Lab work – LBP-based Face Recognition

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1. Objectives

Basic manipulation of images ; Computation of histograms and the associated Chi square distance ; Pattern recognition for face recognition ; Facial representation by LBP; Experimental evaluation, cross-validation, rank one recognition, verification rate at a given FAR

2. Introduction

LBP [1], Local binary patterns, was originally designed for texture description. The operator assigns a label to very pixel of an image by thresholding the 3x3-neighborhood of each pixel with the center pixel value and considering the result as a binary number. Then, the histogram of the labels can be used as a texture descriptor. Formally, the LBP label ø of the pixel at (x_c, y_c) is calculated as:

$$LBP(x_c, y_c) = \sum_{p=0}^{7} S(g_p - g_c) \times 2^p, \; S(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$$

g_c is the value of the central pixel, g_p corresponds to the gray value of the p-th neighboring pixel. See Fig.1 for an illustration of the basic LBP operator.

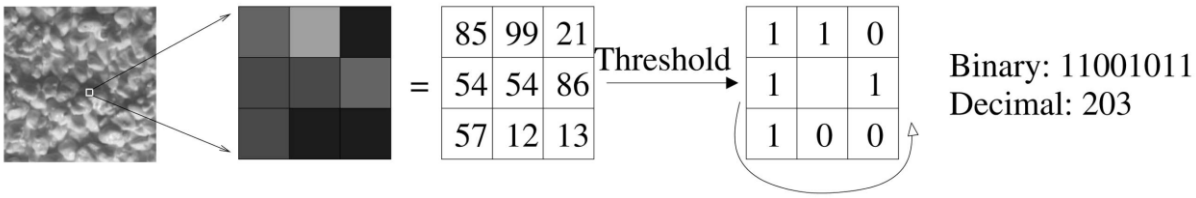

Figure 1 - Basics of the LBP operator

This lab work is based on the paper [2] by T. Ahonen, A.Hadid and M.Pietikäinen who proposed to use LBP for face description and recognition. The whole lab work will be carried out on the Olivetti dataset which contains 40 subjects, each of them having ten face images having slight pose changes and facial expressions as illustrated in the following figure.

3. Face description by LBP

Given a face image, we propose to build two kinds of facial description using LBP, the first one being holistic while the second spatially enhanced.

1.1 Facial description by LBP histogram

We propose here to encode a face image by a global histogram of LBP constructed on this face image. This implies first to compute LBP for each pixel and then to build the overall histogram of LBPs. Program in Mathlab the construction of LBP histogram given a face image as input.

1.2 Facial description by spatially enhanced LBP histogram

The aim here is to encode both the appearance and the spatial relations of facial regions as illustrated in fig.2. As the *m* facial regions $R_0, R_1, \ldots, R_{m-1}$ have been determined, a LBP histogram is computed independently within each of the *m* regions.

Figure 2 - a facial image divided into 7x7, 5x5 and 3x3 rectangular regions

Program in Mathlab the construction of LBP histograms associated with an image divided respectively into 7x7, 5x5 and 3x3 regions.

4. Computing the similarity score

Now given a face image I in the gallery and a new face image P as probe, one needs to compute a similarity measure indicating whether the two face images are similar or not. For this purpose, we propose to make use of the Chi square distance defined as follows on the two LBP histograms respectively computed over I and P :

$$\aleph^2(\alpha,\beta) = \sum_i \frac{(\alpha_i - \beta_i)^2}{\alpha_i + \beta_i}$$

where α (respectively β) designate respectively the LBP histogram associated with the face image I (respectively P).

Now when a face image is divided into m regions where a LBP histogram can be computed over each region. The similarity score between two face images I and P can be obtained as a weighted sum of the individual similarity scores over each region as follows:

$$\aleph^2(\alpha,\beta) = \sum_{j,i} w_j \frac{(\alpha_{i,j} - \beta_{i,j})^2}{\alpha_{i,j} + \beta_{i,j}}$$

Where j designates the j-th region.

4.1 Program in mathlab the Chi square distance between two histograms.

4.2 Propose some fusion strategies regarding the weighting coefficients w_j.

5. Experimentation and evaluation

Using the Olivetti dataset, we want to evaluate the LBP-based face recognition method both for recognition task (one to many) and verification task (one to one). We propose to put 4 face images per subject in the in the gallery, the remaining face images are used for testing.

3.1. Recognition

Compute and compare the rank one recognition rate using respectively the holistic LBP histogram and spatially enhanced LBP histograms.

We propose now to proceed the experiment by cross-validation. Please change randomly 10 times the 4 face images per subject in the gallery and compute the average rank one recognition rate and the associated standard deviation.

3.2. Verification

Now draw the ROC curve for each of the LBP facial representations (Holistic one and the spatially enhanced one). Give the verification rate at FAR=0,01.

6. References

[1] T. Ojala, M. Pietika¨inen, and T. Ma¨enpa¨a¨, "Multiresolution Gray-Scale and Rotation Invariant Texture Classification with Local Binary Patterns," IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 24, no. 7, pp. 971-987, July 2002

[2] Timo Ahonen, Abdenour Hadid and Matti Pietikäinen, "Face Description with Local Binary patterns: Application to Face Recognition", IEEE Transaction of Pattern Analysis and Machine Intelligence, vol. 28, no.12, Dec. 2006