

# Meat Quality Control

## Computer Vision, UPC

Xavier Martín Ballesteros and Adrià Cabeza Sant'Anna

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### **Abstract**

Our goal is to discuss about different binarization methods. We have used the *basic binarization*, *p-tile thresholding*, *optimal thresholding*, *kapur method*.

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## 1 Introduction

The objective of this assignment is to detect the percentage of fat in chops using images. To do it, we have used several different threshold techniques. Those methods consists in setting a constant value called *threshold* ( $T$ ) and separe the pixels depending its value ( $f(i, j)$ ):

$$g(i, j) = 1 \text{ if } f(i, j) \geq T$$

$$g(i, j) = 0 \text{ if } f(i, j) \leq T$$

In the following sections we will introduce different methods to find the threshold value and compared its results.

## 2 Binarization

### 2.1 Basic Binarization

This is the first method we tried and also the fastest and easiest one. Our approach was to print the histogram of the picture and check where we could set the best value for the *threshold* in order to separe the fat. The histograms that we got were bimodal so we could set an acceptable value just by looking at it. We believe that this distribution of pixel values is formed because we are working with grayscale pictures of chops where we can appreciate clearly a lighter tone for the fat and darker tones for the rest.

### 2.2 P-tile Method

This method uses knowledge about the area size of the desired object. It assumes the desired part of the image are brighter that the background and occupy a fixed percentage of the picture area. The *threshold* is defined as the grey level that mostly corresponds to mapping at least that fixed percentage into the object.

### 2.3 Otsu Method

Otsu method is one of the most successful methods for image thresholding. It is very effective for images which are bimodal. However, it may not be accurate for non-bimodal images. In this method we search among all possible thresholds to find the one that minimizes the weighted within-class variance, which is the same than maximizing inter-class variance.

The probability of a pixel to have the gray level  $i$  is

$$p_i = \frac{n_i}{N}, \quad p_i \geq 0, \quad \sum_{i=0}^{L-1} p_i = 1$$

where  $L$  is the number of different gray levels of a given picture,  $n_i$  is the number of pixels of gray level  $i$  and  $N$  is the total number of pixels. Then, the probability of being in class *Background* or *Foreground* is

$$\omega_B = \sum_{i=0}^t p_i \quad \omega_F = \sum_{i=t+1}^L p_i$$

where  $t$  is the threshold value. The mean values of the classes are

$$\mu_B = \sum_{i=0}^t \frac{i * p_i}{n_B} \quad \mu_F = \sum_{i=t+1}^L \frac{i * p_i}{n_F}$$

and the class variances are given by

$$\sigma_B^2 = \sum_{i=0}^t \frac{(i - \mu_B)^2 * n_i}{n_B} \quad \sigma_F^2 = \sum_{i=t+1}^L \frac{(i - \mu_F)^2 * n_i}{n_F}$$

Hence, the within-class variance is computed as

$$\sigma_W^2 = \omega_B * \sigma_B^2 + \omega_F * \sigma_F^2$$

Nevertheless, we can transform this minimization problem into a maximization problem by computing the inter-class variance, which is faster to compute

$$\sigma_I^2 = \omega_B * \omega_F * (\mu_F - \mu_B)^2$$

### 2.4 Optimal thresholding by Clustering Method

Optimal thresholding methods select the threshold based on the minimization of a criterion function. Otsu, for example, tries to minimize the intra-class variance. This method tries to minimize the probability between the maxima of 2 distributions.

We used Ridler Calvard Method which segments the image into two clusters (*Background* and *Foreground*) using the initial threshold value. The algorithm starts assuming that the four corners are the only pixels in the *Background* and the rest is the *Foreground*. It also selects an initial estimate for the threshold  $t_1$ . At each step we compute the mean gray-level of the two clusters

$$\mu_B^{t_n} = \frac{\sum_{i=0}^{t_n} i * p_i}{n_B} \quad \mu_F^{t_n} = \frac{\sum_{i=t_n+1}^L i * p_i}{n_F}$$

Then, the new threshold is compute as

$$t_{n+1} = \frac{\mu_B + \mu_F}{2}$$

The algorithm repeats these steps until  $t$  stabilizes, which means that  $|t_n - t_{n+1}| < \varepsilon$ .

## 2.5 Kapur, Sahoo and Wong Method

In this method two probability distributions are derived from the original gray level distribution of the image(i.e. object distribution and background distribution):

$$\frac{p_0}{P_t}, \frac{p_1}{P_t}, \dots, \frac{p_t}{P_t}$$

and

$$\frac{p_{t+1}}{1 - P_t}, \frac{p_{t+2}}{1 - P_t}, \dots, \frac{p_{l-1}}{1 - P_t}$$

where  $t$  is the value of the threshold and  $P_t = \sum_{i=0}^t p_i$ . Define

$$H_b(t) = - \sum_{i=0}^t \frac{p_i}{P_t} \log_e \left( \frac{p_i}{P_t} \right)$$

$$H_w(t) = - \sum_{i=t+1}^{l-1} \frac{p_i}{1 - p_i} \log_e \left( \frac{p_i}{1 - P_t} \right)$$

Then the optimal threshold  $t^*$  is defined as the grey level which maximizes  $H_b(t) + H_w(t)$ , that is,

$$t^* = \text{ArgMax} (H_b(t) + H_w(t))$$

## 3 Results

## References

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	bla	bli	blu
<b>Otsu</b>			
<b>Kapur</b>			
<b>Optimal Thresholding</b>			
<b>P-tile</b>			

Table 1: Results obtained using different methods of binarization

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