Politecnico di Bari

PROJECT:
OPTIC DISC AND MACULA RECOGNITION IN RETINAL IMAGES

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Image Processing Course

Introduction

The main purpose of this project is the analysis of retinal images and the creation of a recognition algorithm based on image processing techniques for the identification of optic disc and macula.

We can summarize the project in:

1. Enviroment Setup
2. Data Exploration & Visualization
3. Recognition Algorithm
4. Result Analysis

Enviroment Setup

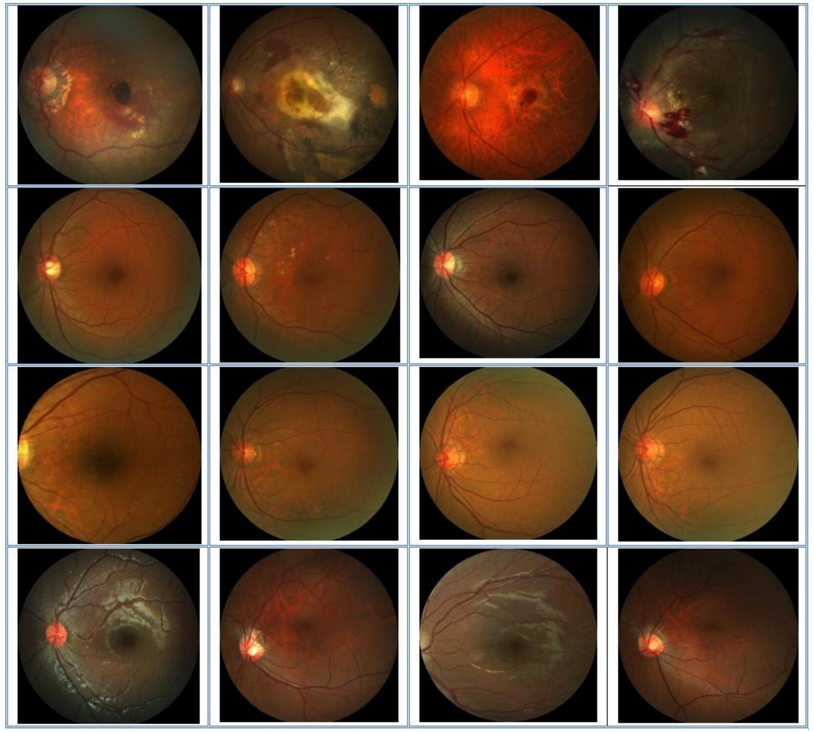
For this project we will work on Windows Environment using MATLAB.

Although MATLAB is intended primarily for numeric computing, the use of the Image Processing Toolbox™ provides a comprehensive set of reference-standard algorithms and workflow apps for image processing, analysis, visualization, and algorithm development.

With this toolbox we can perform image segmentation, image enhancement, noise reduction, geometric transformations, and image registration using deep learning and traditional image processing techniques.

Data Exploration

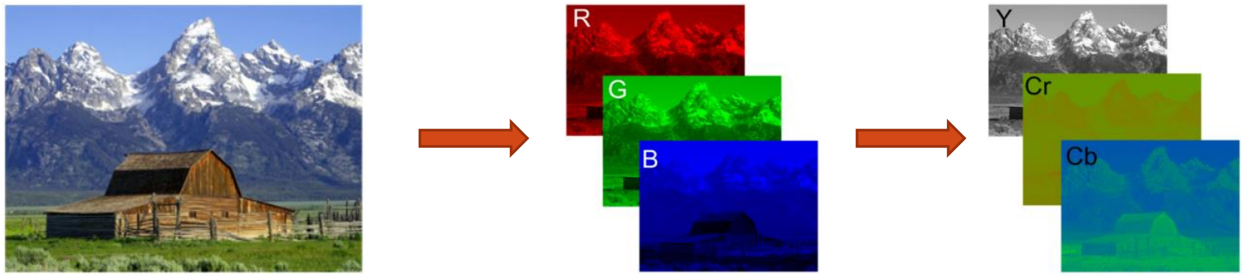
In the image below we can see some common characteristics of the retinal images, as we can see the optic disc and the macula are respectively the brightest and the darkest parts of the image.



That's why we choose to apply an image segmentation based on a thresholding technique.

As we can see in the image, we have RGB images with different colors, so doing a color thresholding technique to segment the images would be a great approach, but in this color space it will be quite difficult and will also give us three different variables to work with so, we need to change approach to create an algorithm which is fast and optimized.

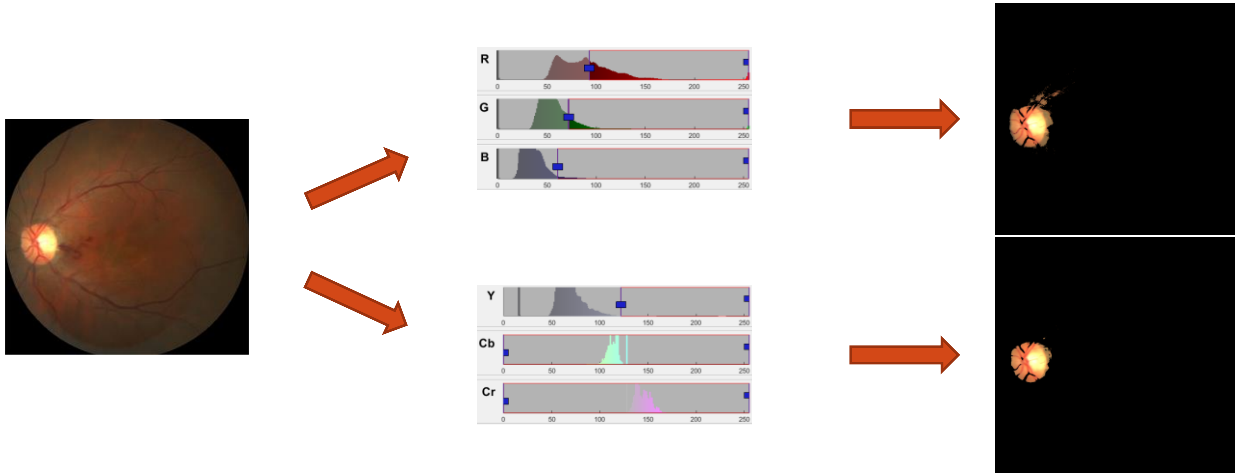
Data Visualization



We have seen before that a better strategy is to point the darkest and brightest parts of the image and for doing so, we will perform a color space transformation from RGB to YCBCR.

In YCBCR (8-bit per channel) encoding:

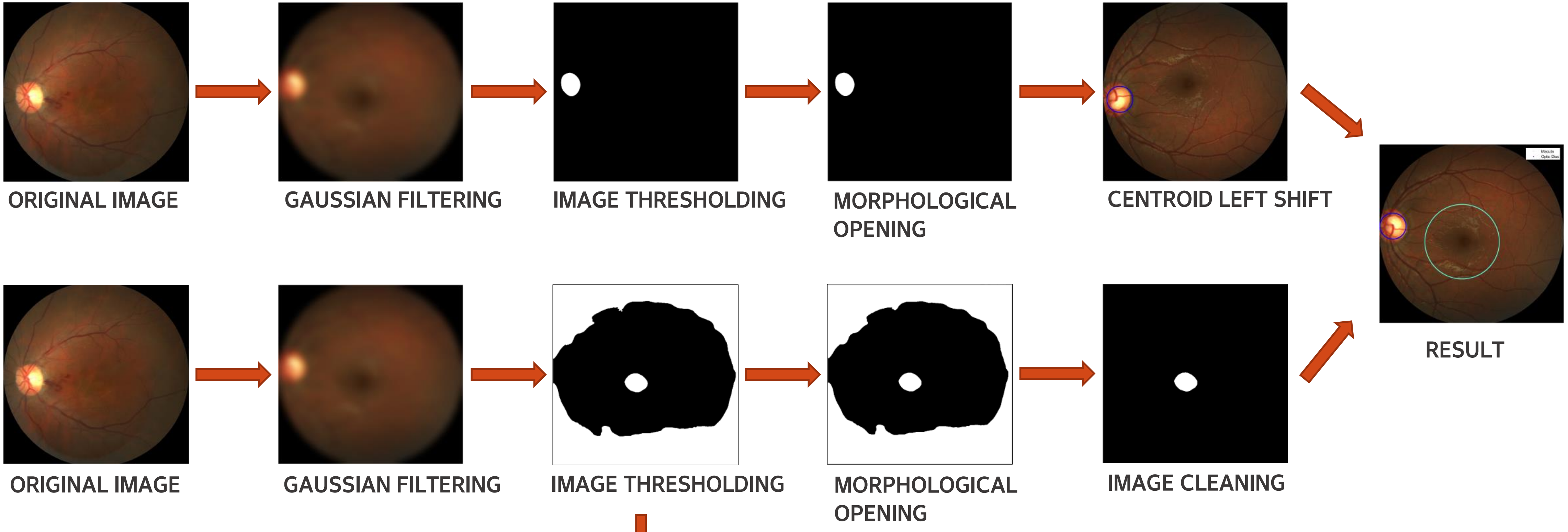
- Y (luminance) ranges from 16 to 235. 16 is the darkest, 235 is the brightest.
- CB and CR (chrominance) range from 16 to 240. 128 is the zero-point.



Has we can see in the images using the YCBCR color space we are not only saving time (less variables to manage) but we are also getting a better precision.

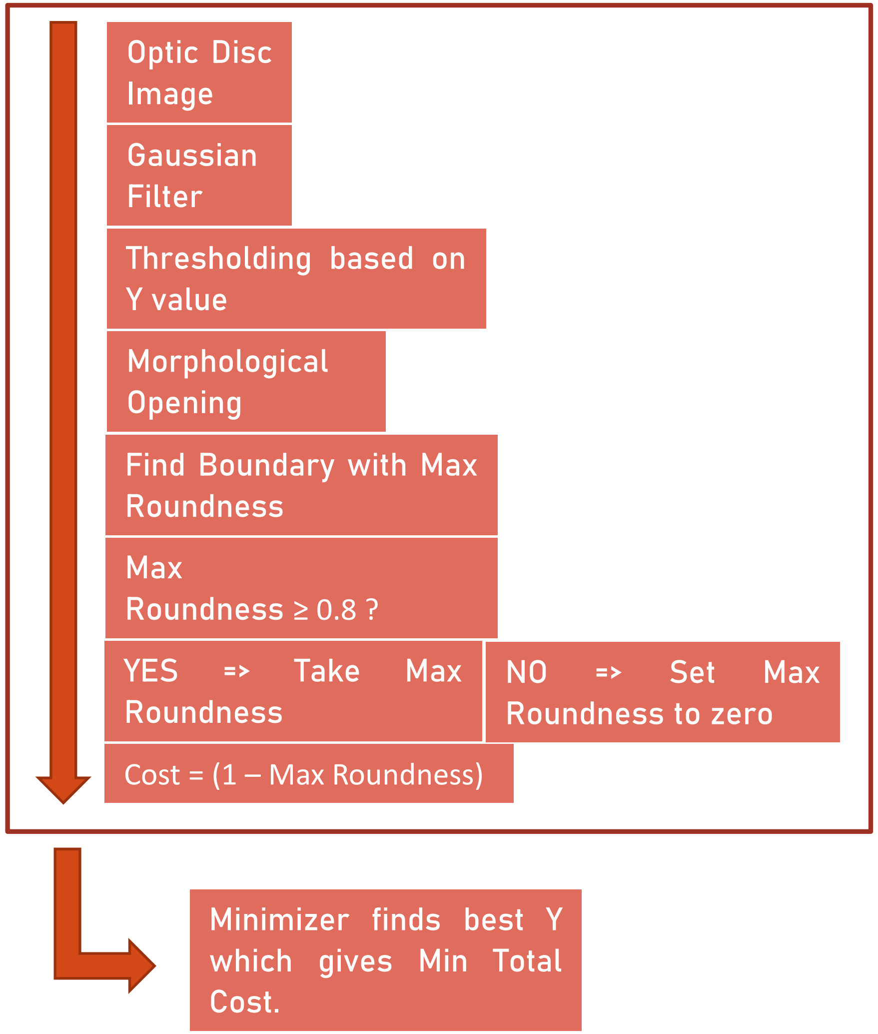
We need to automate the thresholding process, for doing so we are using an approach similar to a Machine Learning algorithm, but we are doing it from scratch.

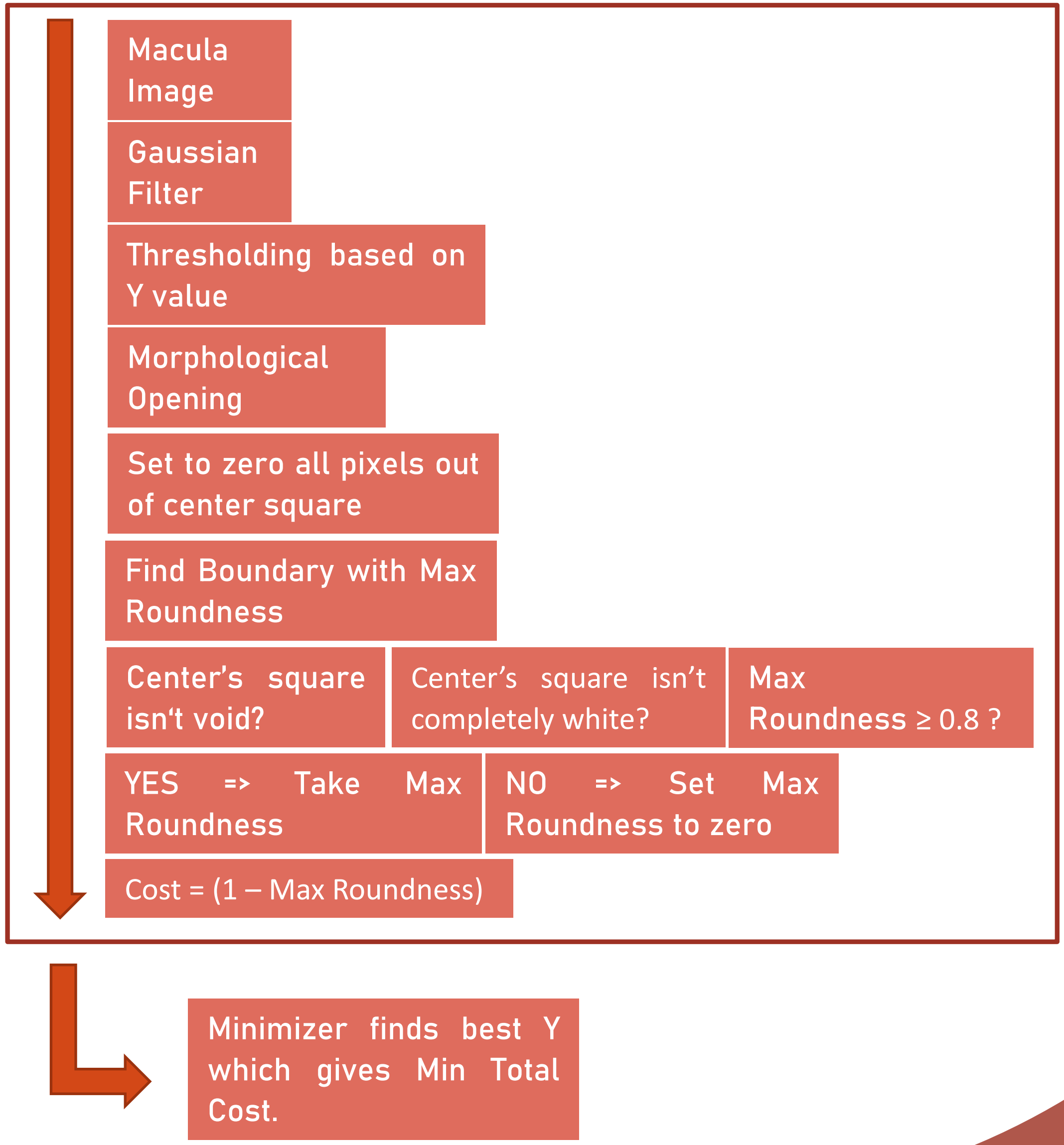
Main Algorithm



Now the problem is to find the best Y value which lets us create the best mask for as many images as possible in our test dataset and for doing so, we are creating a training algorithm which we will train on the training dataset.

Training Algorithms





Result Analysis

- **Optic Disc** (Test Dataset of 400 Images)
  - **Recognized** 77.25% (309 of 400 Images)
    - Perfectly Centered 62.25% (249 of 400 Images)
    - Centered 15% (60 of 400 Images)
  - **Unrecognized** 22.75% (91 of 400 Images)
    - Completely Missed 6.75% (27 of 400 Images)
    - Not Present 16% (64 of 400 Images)

- **Macula** (Test Dataset of 400 Images)
  - **Recognized** 71.25% (285 of 400 Images)
    - Perfectly Centered 58% (232 of 400 Images)
    - Centered 13,25% (53 of 400 Images)
  - **Unrecognized** 28.75% (115 of 400 Images)
    - Completely Missed 28.25% (113 of 400 Images)
    - Not Present 0.5% (2 of 400 Images)

THANK YOU FOR YOUR ATTENTION