Image Processing
Using Otsu's Method Report

Introduction to Otsu's Method for Image Thresholding

Otsu's Method Overview

Otsu's method is a classical image processing technique used for automatic image thresholding. It aims to find the optimal threshold value that separates an image into two distinct regions: foreground and background. This thresholding technique is named after Nobuyuki Otsu, who introduced it in 1979.

Purpose of Image Thresholding

Image thresholding is a process that converts a grayscale image into a binary image by assigning pixel values to either black or white based on a threshold value. The main objective is to segment the image such that objects (foreground) and the background are clearly distinguished. This is crucial in various applications such as object recognition, image analysis, and feature extraction.

Input Image:

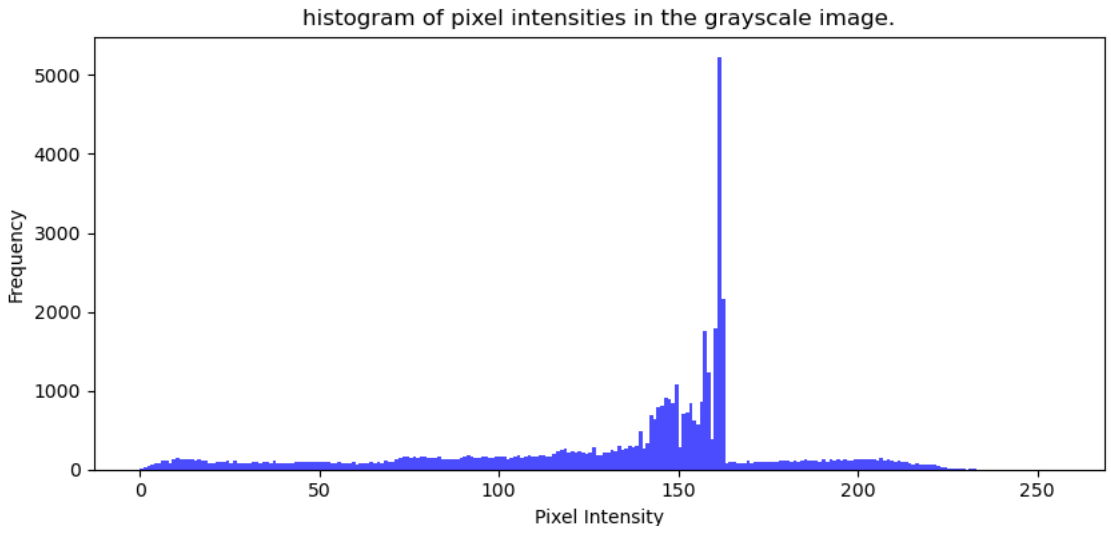
The original color image that will be processed through Otsu's Method for Image Thresholding.

Grayscale image:

The input color image is converted to grayscale to simplify the processing.

Histogram of pixel intensities in a grayscale image:

The is Histogram which is a graphical representation of the distribution of pixel intensities in a grayscale image.



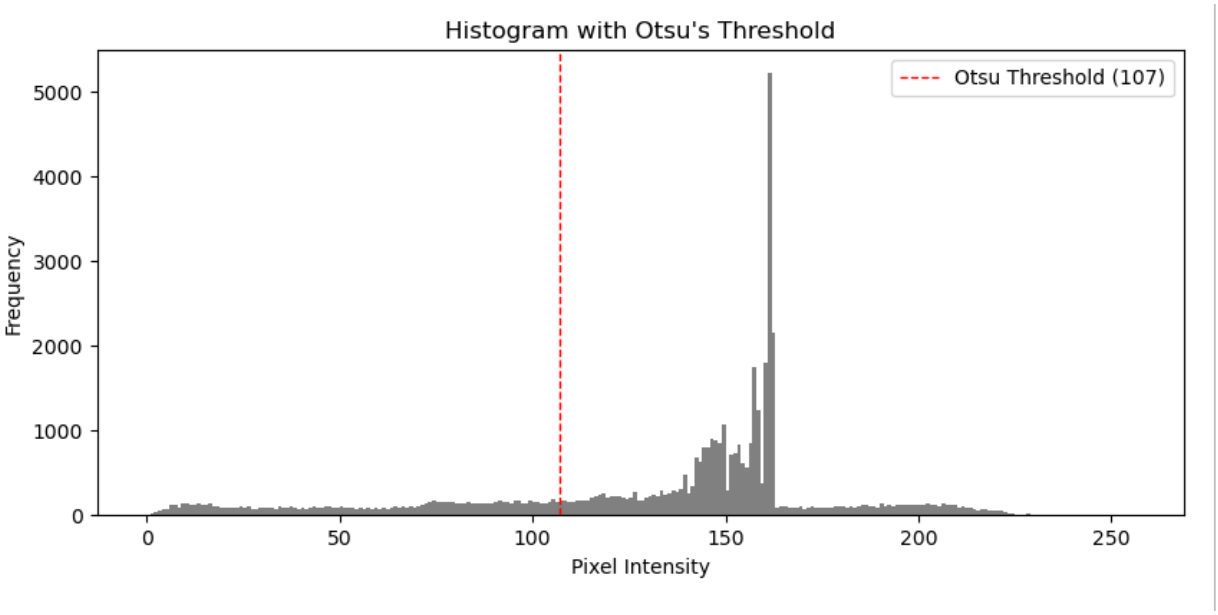
The horizontal axis of the histogram represents the pixel intensity values, ranging from 0 (black) to 255 (white). The vertical axis represents the frequency, which is the number of pixels in the image that have a particular intensity value.

The histogram shows that the image has a high concentration of pixels with intensity values around 150, which corresponds to a light gray color. The histogram also shows that there are relatively few pixels with very low or very high intensity values.

This histogram suggests that the image is likely to be a photograph with a dominant light gray color. It is possible that the image contains objects or areas that are very bright or very dark, but these areas are not as prominent as the light gray areas.

Histogram of pixel intensities in a grayscale image:

This is a histogram of pixel intensities in a grayscale image.



The x-axis represents the pixel intensity values, which range from 0 to 255.
The y-axis represents the frequency, or how many pixels in the image have that particular intensity value.
The histogram is showing that there is a very high peak at an intensity value around 160. This suggests that the majority of the image is comprised of pixels with this intensity value.

The histogram also shows that there are fewer pixels with lower intensities (darker) and higher intensities (brighter). This suggests that the image is likely to be relatively dark, but with a bright "spike" of pixels at 160.
This kind of histogram is used to understand the distribution of pixel values in an image, which can be helpful for things like image processing, analysis, and editing.

Binarized image

A binarized image is one that has been converted to only two colors, typically black and white. This process is done through thresholding, where the image's pixels are divided into black or white based on a specific threshold value.

Simple Explanation:

- **Original Image:** Contains various shades of gray or different colors.
- **Binarized Image:** Contains only two values—black (0) and white (255).

For example, if the threshold value is set to 128, pixels with values below 128 become black, while those with values above 128 become white.

Uses of Binarization:

- **Document Scanning:** It's used to separate text from the background.
- **Image Processing:** It simplifies images for tasks like object detection or edge detection.

Otsu's Optional Threshold:

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Otsu's Optimal Threshold: 107
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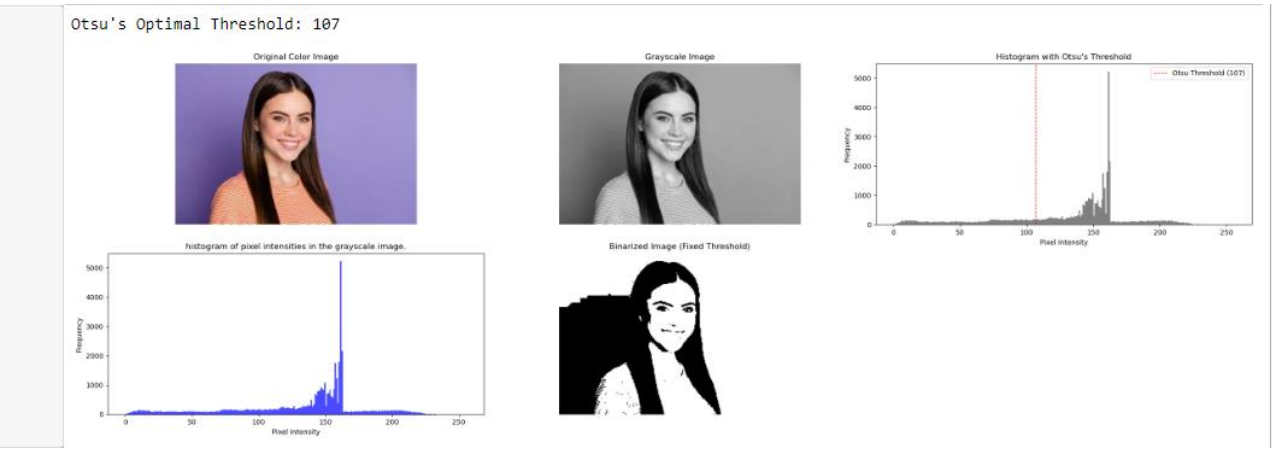
The histogram of pixel intensities in a grayscale image. The histogram shows the frequency of each pixel intensity value, from 0 to 255. The histogram has a sharp peak at around 155, suggesting that a large proportion of the pixels in the image have that intensity value. This is likely due to the presence of a bright object in the image. The histogram also shows a gradual decline in the frequency of pixel intensities as the intensity values increase, suggesting that the image is dominated by dark pixels.

This histogram is useful for understanding the distribution of pixel intensities in an image, which can be helpful for tasks such as image segmentation, image enhancement, and image compression.

Final Output



Conclusion

In this assignment, we implemented Otsu's method, a fundamental technique for image thresholding, to effectively binarize an image by separating its pixels into foreground and background classes. After gaining a solid understanding of the method, we wrote a Python function to calculate the optimal threshold, applied it to a sample image, and successfully converted the image into a binary format. Then we visualized the results, including the original image, its histogram, and the binarized version, demonstrating the efficacy of Otsu's method in enhancing image contrast and aiding in image segmentation tasks. This assignment provided valuable hands-on experience in implementing and applying a critical image processing algorithm.