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An Image Processing based Model for Calculating Score in Electronic Target System using Watershed Algorithm

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Abstract: ***Shooting game has been recognized as one of the most trending events. Now a days the shooting ranges as well as the shooting game events makes use of electronic target systems to analyse their scores. The same has shown a great demand in the market among the shooters for practicing purpose. The paper suggests a model for finding the target score. The scanner will be attached with the target frame where we have the target sheet, after the detection of gunshot the scanned image will be used for further processing to calculate the score. Watershed algorithm has been used in order to find the overlapped or closely touching shots in the image.***

Keywords: *Image* ***Segmentation, Watershed algorithm, Morphological operations, target score***

I. INTRODUCTION

Earlier days the shooting has been restricted for army or forces but now among the various games , shooting games has also been identified as one of the popular event that has been conducted as competitions. Hence, the electronic target system has found their market among various venues where the event is conducted and also among the shooters who use it as for practicing, the system gives very accurate results as well.

There are many techniques that has been used in order to find the target score. This system proposes a electronic target system which is based on scanner. The recording medium , paper is stationary and it is fixed in a metal frame. Once the gun shots are detected the scanner moves and takes the scanned image of the sheet.

This approach mainly takes care of factors like irregular paper movements and inaccuracies due to vibrational movements. The scanned image of the target sheet is then led for further processing to find the target score. Various algorithms can be used to find the bullet hole in the sheet. Here watershed algorithm is used for image segmentation , this algorithm is very effective when we have multiple shots and the when there are overlapping objects.

II. RELATED WORK

Automatic shooting scoring system based on image processing for single shot and was used in live shooting session[1], in which single camera is used and it is installed on shooting scoring frame. The image processing techniques that were used here was target ring detection, perspective transformation, morphological operations, image subtraction and contour detection method. The four main process that were carried out are image transformation, ring detection, bullet hole detection and scoring mechanism[1].

Computer vision based automatic scoring system makes use of morphological operations on the target image which results in the thickening of the bullet hit boundaries and uses hysteresis thresholding that segments the target area, Distance transform is used to segment the bulls eye of the target which helps in calculating the score inside the bulls eye[5].The major steps in this system were image database acquisistion, morphological erosion, image segmentation, labeling and scoring and evaluation of results.

Laser based system makes use of a laser pointer which is attached on the gun or weapon. In this system the shooter trainees shots the target with a laser attached weapon. Here the image of circular target and laser spot are captured by the camera that is attached with the gun.

Python and OpenCVsoftware is used to develop the system [4], In the system to detect circular target, BGR image frame is converted to grayscale image frame followed by the application of median blur filter to reduce noise. Image is then filtered and Canny edge detector is used for the detection of circular edges and in order to find the circle gradients , Hough circle transform technique is used.

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III.WATERSHED ALGORITHM

Watershed segmentation can be carried out on a grayscale image. It is a region based method that has its origin defined in mathematical morphology. Watershed algorithm is normally used to segment the image when two or more regions of interest are overlapping or very close to each other. Watershed segmentation is based on selecting atleast one marker interior to each object, considering background as the separate object. This method considers the object as a topographic map in which the height is represented by the intensity of each pixel. For example, brighter areas can be considered as higher in heights and darker areas can be considered as lower in heights. Fig. 1 shows an image without segmentation and Fig 2 shows the same image after segmentation with watershed line[3].

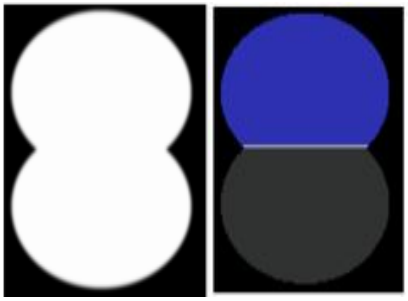

Fig.1. Actual image Fig. 2. Segmentation result with watershed lines

The paper suggests the use of watershed algorithm to segment the shots, considering the case where there are two or more adjacent shots or an overlapping shot found in the scanned image of target paper, in which the edges of each shot does not get separated and considerate as a single image, here the watershed algorithm can be used, which will clearly segment the nearby shots into distinct ones that can help to find the score in this target system

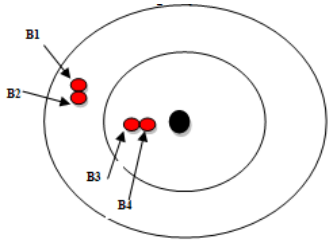

Fig 3. Sample image with adjacent bullet shots

In the above Fig 3 shows a sample state where we get adjacent bullet shots as denoted B1,B2 and another adjacent bullet shot B3, B4. It is impossible to extract it as a separate objects using simple thresholding and contour detection as the two bullet sjots are overlapping or nearby as there are chances to consider it as a single object.The watetshed algorithm can be used in such cases to avoid considering it as a single bullet shot. The watershed segmentation method can be used here to segment the adjacent shot as separate shots or objects and then to find the center of these shots and to find the distance from the center target denoted as T.

IV.PROPOSED SYSTEM

The proposed system shows the steps involved in finding the gunshot from the scanned image, applying watershed algorithm when adjacent shots are detected and calculation of score. Once the gunshot is detected, the scanner moves and takes the image of target sheet. The captured sheet can be then led for processing techniques to extract and obtain score. The Fig 4. Shows the proposed system. The steps involved are as as follows:-

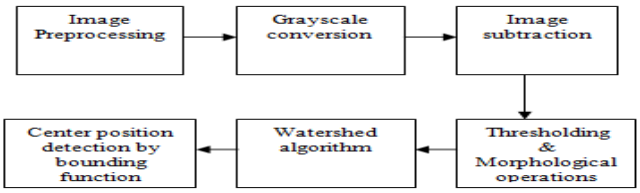

Fig 4. Proposed system

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1) Load the image
2) Transformation step is required inorder to process the distorted image
3) Convert the image to grayscale and perform smoothing to reduce high frequency noise Image blurring or smoothing is attained by performing a convolution operation between the image with a low-pass filter kernel. The major use of this technique is that the picture becomes more clearer and defined , It is useful for removing noise.
4) Next step is to apply thresholding to find the white region in the image, here we need to set a threshold value and if the pixel value is more than the set threshold value, it is assigned one value (may be white) or it is assigned to another value. Thresholding is the fundamental step to image segmentation
5) Perform morphological operations such as erosions and dilations. This step helps to clean up the thresholded image by removing small blobs or noise and then regrowing the remaining regions
6) Next image subtraction step is performed which compares the current image with previous. This process is used to obtain the position of each bullet hole in each captured frame by comparing the previous image with the current image that has been taken. Every frame of the scanned image for each shot will be saved as a comparison image to apply image subtraction process and compared with the new frame with a new bullet hole inside the target sheet.
7) Next step is to extract the bullet holes in the image, here instead of simple contour method , the proposed method is watershed algorithm to segment. Incase of adjacent shots appeared either above or below, the image segmentation can be done by watershed algorithm which is basically used for segmenting objects that are touching or overlapping. This gives more advantage than the traditional contouring methods. In watershed algorithm we need to define the markers based on the object that we need to segment , this markers can be either done manually or can apply image processing techniques to We can set the labels for background and the foreground object. Focusing on the foreground object that is the pellet hole, we can identify one using python function, given the contour of the object, all we need to do is draw the enclosing circle boundary surrounding the object.Similarly compute the bounding box of the object, apply a bitwise operation, and extract each individual holes as well.
8) Center position of the bullet hole can be obtained by using openCV's bounding box function which gives a rectangular boundary for the hole. By this process the center position will be obtained in terms of x,y coordinates which is used for calculating the scores
9) Calculation of score can be done by using simple Pythagoras theorem. let O(x1,y1) be the center of the target sheet or the target point itself and B1(x2,y2) be the center of one of the bullet shot and B2 be another bullet shot. Then the distance of first bullet shot B1 to O can be calculated as

$$\text{Dist}^2 = \sqrt{(x2 - x1)^2 + (y2 - y1)^2}$$

Here Dist is the distance between the target O(x1,y1) and the bullet shot fired by the trainee B1(x2,y2)

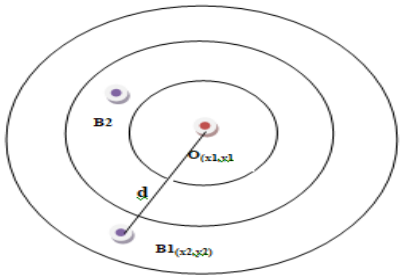

Fig 5. Target sheet with bullet shots

In the above Fig. 5. The target sheet is shown with concentric circles and target being the centre of the circle marked as O(x1,y1) and the first bullet shot is marked as B1(x2,y2) and another bullet shot as B2. The distance d between the target and the bullet shot is calculated using Pythagoras theorem.

V. CONCLUSIONS

This paper presents a system where the scaneed image of the target sheet is used for the processing after the bullet shots have been detected. Here we introduced the concept of involving watershed algorithm that helps in the cases where we have overlapped bullet shots or if there is any closely touching shots which makes the identification of the center of shots aswell as in score calculation. Watershed algorithm is used here in for segmentation and the scores can be calculated accordingly.
In future much more efficient techniques can be used and also OpenCV function can be utilized to develop the system.

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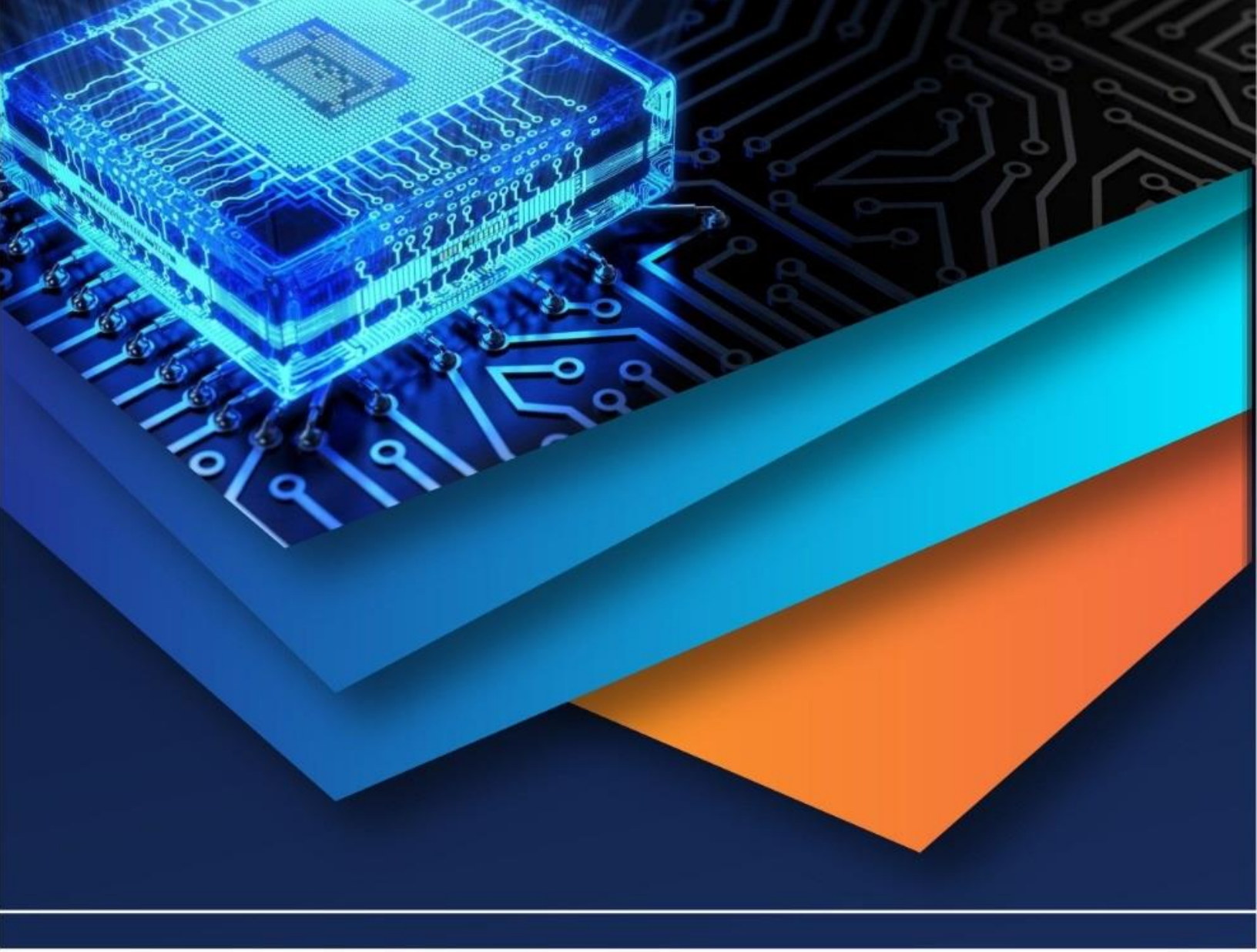

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