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Bullets Defect Detection Based On Digital Image Processing Using Line Detection And Fuzzy Sets

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Abstract

This research discussed about the detection of bullet defect that aims to help the process of quality control in bullets production. This process is examined manually or without tools allowed. It will be very difficult since the capability of human eyes have limitation of sight and vision. In solving the problem, the author uses line detection and fuzzy set as the method based on digital image processing. Line detection here to detect lines of the image and fuzzy set to analyzing its similarities. The object were analyze its similarities to the image of reference. The part of bullet that examined is only on the shell chasing which made by brass. Shell chasing laid in a place with best level of light to produce a good image. The image taken directly using clear and high resolution camera. There are some bullets caliber with the range of 5,56 until 12,7 mm. However, the examination here only on the size of 5,56 mm. The process of detection had been done by using implementation program with accuracy until 70,58% using 4^{th} bullet reference. It successfully applied to 32 real image data of bullet, 17 images of defect bullets and 15 image of bullets with no defect.

Key words: bullets defect, defect detection, line detection, fuzzy set

1. INTRODUCTION

Bullet is a kind of weapons and ammunitions which have caliber ranging from 5,56 mm until 12,7 mm. This research will be discussed bullets with caliber 5,56 mm. Bullets production devided into 3 steps, the last step is quality control. That process is examined manually or without any tools. Quality control process will be very difficult since the capability of human eye have limitation of sight and vision for noticing

something in long term. If this process applied continuously, the accuracy of bullets production will reduced.

The previous research of bullet defect detection is using line detection, with accuracy until 89,89% for defect type I (visible defect) and 55,56% for defect type II (invisible defect) [1]. Template matching detect bullet defect with accuracy until 40% [2]. Another method which has been used to solve a problem of digital image processing is fuzzy rough set which detecting more than 150 cell of histopatology cell [3].

Based on the above description the author try to find another solution for quality control process using technology of digital image processing. The defect in bullet chasing will be detecting using line detection and fuzzy set as a similarity analysis method based on digital image processing.

2. MATERIALS AND METHODS

2.1 DATA

Using the same data with the previous research, bullets as an object which taken directly [4]. Taken data for digital image processing is called image aqcuisition. Acquisition data techniques : image acquisition using by single sensor, strips, and arrays [5].

Focus of the digital image is on the defect part of the bullet. Bullet with no defect are also used for selection reference only. It performed the defect part as the focus of the observation. We only use bullet with caliber 5,56 mm and it all takes by high resolution camera.

2.2 LINE DETECTION

There are some techniques can be used to detecting some pattern of a digital image, one of them is line detection. This technique is used to detecting pattern of line on the certain digital image. This research is used line detection method to detecting pattern of line on bullets chasing.

Detecting process is paired the masks into the reference image and defect image. There are 4 masks will be paired inside, horizontal $0°$, $+45°$, vertical $90°$, and $-45°$ [5].

-1	-1	-1
2	2	2
-1	-1	-1

Horizontal $0°$

-1	-1	2
-1	2	-1
2	-1	-1

$+45°$

-1	2	-1
-1	2	-1
-1	2	-1

Vertikal $90°$

2	-1	-1
-1	2	-1
-1	-1	2

$-45°$

Mask installation can be done by using this calculation :

$$R = w_1 z_1 + w_2 z_2 + \cdots + w_9 z_9$$

$$= \sum_{i=1}^{9} w_i z_i \quad (1)$$

where z_i is the gray level of the pixel associated with mask coefficient, w_i is the mask coefficient. The response of the mask is defined with respect to its center location. It means the calculation is done from left to the right.

2.3 FUZZY SET

Fuzzy set introduced in 1964 by Lotfi Zadeh as a mathematical way to represent the uncertain linguistic, provides a tool for modeling human-centered systems [6]. Fuzzy set very useful to solve many problems in various fields which usually contains the degree of uncertainty.

Membership function is a part of fuzzy set, that is a curve which shows the maping of points of input data into membership value (known as membership degree) ranging from 0 until 1. First is find the differences of each pixel score of image reference and object, then compare with the standard deviation to get the diversity of each pixel certain digital image [7].

$$f(x) = e^{\frac{-(x-x_0)^2}{2\sigma^2}} \quad (2)$$

Find the score of membership function using this formulas :

$$\mu_{\text{low\_reference}}(x) = \begin{cases} 1 - f(x) : x < x_0 \\ 0 : x \geq x_0 \end{cases} \quad (3)$$

$$\mu_{\text{high\_reference}}(x) = \begin{cases} 0 : x \leq x_0 \\ 1 - f(x) : x > x_0 \end{cases} \quad (4)$$

Calculate the fuzzy relation of the above membership function using this formula :

$$\rho(x, y) = \max\{0, 1 - |x - y|\} \quad (5)$$

Where x is variable for $\mu_{\text{low\_reference}}$ and variable y is for $\mu_{\text{high\_reference}}$. Based on the membership function, it can be linked to the value pixel of the reference and the object. The dominant score of fuzzy relation is a decision of bullet defect detection.

2.4 METHODOLOGY

First step of digital image processing is preprocessing, to make the digital image as a simpler format. Image preprocessing is one of digital image processing technique to processing image before detected any of pattern on the object. This technique is not only load one step that have to do, but also include the other steps. There are crop, convert, and resize.

Crop is the first step here to eliminating background image. Image cropping used for seperating image background and image object. The object in this case is bullet chasing with 5,56 mm caliber. Then convert is change the image format, from RGB (Red Gren Blue) into grayscale. This step done to get the simpler value of image pixels, then easier to calculate. Resize, is a proses which change the score of image pixels. This step done to make the same score of image pixels in each digital image. The pixels are resizing into 250x50.

3. METHOD SPECIFICATION AND DISCUSSION

The clue of detection method presented in this paper, is our proposition to use the above given formula in purpose to investigate the similarities between reference and object. If it too small, called the defect bullet. The proposed bullets defect detection process :

Step 1 : Input bullets image – input image should taken directly using camera high resolution and clear.

Step 2 : Apply image preprocesing – in this process including cropping, converting, and resizing bullets image.

Step 3 : Apply line detection method – detecting lines inside the bullet image using formula (1), fragment to get high accuracion by deviding bullet image into 5.

Step 4 : Apply fuzzy set method – get the similarities between reference image and object, calculate the diversity of digital image pixel using formula (2), membership function using formula (3) and (4), choose the dominant score of fuzzy relation using formula (5).

Step 5 : Output – get the decision, the bullet is defect or not.

Here is the simpler block diagram :

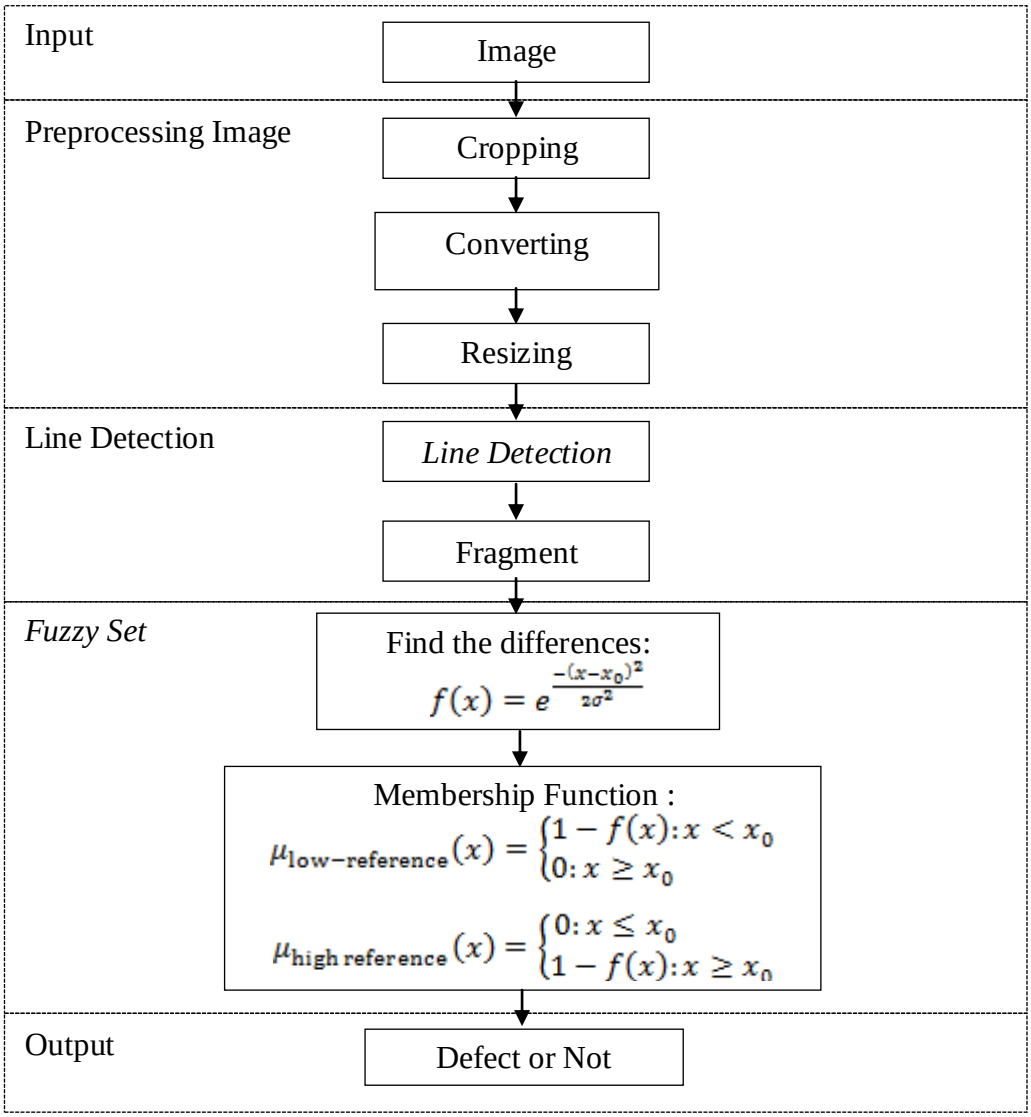

Figure 1.1 Block Diagram

4. EXPERIMENTS AND RESULT

Bullets defect detection here is used line detection based on digital image preprocessing, to calculate the similarities and take the decision using fuzzy set method. Some examples are Figure 1.2 as a reference and Figure 1.3 as an object :

Figure 1.2 Image of Reference

Figure 1.3 Image of Object

Image preprocessing done after input the bullet image as a reference and as an object using implementation program. See figure 1.4 for the output :

Figure 1.4 Implementation Program of Image Preprocessing

Line detection technique done after got the result of image preprocessing. This technique detecting all kinds of line. The result of line detection show at Figure 1.5 :

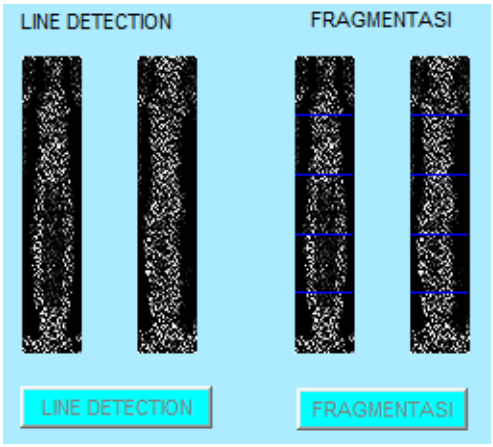

Figure 1.5 Output of Line Detection Technique

Fuzzy set method calculate the defect of bullet, with accuracy until 70,58%. The prosess can be done by following the above given process. The result show at Table 1 :

Table 1. Accuracy of bullets deffect detection

Bullet References	Accuracy	
	Good	Defect
Bullet 1	100%	52,94%
Bullet 2	100%	0%
Bullet 3	100%	52,94%
Bullet 4	100%	70,58%
Bullet 5	100%	0%
Bullet 6	100%	11,76%

Based on Table 1, the best accuracy is 70,58 % of bullet defect detection. Detecting the defect using matlab, with 26 bullets as objects and 6 references. The object devided into 2 types: bullets with defect and no defect. The reference is only bullets with no defect.

5. CONCLUSION

In presented experiments, can be observed that line detection and fuzzy set can be successfully applied. A method for detecting bullet defect, based on digital image processing has been proposed with 70,58 % of accuracy using 4th bullets reference.

6. REFERENCES

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