CP467

Digital Image Processing

Assignment 3

Jashandeep Singh
sing8282@mylaurier.ca
169018282

Table of Contents

1. Introduction

Circle detection is a common task in computer vision with applications in various domains such as iris recognition, object identification, image segmentation etc. This assignment focuses on detecting two of the most prominent boundaries i.e. between the pupil and the iris, and between the iris and the sclera (white part of the eye). To achieve this, this assignment explores a method that combines preprocessing of images with Hough Circle Transform to effectively detect the shapes.

2. Methodology

To achieve the above-mentioned task, the procedure used involves image preprocessing steps, followed by Hough Circle Transform.

2.1 Grayscale Conversion

First and foremost, the image is converted into grayscale. This is done to simplify the subsequent operations by reducing the computational complexity and removing the color information. Although the provided images are already in grayscale, this is done to extend the functionality of this project to coloured images as well.

2.2 Gaussian Blurring

Gaussian blurring is applied to image using a 3x3 mask and sigma value of zero. Since the size of input images was only 320x280 pixels, a 3x3 mask was an appropriate choice. For images of larger size, larger mask could be used as well. Blurring is applied to reduce the effects of noise in the image. This step minimizes the false edge detections making it easier to detect the prominent edges. In place of gaussian blurring, any other blurring technique, i.e. median blurring, average smoothing etc., could be used as well.

2.3 Binary Thresholding

Two binary images with threshold values of 50 and 150 are produced in the third stage of preprocessing. This dual threshold approach enables to effectively detect pupil and iris, which both differ in intensity.

2.4 Edge Detection

Both binary images from the previous stage are processed using canny edge detector to produce two distinct edge maps that highlight regions with strong intensity gradient. In this project OpenCV's in built Canny Edge Detector is used but this could be replaced by any other edge detecting algorithm as well as desired.

2.5 Hough Circle Transform

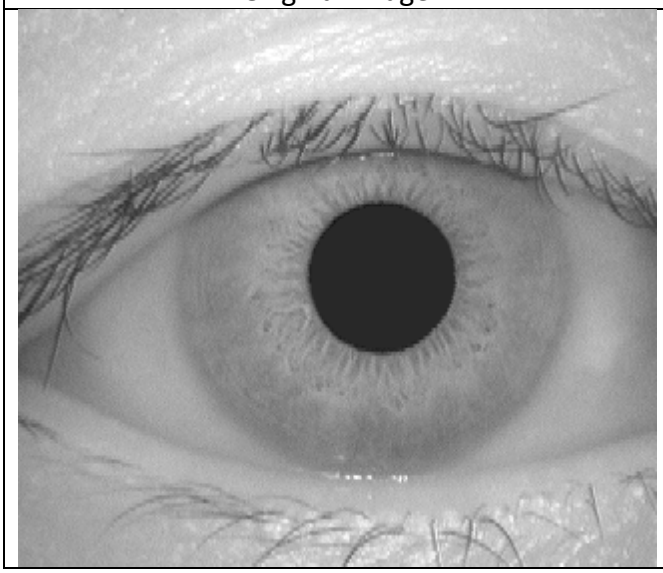
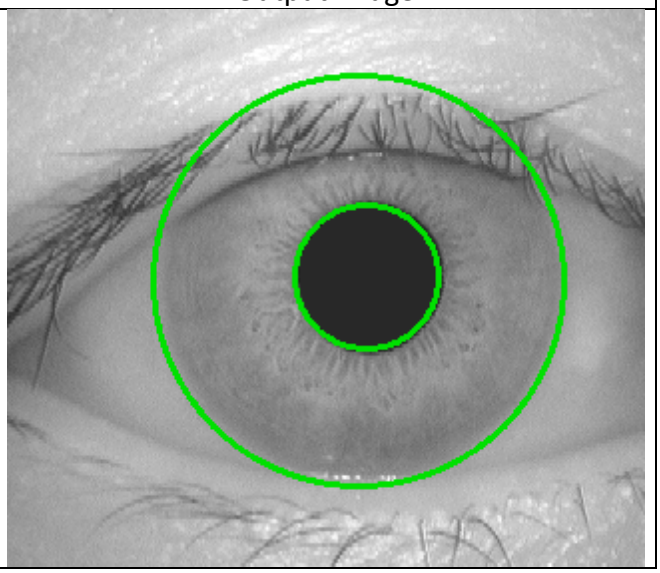
OpenCV's Hough Circle Transform function is used to detect circles on the edge maps. The transform parameters, including minDist, param1, and param2, are tuned for optimal detection of the target circles. The circles detected in both the edge maps are drawn on the original image using green color.

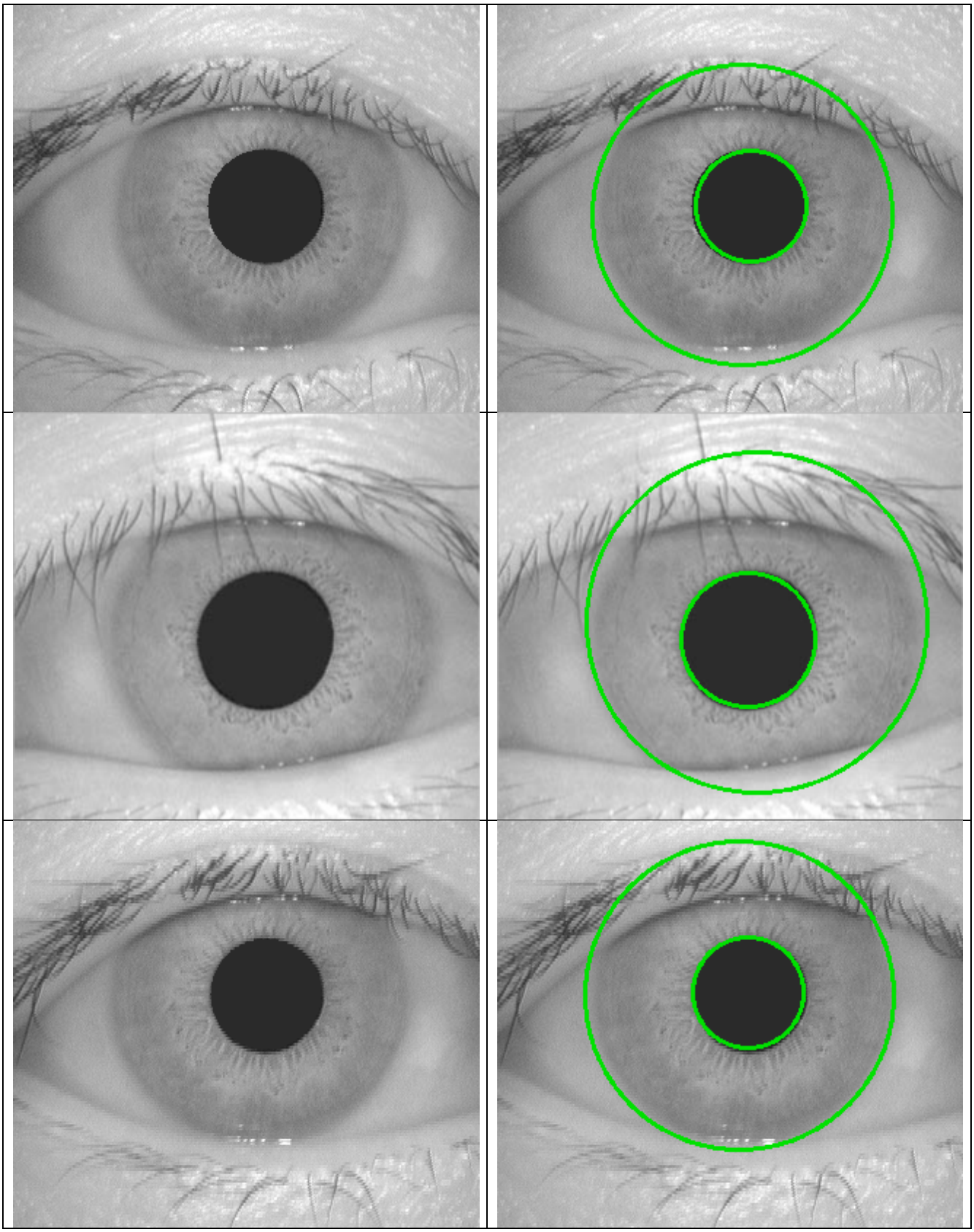
3. Challenges

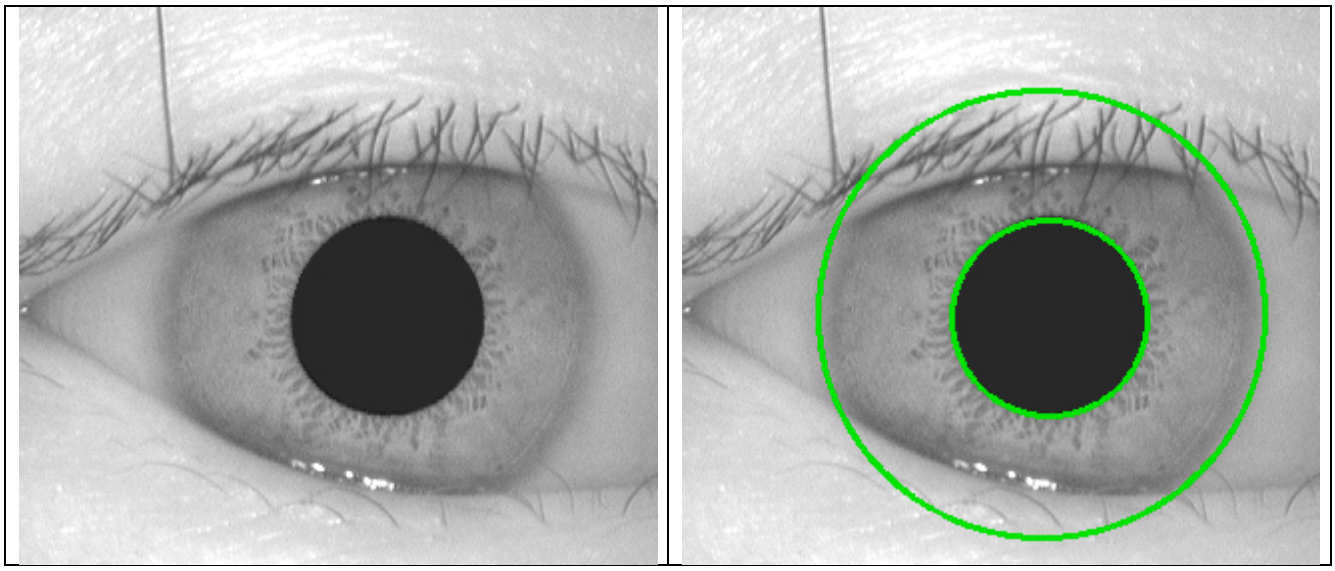
- Fine-tuning of the Hough Transform parameters was required to balance sensitivity and specificity. The minDist parameter was set to 600 to reduce overlapping circles, while param2 was adjusted for optimal circle detection confidence.

4. Results

The approach was effective in identifying circular shapes, achieving high accuracy with well-defined images.

Original Image	Output Image
	





5. References

- Daway, H. G., Kareem, H. H., & Hashim, A. R. (2018, October 1). *Pupil detection based on color difference and circular Hough transform*. Daway | International Journal of Electrical and Computer Engineering (IJECE). https://ijece.iaescore.com/index.php/IJECE/article/view/8049/11031
- Kevin Wood, Robotics & AI. (2023, June 20). *OpenCV Python Image thresholding* [Video]. YouTube. https://www.youtube.com/watch?v=esI-f6zEud8