Local Diagonal Extrema Pattern: A New and Efficient Feature Descriptor for CT Image Retrieval

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Introduction

The major problems with the existing descriptors are, 1) discriminative descriptors are high dimensional and 2) low dimensional descriptors are less discriminative.

Local Diagonal Extrema Pattern (LDEP) uses the relationship among local neighbors as well as relationship of center with local neighbors.

The consideration of only diagonal neighbors greatly reduces the dimension of the feature vector.

The superiority in terms of performance and efficiency in terms of speedup of the proposed method are confirmed by the experiments over two CT image databases.

Local Diagonal Extrema Pattern

The relationship of local diagonal extremes (i.e. maxima and minima) with the center pixel is used to encode the LDEP descriptor.

The computation process of LDEP is illustrated using an example in Fig. 1.

The example considered is depicted in Fig. 1(b).

Let \( \tau_{\text{max}} \) and \( \tau_{\text{min}} \) are the position of maximum and minimum diagonal neighbors.

The values of maximum and minimum diagonal neighbors (i.e. \( i_{\text{max}}^{ij} \) and \( i_{\text{min}}^{ij} \) respectively) as well as center pixel are extracted in Fig. 1(c).

The values of \( \tau_{\text{max}} \) and \( \tau_{\text{min}} \) are shown in Fig. 1(d).

The values and indexes of the local diagonal extremes are computed which is used with the central pixel to form the local diagonal extrema pattern.

The local diagonal extrema pattern (LDEP) for \( P^{ij} \) is represented as a binary pattern \( LDEP^{ij} \) as follows,

\[
LDEP^{ij} = (LDEP_{1}^{ij}, LDEP_{2}^{ij}, ..., LDEP_{d}^{ij})
\]

where \( \dim \) is the length of the LDEP pattern and \( LDEP_{k}^{ij} \) is the \( k \)th element of the LDEP pattern and given using the following formulae,

\[
LDEP_{k}^{ij} = \begin{cases} 
1, & \text{if } k = (\tau_{\text{max}} + 8) \\
0, & \text{else} \\
\end{cases}
\]

Note that the dimension of the pattern \( LDEP^{ij} \) is the maximum possible value of \( k \) which is \( 24 \) when \( \tau_{\text{min}} = 4 \) and \( \delta = 2 \). It means that the dimension \( \dim \) of the LDEP is \( 24 \).

The value of \( \delta \) for considered example is demonstrated in the Fig. 1(e).

Finally, the LDEP pattern is depicted in Fig. 1(g). Only two elements of the pattern are set to 1 and the rest are zeros.

Experiments and Results

Databases Used –

Emphysema-CT [1]: Three categories Normal Tissue (NT), Centribular Emphysema (CLE), and Paraseptal Emphysema (PSE) containing 59, 50 and 59 images respectively. NEMA-CT [2]: The 499 CT images from different parts of the body are collected from National Electrical Manufacturers Association (NEMA) and categorized into 8 categories having 104, 46, 29, 71, 108, 39, 33 and 69 images.

Descriptors Compared –

Local Binary Pattern (LBP) [3], Local Ternary Pattern (LTP) [4], Center Symmetric LB (CSLBP) [5], Center Symmetric LTP (CSLTP) [6], Local Mesh Pattern (LMP) [7], and Local Ternary Co-occurrence Pattern (LTCoP) [8].

Results –

The retrieval results are reported in terms of average retrieval precision (ARP), average retrieval rate (ARR), F-score, and total retrieval time in seconds. Fig. 2 illustrates the comparison results over Emphysema-CT database. Fig. 3 depicts the retrieval results over NEMA-CT database. The proposed descriptor is having the comparable performance with best one while maintaining very less retrieval time.

References


