Assignment 1: Eye Detection

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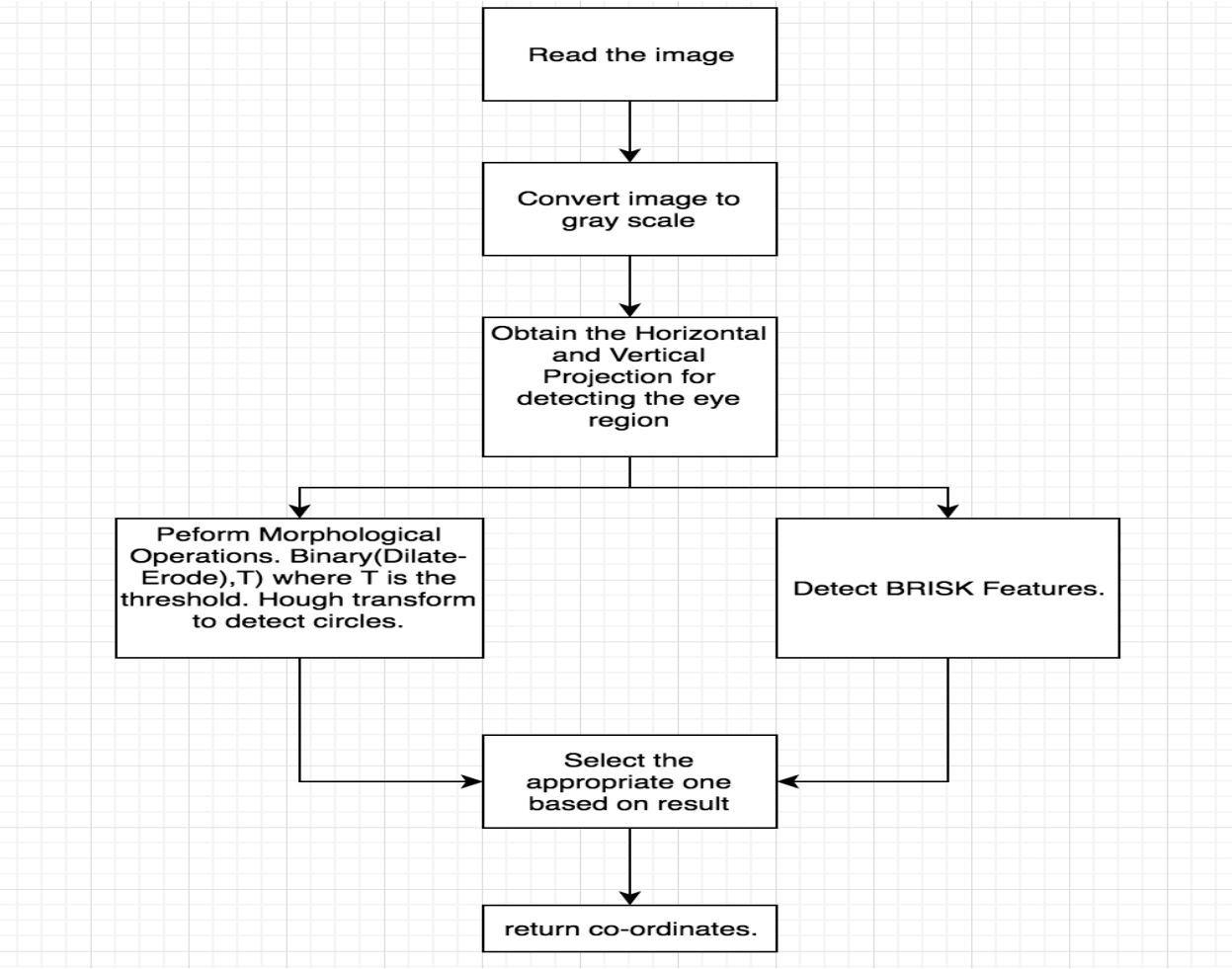
Eye detection using Projection function, Hough Transform and BRISK features.

In this assignment, we are trying to detect eyes of human with varying degree of image size, face shape and pixel ratio. The idea is, given an image which has a human and pair of eyes will the algorithm be able to predict it without having applied an already trained classifier like the cascade object detector which is implemented on Viola-Jones paper? To tackle this problem, we will use some classic image processing techniques
Below is the flow of the complete algorithm that was used to decide the eye-coordinates in the image.

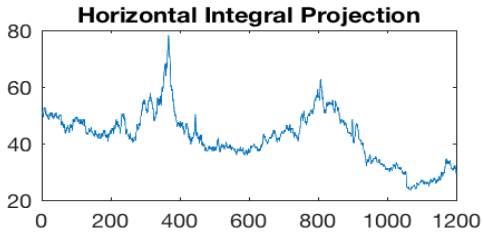


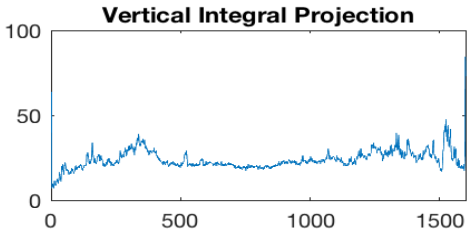
(Fig 1: Flow Diagram for detection of eye)

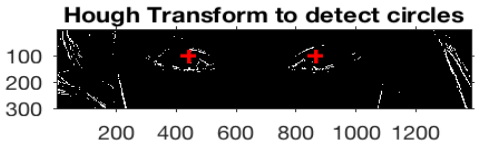
Detailed Explanation of the steps

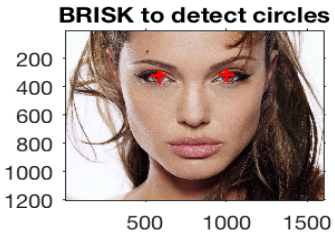
1) Convert RGB to Gray scale: We convert the image to gray scale for processing the image one for reducing the computation time of the image and also to reduce the noise factor that is associated with RGB images which can help filter and edge detection. Once the image is converted it gray scale, we pass it through edge detector. In this case we use *"sobel",* since we wanted the largest possible change in the gradient from a lighter to darker region. This is only a supplementary step and not the main part of the algorithm as such, as the algorithm just uses this to trim the search region for where the eye may be located and to cut down the background of the image which is usually highly luminated and closer to white pixel range i.e. > 200.
2) Integral Projection: We then calculate the vertical and horizontal integral projection on the magnitude of the gradient of image. This idea was inspired by [1] and [2]. This will give the region where the eye is located.
3) Morphological Operations: The algorithm then performs dilation and erosion of the extracted image with structuring element being a disk. The difference of dilation and elation is then passed through a threshold. The threshold is calculated to convert it into a binary image. The threshold is calculated by finding the standard deviation of the image divided by the max (I (x, y)) for the eye region.
4) Hough Transform: Because of the morphological operations performed usually we will be left out with only white pixel's in the eye region which is usually the pupil of the eye since that is highly luminated. We then use Hough Transform to detect the circles in the image.
5) BRISK features (Binary Robust Invariant Scalable Key points): There were 2 option's either use BRISK or use SIFT, BRISK [3] was chosen because of the relatively lower computation and also because we had narrowed down the search space.
6) Decision function: The decision function has 4 option
    - Strong, Strong – Which means both HT and BRISK were able to detect the eye co-ordinates
    - Strong, Good – Which means that HT was better in detecting the points, so we pass the result of HT.
    - Good, Strong – Which mean that BRISK was better in detecting the points, so we pass the result of BRISK.
    - Bad, Bad – Neither of the two were able to find good point we guesstimate eye location.

Result:









Reference:
[1] Peng, Kun, et al. "A robust agorithm for eye detection on gray intensity face without spectacles." *Journal of Computer Science & Technology* 5 (2005).
[2] Zhou, Zhi-Hua, and Xin Geng. "Projection functions for eye detection." *Pattern recognition* 37.5 (2004): 1049-1056.
[3] Leutenegger, Stefan, Margarita Chli, and Roland Y. Siegwart. "BRISK: Binary robust invariant scalable keypoints." *Computer Vision (ICCV), 2011 IEEE International Conference on*. IEEE, 2011.