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## MatLab Application Development of Accurate Detection and Instant Scoring System for Shooting Drills

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# MatLab Application Development of Accurate Detection and Instant Scoring System for Shooting Drills

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**Abstract.** The objective of this research was to make it easy to calculate the score on shooting drills, to help replace operators, to help evaluate the athlete's performance in shooting practice, and to avoid cheating in shooting calculations. At this time in doing the calculations score on practice shooting still use score calculation manually. In addition to requiring time and effort is wasted so in the shoot practice and needed a long time when the calculation of shot scores. Image processing method used is the edge detection method, include image restoration, image enhancement, data compaction, image analysis, and image reconstruction. By using some method on image processing to detect and assess on the target into helping operators in the field. The result of this study is that the image segmentation using multiple functions in MatLab can avoid the shadow effects on image. On these systems, the image itself is limited in the form of a circular firing target thickness 0.1 mm circles line up to 0.22 mm and the diameter of 154 mm. His own bullet-sized diameter 4.5 mm. Percentage error rates on application own 4 % and the percentage accuracy detection 98.01% for 100 data. It can be concluded that this tool is capable of reading the image of a bullet trace in the form of a circle, and to reduce the impact of shadows on the image of the bullet.

## 1. Introduction

The importance of accuracy in calculating the score in shooting practice is a benchmark in knowing the results of a shot. The accuracy of shooting itself is the value of the distribution of shots at the target obtained in a shooting, both in shooting practice and in the shooting competition. Where at this time, in knowing the value of accuracy of shots still visually, that is by looking directly at the target and counting manually. The process of assessment and calculation like that requires a very long time and wasted energy so that the implementation of shooting exercises is not optimal causing it takes a long time when calculating [1]. Compared to the manual method performed by the officer, by using the score calculation application, the latter calculation will give a more efficient assessment result. By using this device, the process of shooting practice by elements of the Indonesian National Army (TNI), police and shooting athletes will be very helpful to evaluate and improve their performance, while applying technology applications to existing shooting exercises [1]. The process used uses image processing techniques, then the process of calculating the accuracy of the shot on the target is carried out. For the process of taking pictures carried out by the shot the result of the shot which will later be used as a sample to calculate the results of the shot [2,3,4].

In the system of detection and calculation of this score using image processing techniques or image processing for the process of shooting is carried out by loading the shots shot. Designing an image processing system in the score calculation using the MatLab programming language [1,2,4]. MatLab as one of the programming tools to help the field of education and research has provided a variety of 'toolboxes' that are tailored to each scientific field, one of which is the 'Image Processing Toolbox'. By



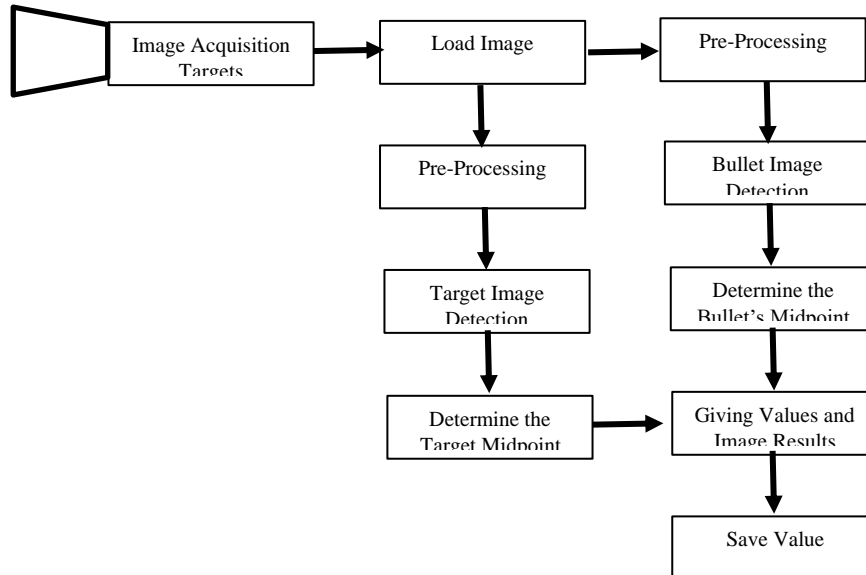
utilizing the 'toolbox', users can easily carry out their research. [5] Image segmentation means dividing an image into homogeneous regions based on certain similarity criteria between the gray level of a pixel with the gray level of neighboring pixels, then the results of this segmentation process will be used for further high-level processes that can be done on an image, for example the image classification process and object identification process. [2] The process that aims to detect the target circle in the image obtained from the process of loading the target image that has been taken.

- a. Morphological basis of dilation and erosion
- b. Image subtraction
- c. Background segmentation functions
- d. Find circle (looking for the circle on the bullet and the distance between the target and the bullet trace) [9, 10]

The objective of this research was to make it easy to calculate the score on shooting drills, to help replace operators, to help evaluate the athlete's performance in shooting practice, and to avoid cheating in shooting calculations.) Image processing method used is the edge detection method, include image restoration, image enhancement, data compaction, image analysis, and image reconstruction.

**2. Methods**

At this stage, in Figure 1, there are several block diagrams that will explain the design of software.



**Figure 1.** System design the main block diagram

**1. Taking Target Images and Bullet Traces.**

Taking target image and bullet footprint are divided into two stages of detection between the target image and the bullet footprint then for the process of taking pictures carried out load shots that have been captured by the camera will then be used as samples to be used to calculate the shots. Samples taken 120 sheets of target paper shot that had a bullet trail.

2. Pre-processing.

Pre-processing in the block diagram here aims to improve image quality, target image extraction and extraction of bullet trace images used later in the process of background Pre-processing segmentation here includes grayscale, normalization, and image extraction.

3. Detect the target.

At this stage the application is calibrated to recognize the target image of the gun, determine the position of the target midpoint and the radius of the point from the number seven shot target using image processing functions. Then detect all target circles with several filter functions. So that it can be used can be used to find the midpoint and radius of the target circle.

4. Detect bullet tracks.

This stage is to find the midpoint of the bullet trail and know the radius of the length and width of the bullet hole on the target.

5. Grading or calculation of the score.

This stage is where to find out the final score of the stage of giving the result of the shot. Giving values and scores themselves follow the regulations during exercise training through the air rifle [7].

Example of a target image of 17 x 17 mm can be seen at Figure 2.



**Figure 2.** Example of a target image of 17 x 17 mm

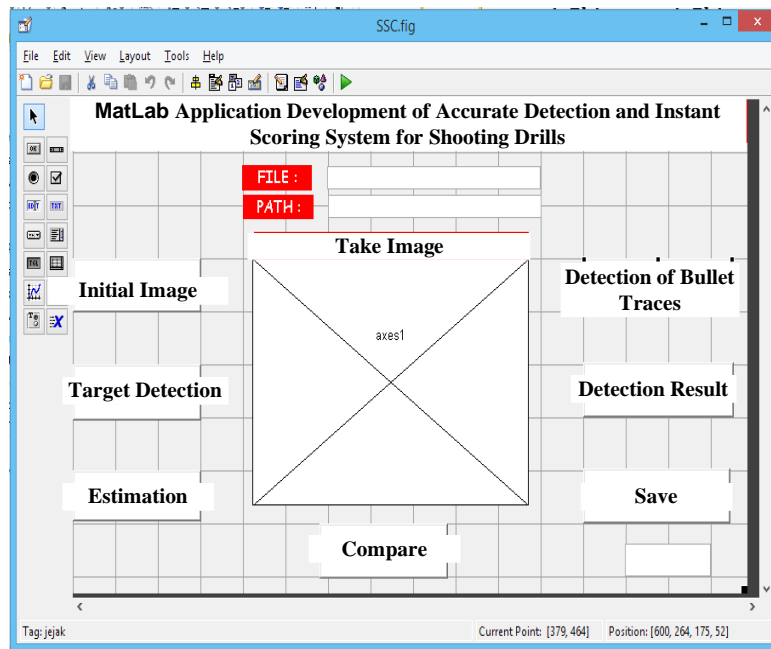
It is designing to detect the target image of a shot in the form of a circle with a diameter in ring 10 is 154 mm. And the inner circle of ring six which is black is 74 mm. The target paper itself is 17x17mm. Type of 4.5 mm air rifle bullet can be seen at Figure 3.



**Figure 3.** Type of 4.5 mm air rifle bullet

Bullets or pellets are projectiles that are driven by a shotgun or wind gun which usually do not contain explosives, but are capable of making damage to the intended target. In Figure 3, the bullet itself uses a 4.5 mm caliber (0.177 in) air rifle bullet used in the 10m air rifle which has a front that is almost flat so that it can leave a good trail of holes on the target paper (not torn).

Interface design model in MatLab Simulation can be seen in Figure 4.

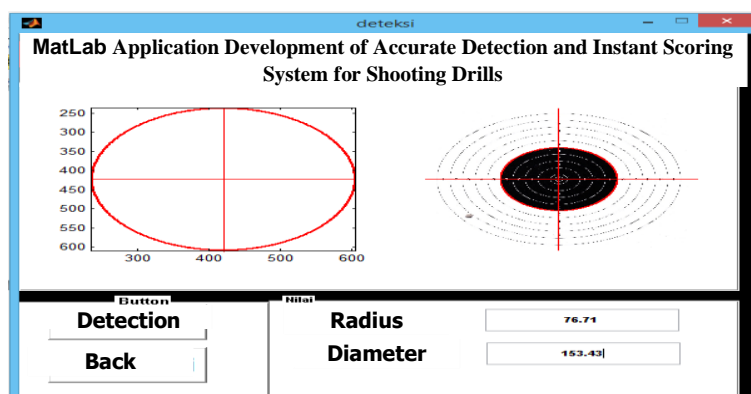


**Figure 4.** Interface design model in MatLab Simulation

In Figure 4, designing interfaces or interfaces is a display of an application program in the form of a communication medium that is used as a means of dialogue between programs and users. The following is the design of the interface on the system that will be created [3, 4, 8].

### 3. Results and Discussion

Testing the detection results of firing targets can be seen in Figure 5.



**Figure 5.** The results of the detection of the MatLab application on the target

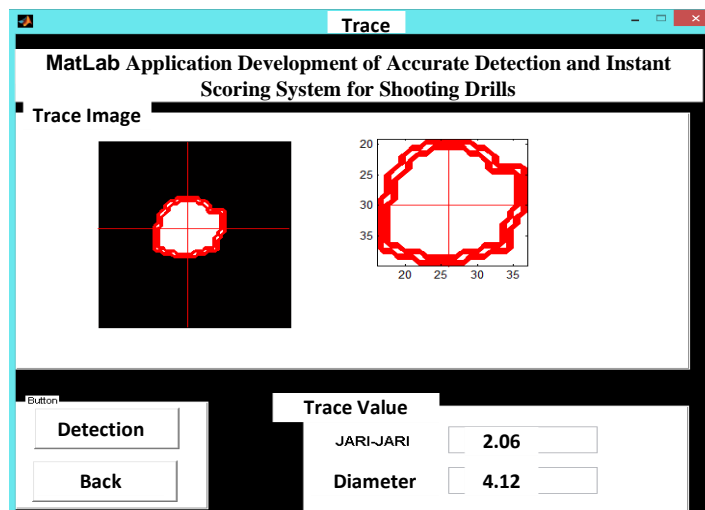
In Figure 5, the data taken in the form of a shooting target image 10 meters of air rifle with a bullet trail shot from 10 shooters with 10 shots. The purpose of the end of this test is to assess the accuracy of the shooting application in recognizing the target image of the shot and the bullet trail, so that it can produce a more accurate shooting score compared to manual or visual methods.

At this stage, the application is tested to recognize the target shooting image so that it can determine the middle position of the target and determine the radius of the circle from the seventh circle using image processing functions. At figure 5, it is the result of target detection. Then analyze the accuracy level. Using the diameter and finger as a parameter. Where D1 is diameter of the original image of the circle of the entire ring, and D2 is diameter of the circle image as a result of detection.

What level of accuracy is  $\frac{D_2}{D_1} \times 100\%$  ?

So  $\frac{154,3}{155} \times 100\% = 98,98\%$  is the level of accuracy of circle detection in the application.

Testing the detection results of the target image bullet trace can be seen in Figure 6.



**Figure 6.** The results of the detection of the MatLab application on the bullet trace

In Figure 6, the diameter of the air rifle bullet is 4.5 mm. Because the very small diameter of the meal is needed to detect the circle on the trail of the target by using segmentation functions, using the pixel size obtained from detection of the target shoot. Under this stage the detection of bullet traces.

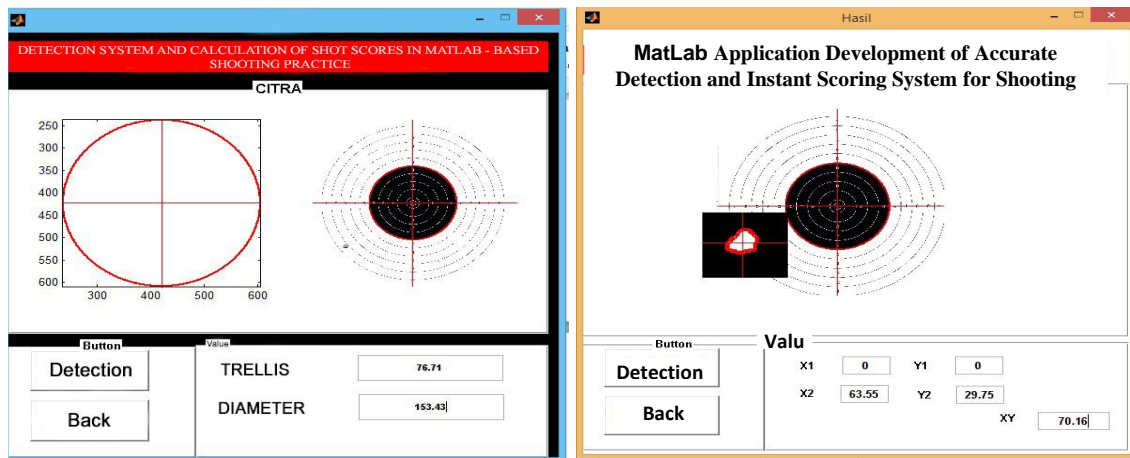
Then analyze the accuracy level. Using the diameter and finger as a parameter. Where D1 is diameter of the original image of the target track circle, and D2 is diameter of the circle image detected by the target trace.

What level of accuracy  $\frac{D_2}{D_1} \times 100\%$  ?

So  $\frac{4,12}{4,5} \times 100\% = 91,55\%$  is the level of accuracy of circle detection in the application.

Testing for the evaluation of shots can be seen in Figure 7.

$$Distance\ AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$



**Figure 7.** Determination of trace distance and target values

In Figure 7, this test is carried out after obtaining the results of detection of target images and bullet traces with the process of image processing. What is done by pre-processing so that the middle value on the target is given a name (A) and the bullet trace is named (B). then after the detection is complete proceed by looking for the distance between the two midpoints (AB) with a mathematical formula with Pythagoras:

Manual measurements get the following values:

$$X1 = 0; X2 = 65;$$

$$Y1 = 0; Y2 = 30;$$

$$\begin{aligned} XY &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} = \sqrt{(-65 - 0)^2 + (-30 - 0)^2} = \sqrt{(-65)^2 + (-30)^2} \\ &= \sqrt{1225 + 900} = \sqrt{2152} = 71,58 \end{aligned}$$

Using manually can get distance is 71,58 and using application gets 70,16. So to compare the accuracy value it is obtained as follows:  $\frac{70,16}{71,58} \times 100\% = 98,01\%$ .

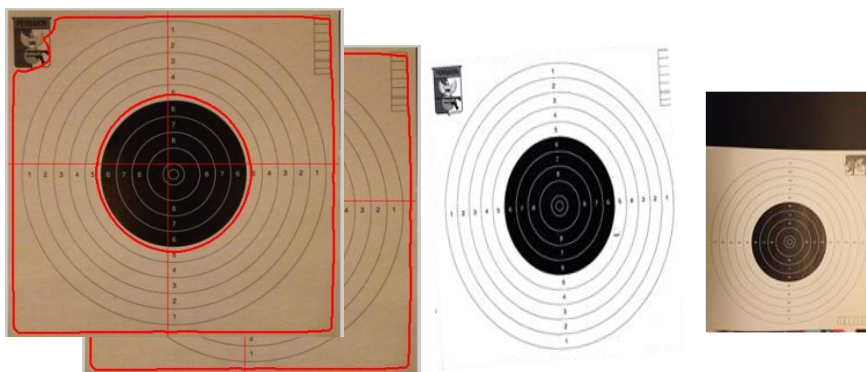
here are almost the same data results on the 7th and 6th shooter. If the calculation uses manual or visually, the 7th and 6th shooter must do a rematch because of the total score, the average value and the biggest value is the same shot.

Table 1 shows the result of the 6<sup>th</sup> and 7<sup>th</sup> shooter shots. If the calculation uses manual or visually, the 7th and 6th shooter must do a rematch because of the total score, the average value and the biggest value is the same shot. However, each shot is of different value. So if you use this application you can see the final score and the average shot is different. There are several factors for reading and taking the wrong image on the application.

**Table 1.** The results of the 7th and 6th shooter shots

	6 <sup>th</sup> shooter			7 <sup>th</sup> shooter			
T.6.1	7.00	7.10	0.10	T.7.1	7.00	7.20	0.20
T.6.2	7.00	7.10	0.10	T.7.2	5.00	5.24	0.24
T.6.3	8.00	8.20	0.20	T.7.3	1.00	1.02	0.02
T.6.4	1.00	1.25	0.25	T.7.4	6.00	6.90	0.90
T.6.5	7.00	7.10	0.10	T.7.5	6.00	6.10	0.10
T.6.6	3.00	3.12	0.12	T.7.6	6.00	6.20	0.20
T.6.7	2.00	2.30	0.30	T.7.7	1.00	1.10	0.10
T.6.8	3.00	3.10	0.10	T.7.8	7.00	7.05	0.05
T.6.9	7.00	7.25	0.25	T.7.9	5.00	5.20	0.20
T.6.10	7.00	7.09	0.09	T.7.10	8.00	8.40	0.40
Final Score	52.00	53.61	1.61		52.00	54.41	2.41
Highest Score	8.00	8.20	0.20		8.00	8.40	0.40
Lowest Score	1.00	1.25	0.25		1.00	1.02	0.02
Average	5.20	5.36	0.16		5.20	5.44	0.24

Figure 8 shows a shooting error and retrieval position error.



**Figure 8** (a). Shooting error (b). Retrieval position error

In Figure 8 (a) is an example of shooting errors that are under-lighting when shooting a target image. Hen taking the target image the position is very influential, because when the light enters the image it causes excessive dirt and shape so that the bullet trace is not visible [3,4,5]. In Figure 8(b) the taking position also affects, causing difficulty in determining the midpoint of the image, if the position of the sloping image calculates and detects errors that cause too much shape. So that the determination when taking is very influential.



#### 4. Conclusions

The system can read the image of a bullet trace in the form of a circle. So as to facilitate calculations, if you are in the same direction. Using image processing techniques perform calculations faster than manual. And the use of several background segmentation and grab cut threshold functions reduces the impact of shadows on the image of the bullet footprint giving good results. When compared with a certain threshold. The position of image taking and lighting when taking an image is very influential. When compared to visual averages the results of the calculation of the score with the application are better. The level of accuracy in detection uses the image processing method in MatLab 91.55% for detection of circle of bullet traces and 98.98% for detection of target circles. The error rate reaches 4% for 100 detected data applications and the accuracy rate of the target midpoint to the bullet midpoint is 98.01%.

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