Dart Score Estimation

Team 10: 106061223 徐浩宇、106061125吳俊毅

Outline

- Introduction
- Methodology
  - Region Segmentation
  - Dart Location Estimation
- Experimental Results
- Conclusion (Future Works)

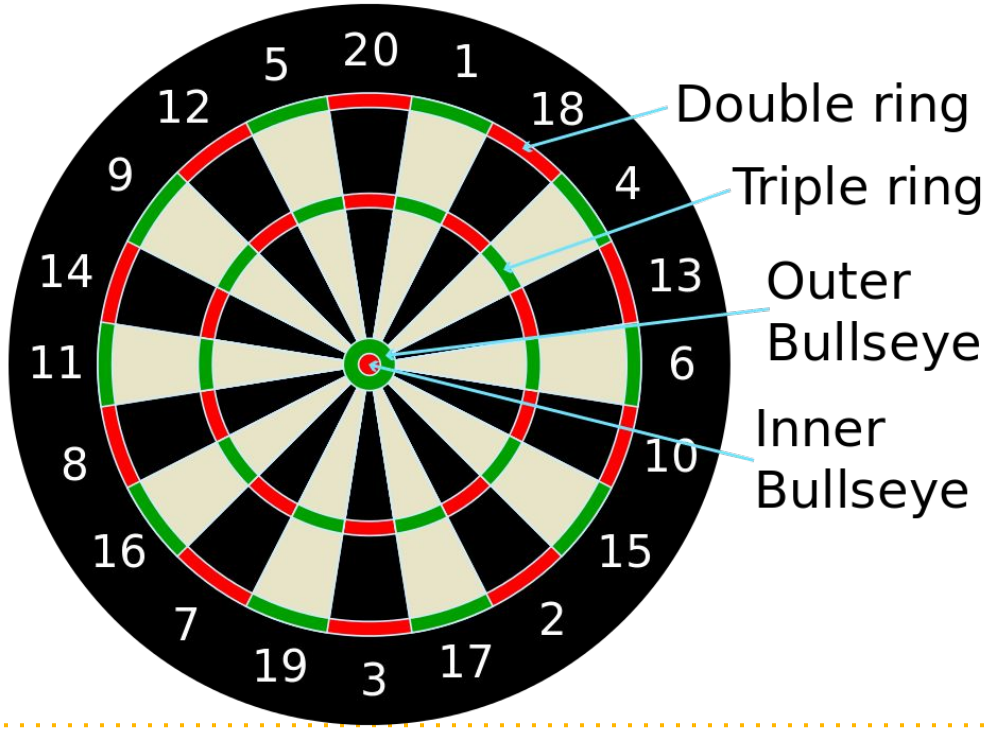
Introduction

Introduction

- Darts has become a popular sport.
- **Regular dartboard** is more preferable than electronic one.
  - *Regular dartboard: manually (drawback!!!)*
  - *Electronic dartboard: **automatically***
- We aim to build a scoring system to estimate score on **regular dartboard automatically**

Methodology

Methodology



Methodology

- The workflow is divided into two parts
- ***Region Segmentation***
  - Take a background image ‘B’
  - Identify multiplier regions and radial dividers
  - Create a point map in pixel level
- ***Dart Location Estimation***
  - Take a dart image ‘D’
  - Discern the potential location of the dart
  - Calculate score based on point map above

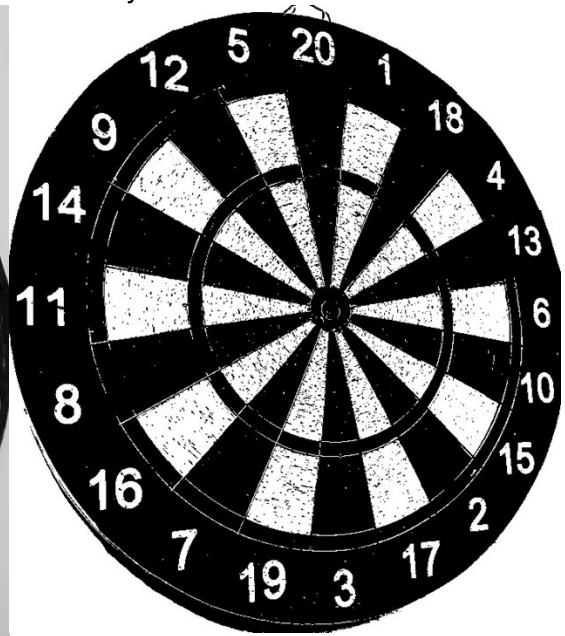
Region Segmentation

Region Segmentation

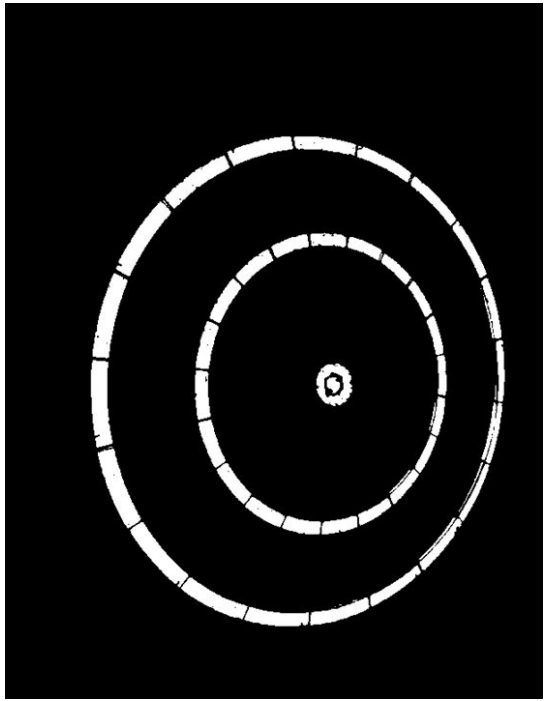
Original

Grayscale

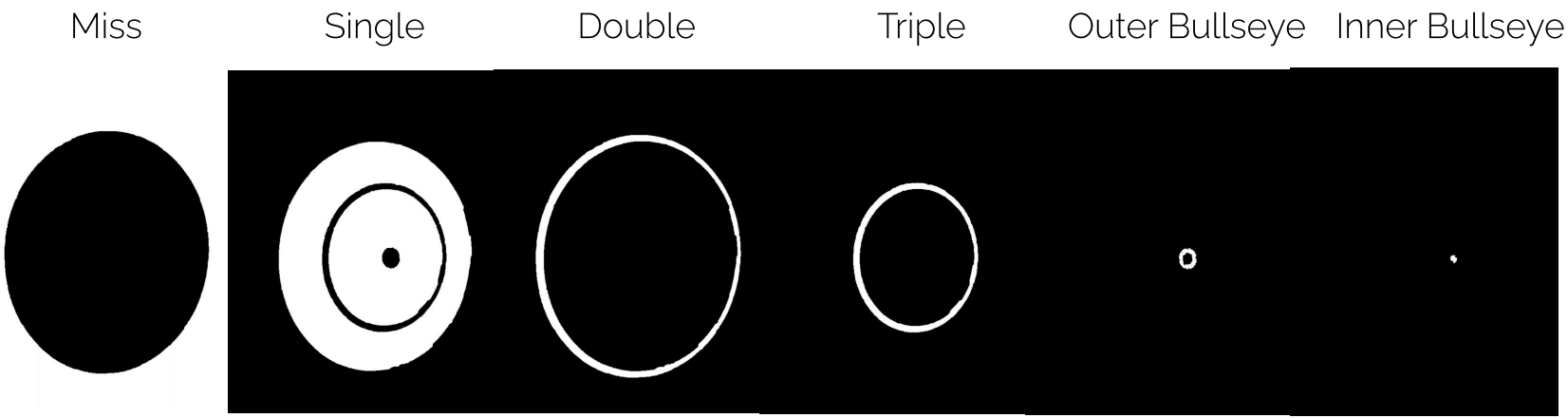
Binay after Ostu's method



Region Segmentation

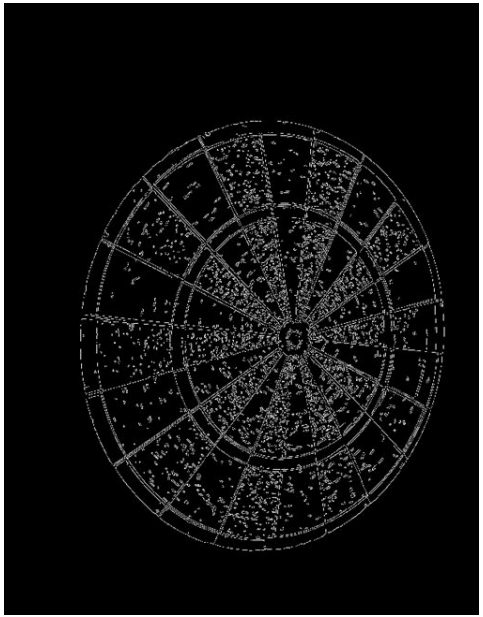


Region Segmentation

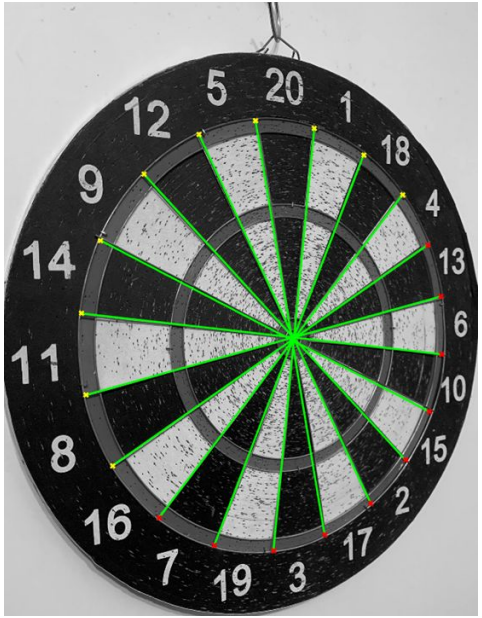


Region Segmentation

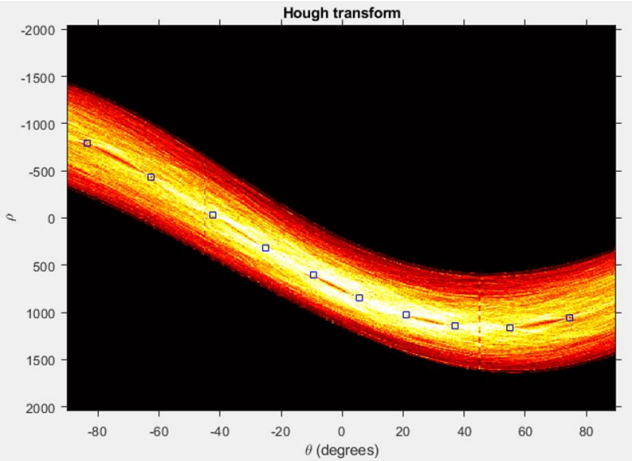
Canny Edge Detector



Result



Hough Transform



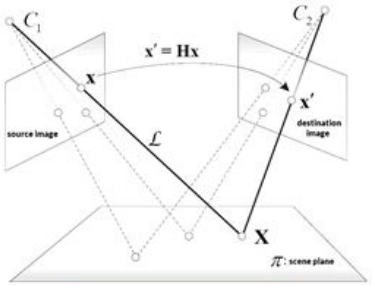
Dart Location Estimation

Dart Location Estimation

Background Image

Dart Image

SIFT feature matching

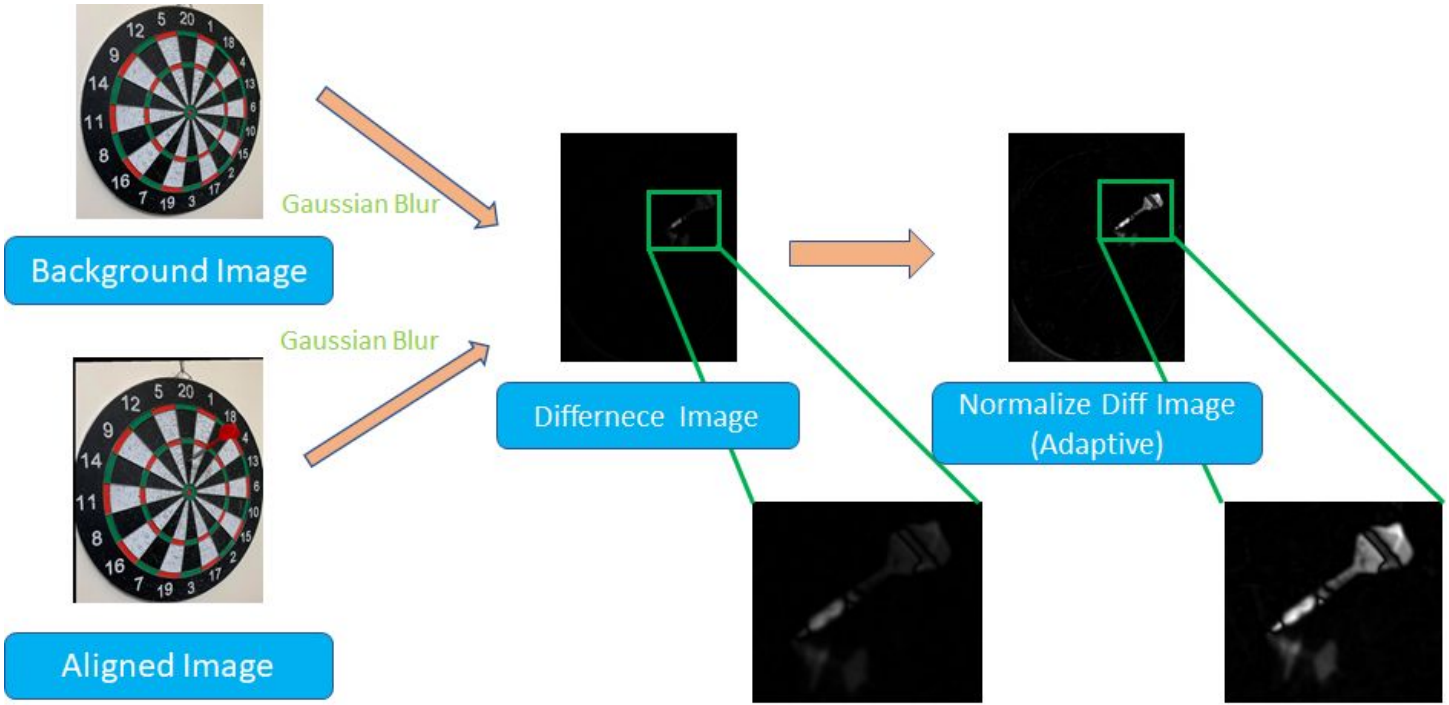


Homography Matrix

Alignment

Aligned Image

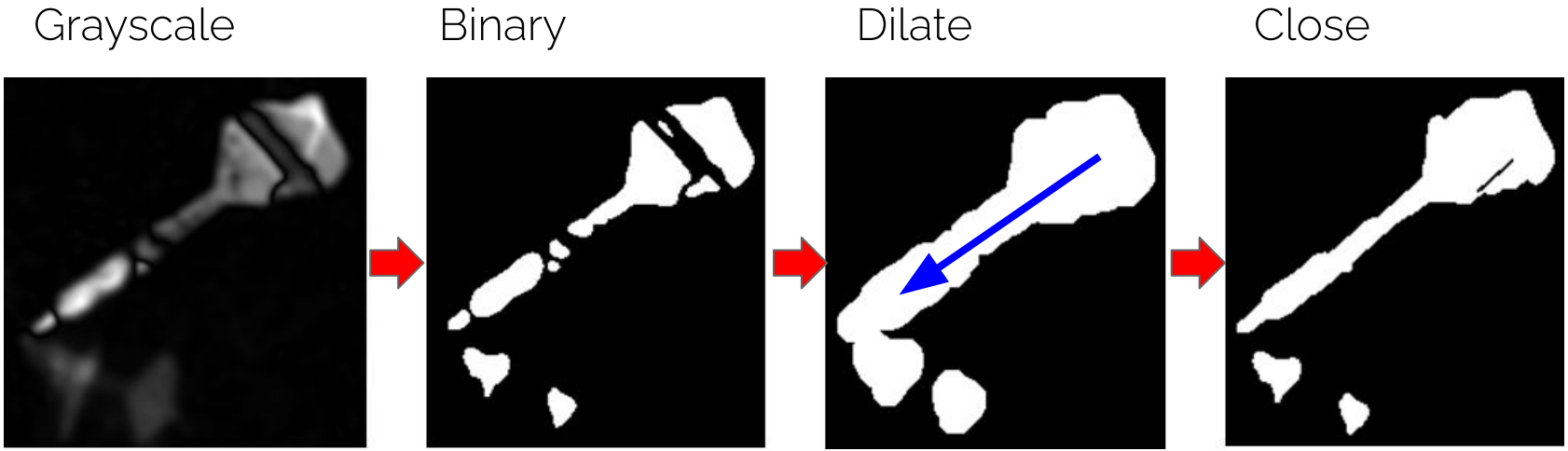
Dart Location Estimation



Dart Location Estimation

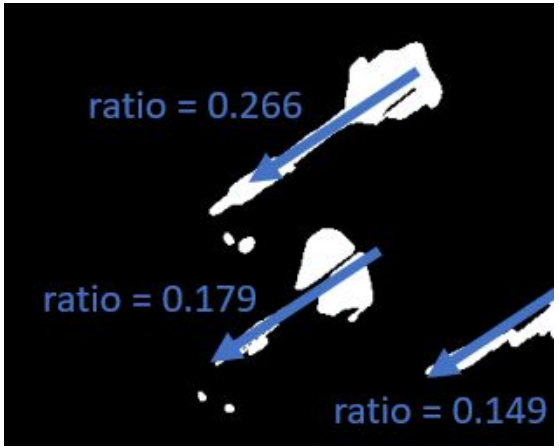
- **Align background and dart image**
  - Use *SIFT* match techniques to match the features of two images
  - Compute *homography matrix* then align the dart image
  - This process address with the slight movements of camera between the times two images taken.
- **Compare the difference and find foreground**
  - Apply *Gaussian Blur* on dart & background image to smooth out sharp transition.
  - *Normalize the difference* of two images to reduce the intensity variations between light and dark patterns.

Dart Location Estimation



Dart Location Estimation

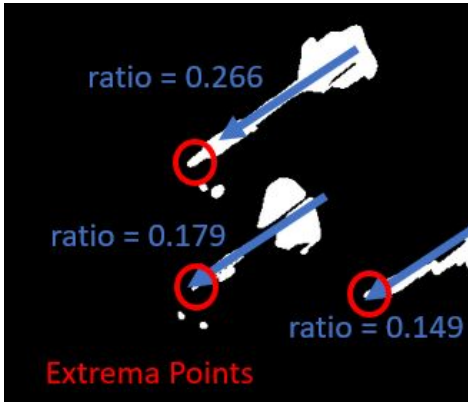
- regionprops() measures 'Orientation', 'Area', 'Extrema', 'BoundingBox' of each image region.
- Ratio = Dart width / Board width
  - This ratio indicates whether this region contains dart or not
  - Set ratio threshold = 0.1



Dart Location Estimation

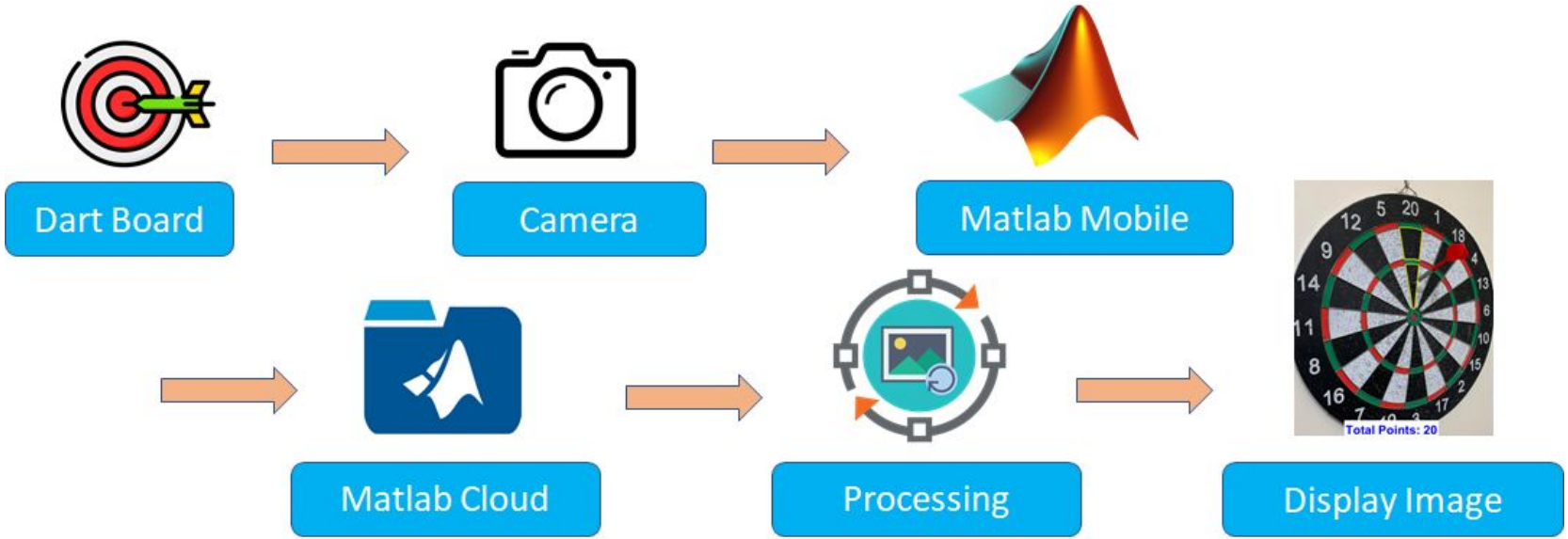
- Tilted angle can be derived by orientation
  - If angle > 0: find top-left extrema coordinate
  - If angle < 0: find bottom-left extrema coordinate
- Extrema coordinate is treated as estimated dart location

- Map the estimated dart location back to point map to get the score of this attempt

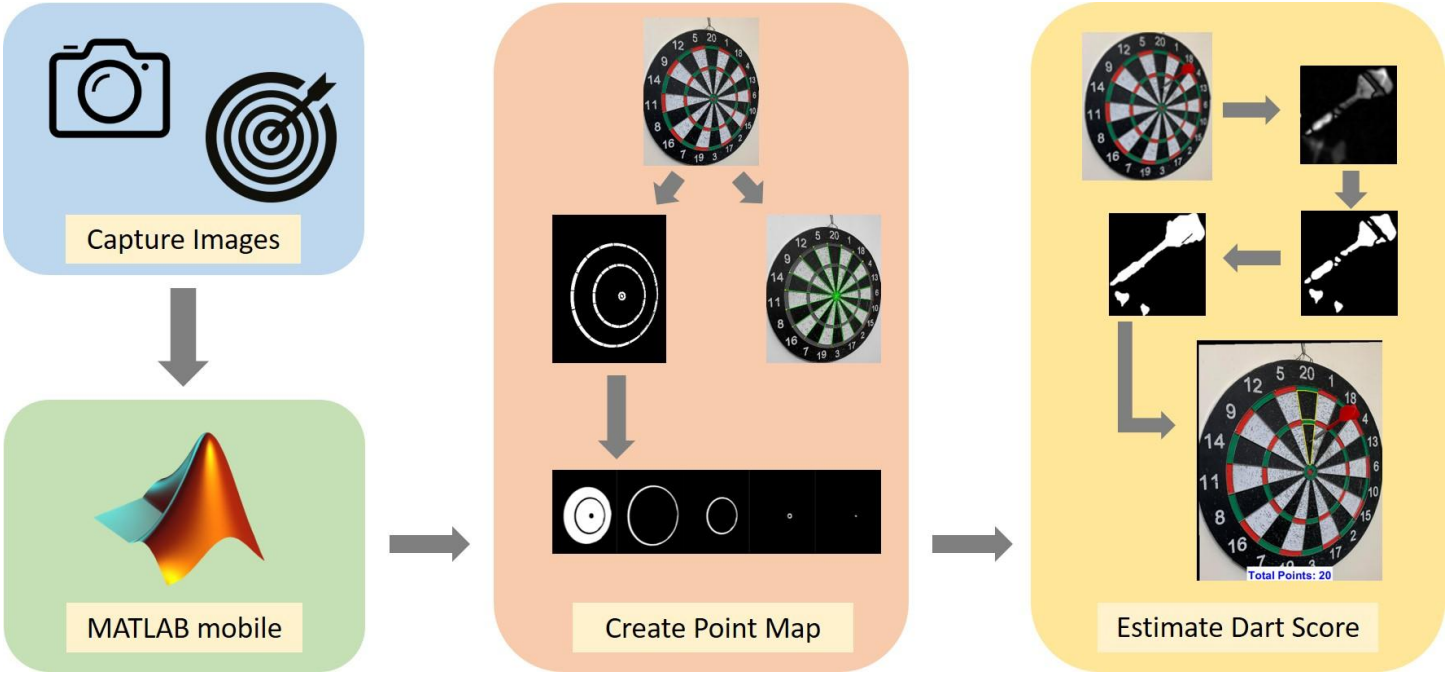


Experimental Results

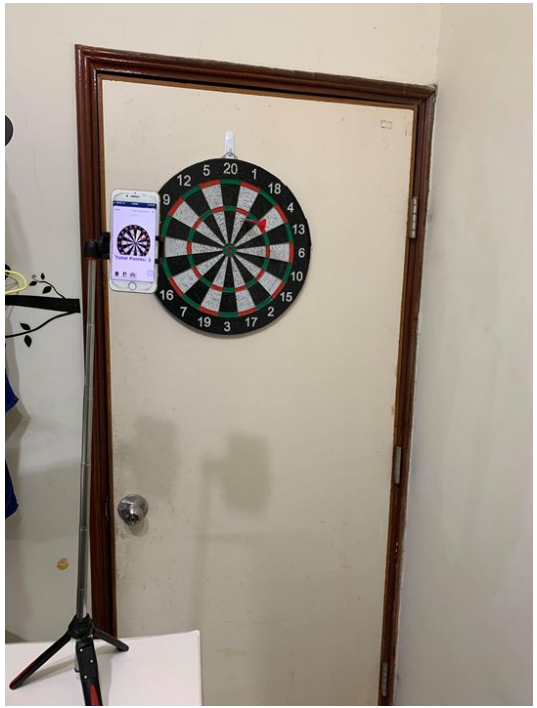
Experimental Setup

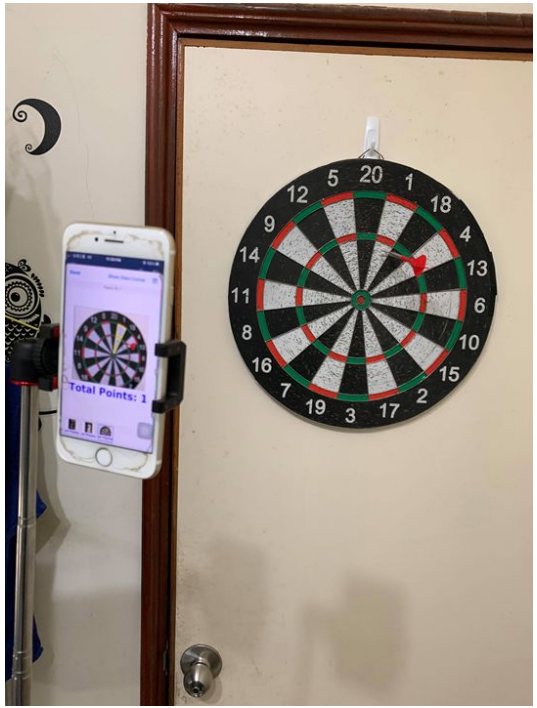


Experimental Setup



Experimental Setup





Experimental Results

Conclusion

Conclusion (Future Works)

- We successfully identify scoring region & dart location, and further perform automatic scoring with basic Digital Image Processing & Computer Vision techniques.
- Limited by insufficient image quality (1280x720) due to MATLAB mobile configuration, the estimated dart location is sometimes imprecise.

Conclusion (Future Works)

- Some problems were solved during implementation.
  - Image alignment would induce noise on edges if two images are from different POV. -> ***Align Camera***
  - Dart color (red in this project) may be mixed with the color on the dartboard -> ***Paint the dart with other color***
  - Some pinholes on the dartboard may induce noise when preprocessing. -> ***Gaussian Blur before operation***

- **Some problems can NOT be solved (Future Works)**
  - Can NOT separate overlapped darts.
  - The shade of darts would cast on dartboard, which effects the estimation of dart location

Thanks!