Image Segmentation

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1 Objective

To segment the given image into different segments based on an optimal threshold.

2 Analysis

Some of the concepts that were used to solve this task are covered here.

2.1 Segmentation

Segmentation is a useful tool to analyze images and primarily works by partitioning the image into different constituent segments. There are 2 types of segmentation, based on how the image is segmented. One is based on discontinuities in the image and another based on regions of similarity. Discontinuities can be points, edges or lines while regions of similarity are entire regions in the image that share some common property.

2.2 Optimal threshold

This is a similarity based segmentation technique wherein regions sharing some common property are grouped together into a segment. Here the common property is whether a pixel's intensity is greater than a particular threshold. Thus pixels lesser than this threshold become part of one segment while pixels greater than this threshold become part of another segment. The threshold is chosen based on the probability distribution of the intensities of the image, ensuring that the error of classification of the object as background or background as object is kept minimum. This is effective for thresholding images which have different probability distributions for the object and the background with some minor overlap.

3 Method

The following steps were followed to segment the given image with an optimal threshold.

1. The histogram of the gray level pixel intensities of the image was plotted. This histogram is representative of the probability distribution of the intensities and was thus used for finding the optimal threshold.

2. On observing the histogram, valleys or regions between peaks were recorded to find thresholds that separated pixels of shared intensity distributions.

3. Based on the recorded thresholds, the image was segmented. The threshold which resulted in segmentation of the image into the objects of interest was determined to be the optimal threshold.

4. The binary image showing the objects detected with the optimal threshold as well as the given image with a bounding box to show the objects detected were created and stored.

5. Bounding boxes for each object were drawn in the program by scanning the thresholded image for connected regions. Regions that were vertically disconnected by more than 20 pixels were not considered to be part of the same object.

4 Results

The histogram of the gray level intensities of the image was plotted and is shown in Figure 1. The intensity 0 was not plotted since most of the pixels in the image had 0 intensity and skewed the appearance of the histogram, making it difficult to observe the distribution of the rest of the pixels. Also since the object of interest was not the filet, not plotting 0 intensity had no significance.

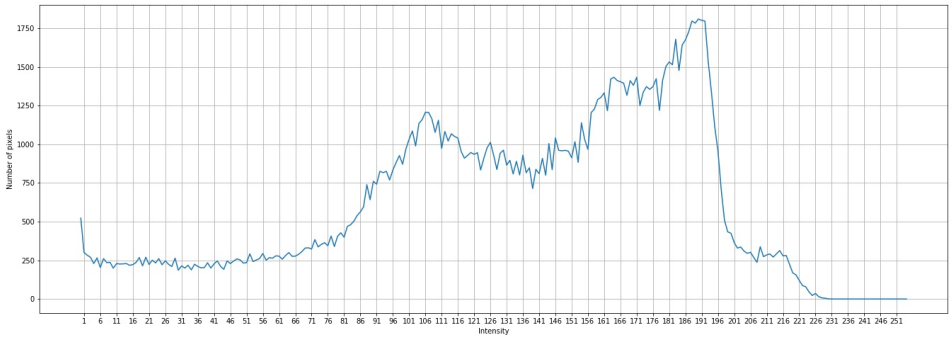
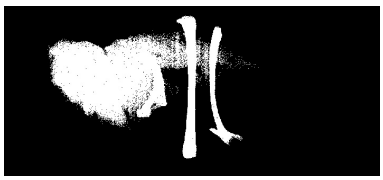


Figure 1: Histogram of gray level pixel intensities for the given image.

On observing the peaks and valleys of the histogram 3 possible optimal thresholds were recorded. They were 139, 178, 209. Since the objects of interest were the bones and the threshold 209 was the one which was best able to detect the bones, it was chosen to be the optimal threshold.

Using the optimal threshold, a binary image was obtained to observe the result of segmentation and bounding boxes were drawn on the image for each object detected.

(a) Threshold = 139.



(b) Threshold = 178.

(c) Threshold = 209. (Optimal Threshold)

Figure 2: Image segmented using thresholds 139, 178, 209. 209 being optimal threshold.

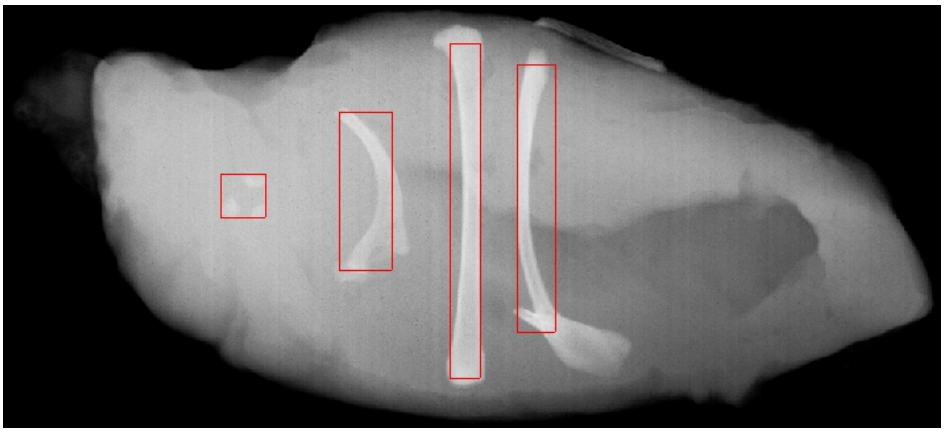


Figure 3: Objects detected in the image segmented with the optimal threshold 209 shown with bounding boxes.