STATISTICAL TEXTURE DESCRIPTORS

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Texture is a most high-quality invariant used for identification and classification of the complex biological objects such as iris and white blood cells. There is three different approaches for specify texture: structural, spectral and statistical. The statistical approach has a most efficient for classification as was determined while investigations of the human white blood cells. This approach is based on the modified gray-tone spatial-dependence matrixes.

Gray-tone spatial-dependence matrix is an estimate of the second order probability distribution density. Matrix element is conditional probability $P\,(i\,|\,j)$ of gray level *i* occurring on the distance *d* from gray level *j* occurring. It's quite reasonable to calculate four matrixes for each step *d* for 0, 45, 90 and 135 degrees directions. Matrixes above are squared and with size equal to number of gray levels on the image – N_g. Then step > 1 is used for matrixes build, it's possible to modify algorithm above to achieve more self-descriptiveness of the statistical descriptors. Probability $P\,(i\,|\,j)$ in this case is the conditional probability of gray level *i* occurring **sequence** with size *d* after gray level *j* occurring. In this case gray-tone spatial-dependence matrix become non-symmetrical (unlike in classic case). That allows including the new texture descriptors, for example triangular symmetry. During practical investigation it was clarified that such approach is improve divide ability of a number of statistical descriptors.

Statistical texture descriptors are built on basis of obtained gray-tone spatial-dependence matrixes. 14 classic parameters are mentioned first at [1]. 7 parameters were added to them in [2]. For example let's consider two of them:

$$T_1 = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (P\,(i\,|\,j))^2 \qquad (1)$$

$$T_2 = \left(\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (ij) P\,(i\,|\,j) - \mu_x \mu_y \right) / (\sigma_x \sigma_y) \qquad (2)$$

where μ_x, μ_y, σ_x and σ_y are the means and standard deviations of the marginal distributions associated with $P\,(i\,|\,j)$.

Angular second moment (1) is a measure of homogeneity of the image. Correlation (3) is a measure of gray-tone linear-dependencies in the image. Each textural parameter is calculated four times by number of achieved gray-tone spatial-dependence matrixes (for 0, 45, 90 and 135 degrees directions). Most often it's necessary to analyze objects invariant by rotate. In this case statistical values based on four oriented values can be used (such as minimum, maximum, mean, standard deviation, etc).

The main task is searching of the minimal set of the most informational high-correlated parameters. Size and structure of this set is strongly dependent from the recognition task (class of processed objects), and also from step selected for matrixes building. Correctly built set significantly increases probability of the true classification and also decreases computational resources required while classifier is building, learning and working.

Literature

1. *Haralick R. M.* et al. Textural features for image classification// IEEE Transactions on Systems, Man and Cybernetics. 1973. pp. 610–621
2. *Pressman N. J.* Markovian analysis of cervical cell images// The journal of histochemistry and cytochemistry. 1976. pp. 138–144