Tsallis Entropy-based mass and non-mass classification

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1 Introduction

Breast cancer is the most frequent disease among women. In 2012 about 1.7 millions of new cases were registered around the world [1]. Screening mammography provides a significant reduction on breast cancer mortality rate and computational methods are improving this exam efficiency. This paper presents a new approach for mass and non-mass classification based on Tsallis entropy feature extraction from singular value decomposition (SVD).

2 Methodology

Figure 1 shows the pipeline of the process of this work.

Based on [2], gray-level co-occurrence matrix (GLCM) was calculated for each quantized image on database fixing a distance $d$ and varying the direction $\theta$. From GLCM results, SVD was applied using Equation (1).

$$ A = U_{(G \times G)} \Sigma_{(G \times G)} V_{(G \times G)}^T $$

where $G$ corresponds to gray-level value ($G \in \{2^3, 2^4, 2^5, 2^6, 2^7, 2^8\}$), $U$ and $V$ matrices are composed by eigenvectors of $AA^T$ and $A^TA$, respectively. $\Sigma$ matrix represents the

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diagonal matrix ($\Sigma = \text{diag}(\sigma_1, \sigma_2, \sigma_3, \ldots, \sigma_G)$) composed by all singular values. These values were used then to calculate Tsallis entropy [3] through Equation (2)

$$S = \frac{1 - \sum_{i=0}^{G} (\sigma_i)^q}{q - 1} \quad (2)$$

where $q$ is an real number that can be changed according to the application.

3 Results

Exhaustive tests were developed to refine $q$-index range and the best results were provided by $q \in [1.71, 1.79]$. The best results are described on Table 1.

Five metrics statistics were calculated over classification results: accuracy, sensibility, specificity, positive predict value and negative predict value.

<table>
<thead>
<tr>
<th>$q$</th>
<th>$d$</th>
<th>Statistics (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acc.</td>
</tr>
<tr>
<td>1.73</td>
<td>1</td>
<td>82.2</td>
</tr>
<tr>
<td>1.76</td>
<td>1</td>
<td>84.2</td>
</tr>
<tr>
<td>1.79</td>
<td>1</td>
<td>82.6</td>
</tr>
</tbody>
</table>

4 Conclusions

The main proposal was to provide a novel approach for mass and non-mass classification based on Tsallis entropy extraction from SVD of GLCM matrices. To improve accuracy rate, $q$-index value were adjusted and the best value was provided for pair $(q, d) = (1.76, 1)$ where accuracy was 84.2%.

Referências

