$  = The number of grouping that is involved in the operation

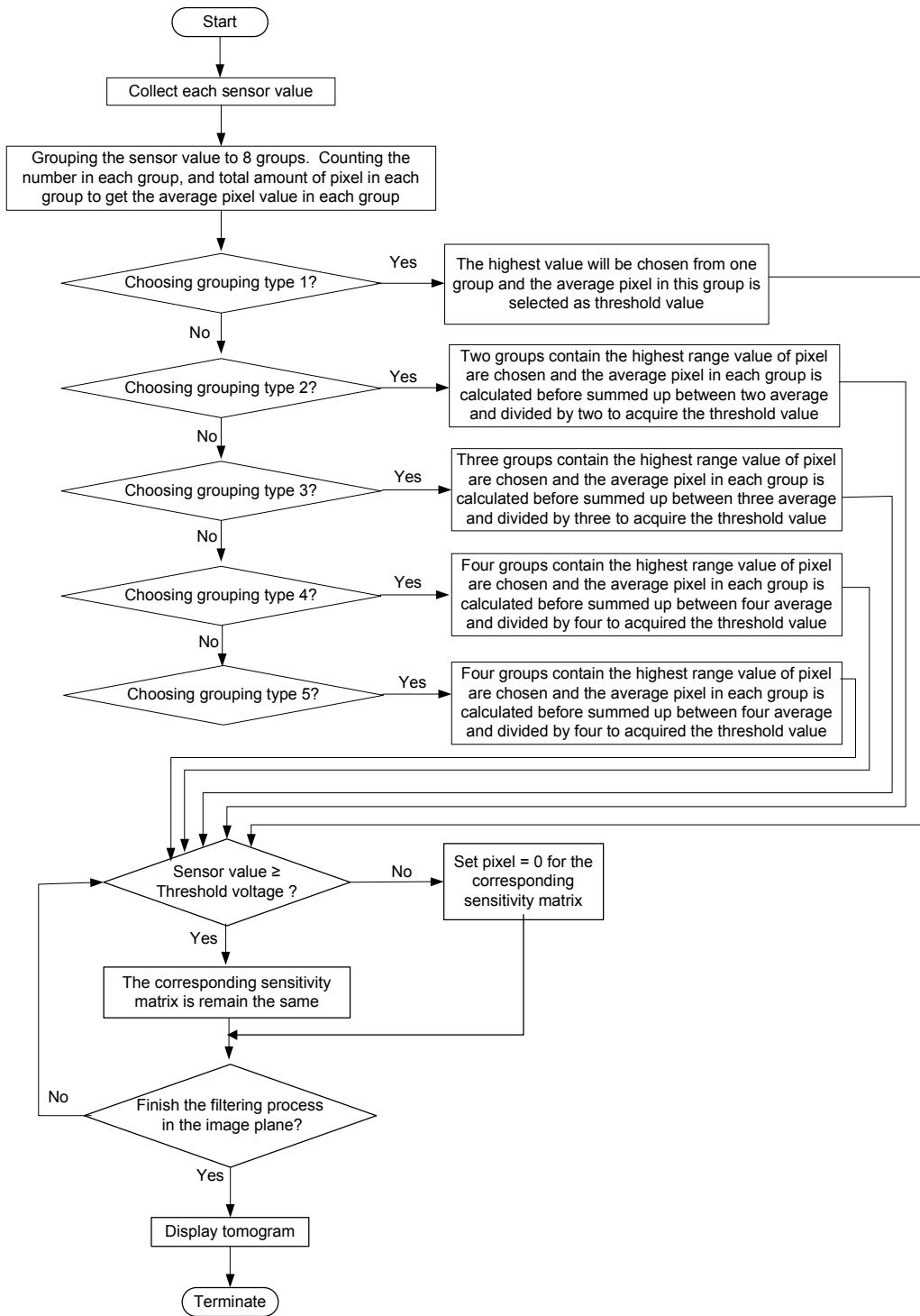


Figure 1: Flow chart for FBP using AGC Bar until Type 5

### III. RESULT AND DISCUSSION

In this research, there are three models that had been tested which is Model A (2 smaller objects), Model B (2 bigger objects) and Model C (3 objects). Each of the model has been tested using MPFBLR projection to see the resultant image. MPFBLR is a combination projection between parallel and fan beam projection where the fan beam has been modified therefore it can be realized in real time. Firstly the image is captured real time using Linear Back projection (LBP). LBP produce a smearing effect therefore other technique is used to improve the image that is Filter Linear Back Projection (FLBP) using Averaging Grouping Colour (AGC) bar.

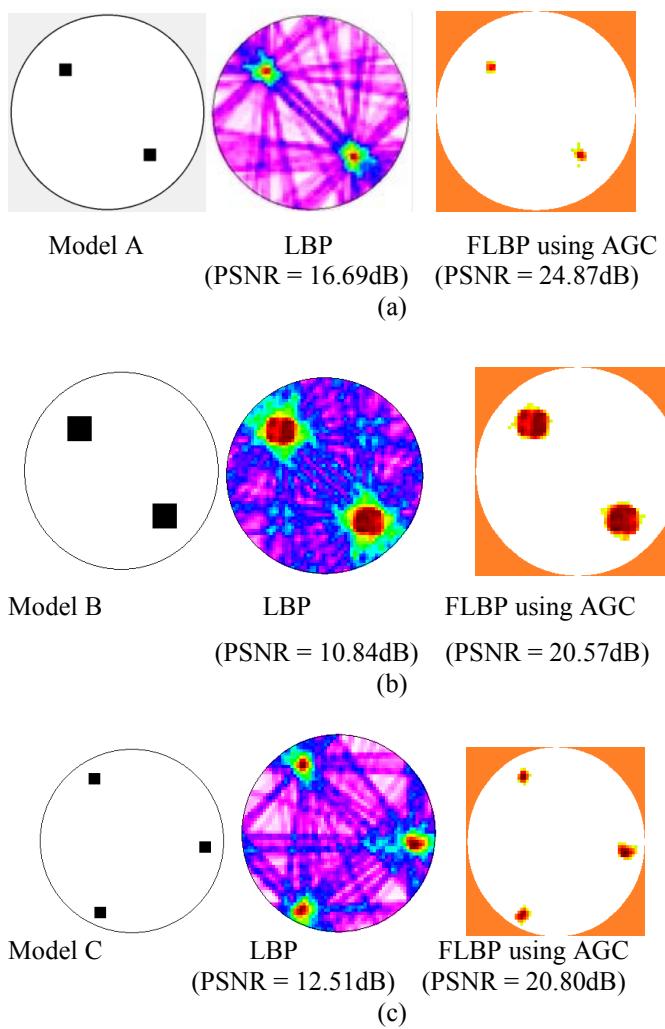


Figure 2: Implementing FLBP using AGC type 5 in the filtering technique (a) Model A (b) Model B (c) Model C

From the result as shown in Figure 2, the entire flow model shows that FLBP using AGC type 5 shows the improvement compared to LBP algorithm in terms of its PSNR value. Type 5 is selected after making some

experiment using the number less than 5 and also more than 5. If it is less than 5, the smearing effect is still occur in the image. If the number is more than 5, the object image is disappear with the background noise. Therefore type 5 is selected as it can give the best result.

### IV. CONCLUSION

The new filtering technique has been introduced to give the improvement result towards the image. The new technique considered an average value between the colour existed in the image. The resultant image shows that this technique can improve the image that get from LBP technique. Threshold type 5 is selected as it shows the best result.

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