Software

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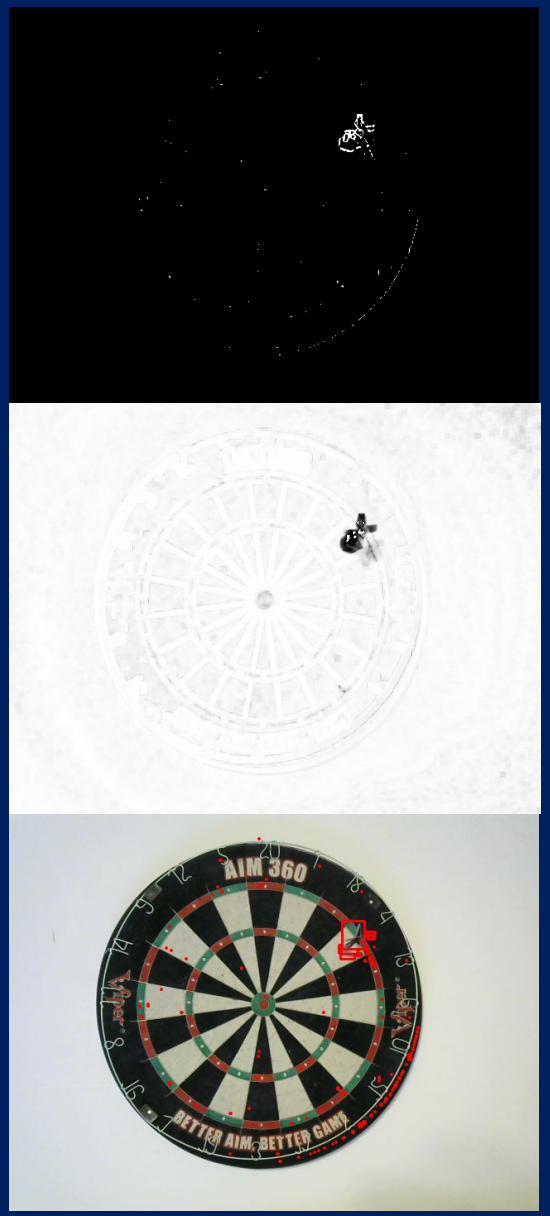
Finding the Difference: Before and After



How the Difference is Determined and Used

Difference (SSIM)

Adaptive Thresholding

Bounding Rectangles

Difference (SSIM)

Using the Structural SIMilarity index (SSIM), the representation shown can be retrieved.

It represents a quality measure of the image being compared to the original (from -1 to 1).

The value shown below the picture is used to determine if there is a dart on the board before any thresholding takes place.

Adaptive Thresholding

The software determines the threshold for a pixel based on a small region around it.

Why adaptive thresholding? Lighting changes across the image.

The contours are used to create bounding rectangles that assist in calculating the score.

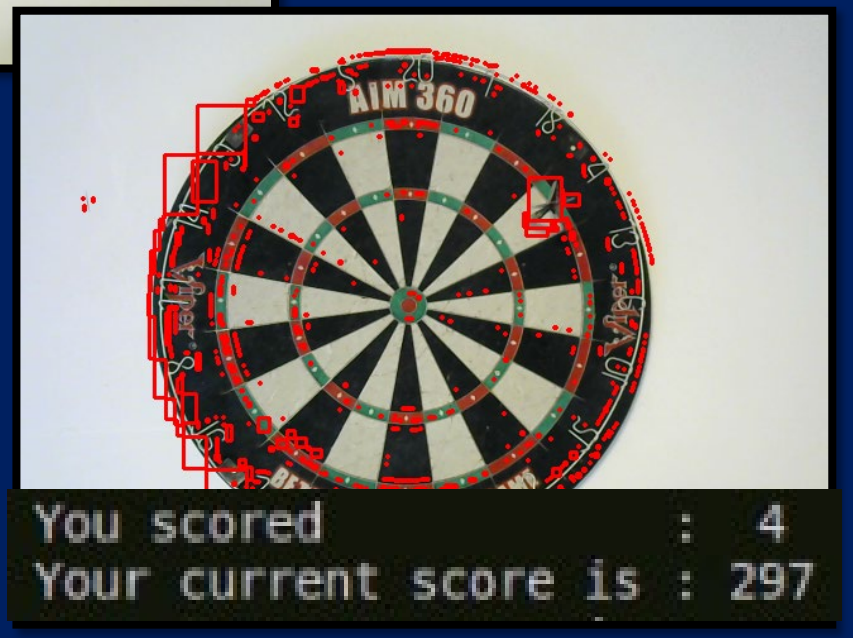
```
thresh = cv2.adaptiveThreshold(diff, 255, cv2.ADAPTIVE_THRESH_GAUSSIAN_C, cv2.THRESH_BINARY_INV,11,30)
cnts = cv2.findContours(thresh.copy(), cv2.RETR_EXTERNAL,  cv2.CHAIN_APPROX_SIMPLE)
cnts = imutils.grab_contours(cnts)
```

Bounding Rectangles

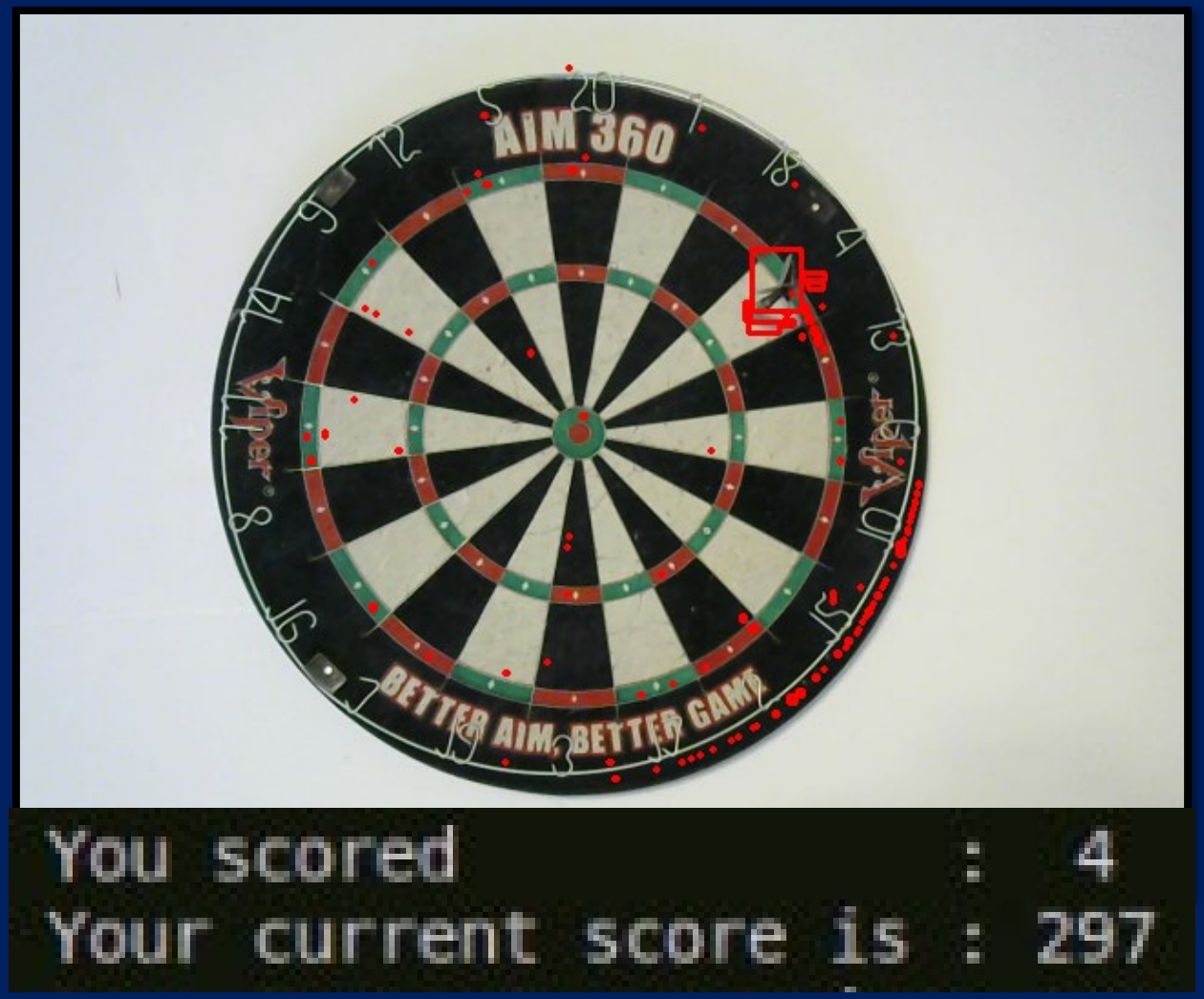
Using the contours found with OpenCV and the Thresholding image, the software creates bounding rectangles around the difference regions on the board.

This is used to identify the dart and calculate the score.

The additional boxes or “noise” seen in the second image can sometimes occur but will not impact the software's ability to score.



Scoring



The software performs calculations on the bounding rectangles to determine which one has the greatest area within the boundaries of the dart board.

The largest source of difference is the dart and so those coordinates are used by the scoring function to determine the point value associated with the darts position.

Final Score

```
    if (score > 0.98 or Points == 0):
        print("New hit not registered")
    else:
        print("You scored                : ",Points)
        finalScore = finalScore - Points
```

```
if (finalScore == 0):
    print("Winner!")
    break
if (finalScore < 0):
    print("Score exceeded...try again")
    finalScore = finalScore + Points
print ("Your current score is : {}".format(finalScore))
```

```
New hit not registered
Your current score is : 253
```

```
 You scored                : 4
 Your current score is : 297
```

The software performs calculations on the bounding rectangles to determine which one has the greatest area within the boundaries of the dart board.

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