ENEL4AI H2 - Artificial Intelligence - 2016

Practical 1: Assigned on: 08 August 2016
Due: 22 August 2016

1 Goal

Given a grayscale image want to write a module in C++ and OpenCV that extracts Haralick features of this image. Haralick features are extracted from the GLCM (Gray Level Co-occurrence Matrix); they are used for modeling textural characteristics. The GLCM, $GLCM(i, j|d, \theta)$, encodes the spatial dependencies of tonal intensities for a given distance and orientation, providing a basis for extraction of second-order statistical features. Given an image I with spatial dimensions $M \times N$ and L grey levels, the GLCM is defined as

$$GLCM(i, j|d, \theta) = \sum_{x,y} G\{I(x,y) = i \text{ and } I(x + d\theta_0, y + d\theta_1) = j\} \tag{1}$$

where,
$0 \leq x \leq M-1$, $0 \leq y \leq N-1$, $0 \leq i, j \leq L-1$ and

$$G(x) = \begin{cases} 1, & \text{if x is true} \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

The orientation θ is quantized to four values , which are represented as shown in Eq. (3)

$$\theta = \begin{cases} 0^\circ, & \text{if } \theta_0 = 0 \text{ and } \theta_1 = 1; \\ 45^\circ, & \text{if } \theta_0 = -1 \text{ and } \theta_1 = -1; \\ 90^\circ, & \text{if } \theta_0 = 1 \text{ and } \theta_1 = 0; \\ 135^\circ, & \text{if } \theta_0 = 1 \text{ and } \theta_1 = -1; \end{cases} \tag{3}$$

This work uses all four orientations shown in Eq. (3) and two distances, $d \in [1, 3]$. Eqs. 4-9 compute six Haralick features extracted from the GLCM matrix. We will assume for the rest of the text that, as soon as the orientation θ and the distance d are chosen, $GLCM(i, j|d, \theta)$will just be represented by $GLCM(i, j)$ and we can compute $p_{i,j} = \dfrac{GLCM(i, j)}{\sum_{i=0}^{L-1} \sum_{j=0}^{L-1} GLCM(i, j)}$.

$$\text{Maximum probability} = \max(p_{i,j}) \tag{4}$$

$$\text{Energy} = \sum_{i,j=0}^{L-1} p_{i,j}^2 \tag{5}$$

$$\text{Homogeneity} = \sum_{i,j=0}^{L-1} \frac{p_{i,j}}{1+|i-j|} \tag{6}$$

$$\text{Contrast} = \sum_{i,j=0}^{L-1} p_{i,j}|i-j|^2 \tag{7}$$

$$\text{Correlation} = \sum_{i,j=0}^{L-1} \frac{p_{i,j}(i-\bar{\mu}_i)(j-\bar{\mu}_j)}{\sigma_i \sigma_j} \tag{8}$$

$$\text{Entropy} = \sum_{i,j=0}^{L-1} p_{i,j}(-\ln p_{i,j}) \tag{9}$$

You are required, given a gray level image, to generate a vector of 48 (2 distances x 4 orientations x 6 features) features, and save it in a text file. It means, if you are given 100 images you will create a text file of 100 lines.

2 The data set

The data set used consists gray level images.

SUBMISSION INFORMATION

Your submission must include the following:

(a) Your source code and executable.

(b) A report using the template provided.

Submitting the project

Submit item (a) at : **http://learn.ukzn.ac.za** and a hard copy at office 5:03 (Electrical Engineering Building North) Make sure you include your details in all documents related to your submission.
