COMP27112 Lab 3 Queries

Samuel Belkadi (n61655sb)

March 20, 2023

1 Queries

1.1 Is Otsu's method successful in thresholding all the images?

When performing Thresholding with Otsu's method on some of the images, we can observe an inappropriate threshold value, resulting in poorly segmented images. Below shows some examples of images obtain using OTSU thresholding compared to Binary Thresholding.

Figure 1: Original image
.

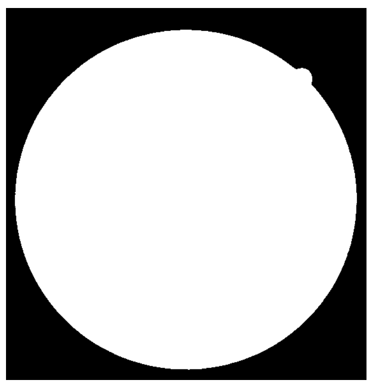

Figure 2: OTSU Thresholding ($T = 60$)

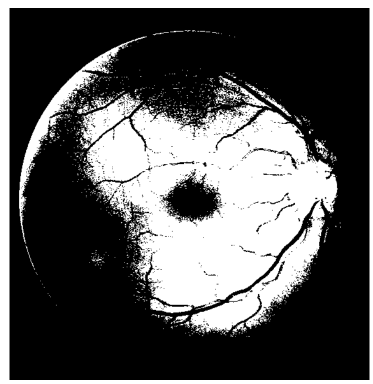

Figure 3: Binary Thresholding with $T = 114$

The original image is a **fundus** and is taken from a set of images used to train and test algorithms for recognising the effects of diabetes on the retina. The ima of the processing is to identify the blood vessels.
We can see the the OTSU algorithm failed to give a correct result *(Figure 1)*, as opposing to Binary Thresholding with $T = 114$ *(Figure 2)* which highlight blood vessels much better.

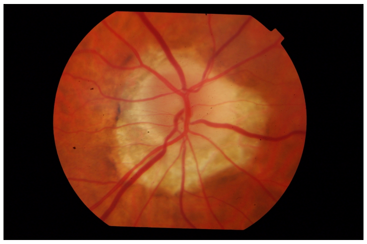

Figure 4: Original image
.

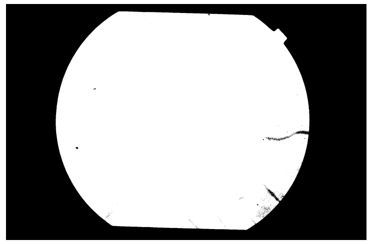

Figure 5: OTSU Thresholding ($T = 50$)

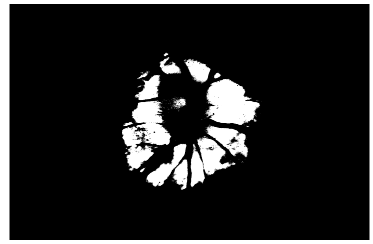

Figure 6: Binary Thresholding with $T = 139$

This time, the original image is a **glaucoma** and is taken from a set used to train ophthalmologists to recognise glaucoma. The aim of processing is to find the diffuse bright region towards the middle and the brighter area inside it.
We can see the the OTSU algorithm failed to give a correct result *(Figure 5)*, as opposing to Binary Thresholding with $T = 139$ *(Figure 6)* which highlights both regions asked above efficiently.

As we have seen with those examples, we conclude that Otsu's method is **not** successful in thresholding all the images.

1.2 How would you modify the thresholding algorithm to address any problems?

Let's first plot the histogram of the **glaucoma** image in grey scale.

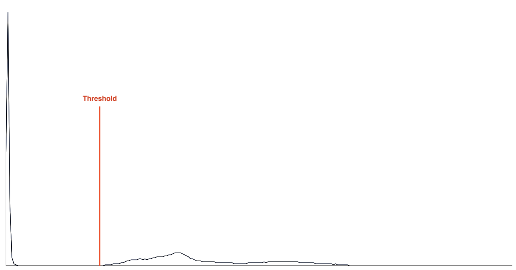

Figure 7: *glaucoma.png* greyscale histogram

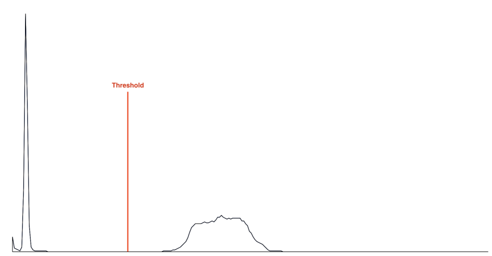

Figure 8: *fundus.png* greyscale histogram

As we can observe there is a bimodal distribution between the foreground (being the full glaucoma object) and the black background. For the OTSU algrithm this is actually a good configuration to separate the foreground of the image to its background, and as we can observe using OTSU thresholding, this is actually what the result looks like.

In our case, we would like to separate the inside brighter regions to the rest. However, separating regions of the object with different **discrete** intensity is hard with OTSU. In some cases, that might result in the Otsu algorithm actually separating the entire object to the background, even though the object may have different discrete brightnesses within it. This happens when the variance within the object is greater than the variance between the object and background.

In such cases, it may be necessary to use a more advanced thresholding method that takes into account the texture or other features of the object, or to preprocess the image to reduce the texture before applying the Otsu algorithm.

Below are some ways to improve the thresholding algorithm to address this problem:

- use **adaptive thresholding** techniques calculating a local threshold for each pixel based on its surrounding neighborhood. This approach can be useful to solve problems such as uneven lighting or contrast.
- use **multiple thresholds** to segment the image into more than two regions. This approach can be useful to solve problems when images has multiple objects or complex backgrounds.
- make **preprocessing** on our image, such as enhancing the contrast of an image before thresholding. This approach can be useful to better identify the foreground and background regions and therefore improve the accuracy of the algorithm.

It could be good practice to combine some techniques to have accurate thresholding on complex images.

1.3 What metrics are there for assessing the success of thresholding?

In order to assess the success of thresholding, we could make use of the following metrics:

- **Accuracy:** measures the percentage of pixels that are correctly classified as either foreground or background. A high accuracy indicates a good separation of the foreground and background.
- **Precision and Recall:** Precision is the percentage of correctly identified foreground pixels out of all the pixels identified as foreground, while Recall is the percentage of correctly identified foreground pixels out of all the actual foreground pixels. We could also use an **F1 Score** being the harmonic mean of Precision and Recall.
- **Entropy:** the principle is to measure the amount of information contained in an image. It can be used to assess the quality of the thresholding result by comparing the entropy of the original image and the thresholded image. A good thresholding result should have a lower entropy than the original image, meaning that the image has been simplified by removing information.

It could be good practice to combine some techniques to have accurate assessing evaluation on our thresholding.