Local Bit-plane Decoded Pattern: A Novel Feature Descriptor for Biomedical Image Retrieval

IEEE Journal of Biomedical and Health Informatics, 2016

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Introduction

- Local Bit-plane Decoded Pattern (LBDP) encodes the local information in two ways, 1) relationship among the local neighbors at each bit-plane and 2) relationship of center with its neighbors.
- The dimension of other methods increases significantly while trying to enhance the discriminative ability, whereas, the dimension of LBDP is same to the Local Binary Pattern (LBP).
- The improved performance is observed over one MRI and two CT databases.

Local Bit-plane Decoded Pattern

Let M is a image of dimension $m_1 \times m_2$ with bit depth of B-bit. The $P^{i,j}$ is a pixel at coordinate (i,j) with intensity value $I^{i,j}$. The N local neighbors of $P^{i,j}$ at a circle of radius R are represented by $P^{i,j}_{R,N}$. The t^{th} neighbor of $P^{i,j}$ is denoted as $P^{i,j}_{R,N,t}$ having intensity value $I^{i,j}_{R,N,t}$ where $t \in [1,N]$. The binary value $I^{i,j,k}_{R,N,t}$ of t^{th} neighbor of $P^{i,j,0}$ in k^{th} bit-plane is defined as follows,

$$I^{i,j,k}_{R,N,t} = \left\lceil \frac{f^k}{2} \right\rceil - \left\lfloor \frac{f^k}{2} \right\rfloor \quad where \quad f^k = \begin{cases} I^{i,j,0}_{R,N,t} & ,if\ k = 1 \\ \left\lfloor \frac{f^{k-1}}{2} \right\rfloor & ,otherwise \end{cases} \tag{1}$$

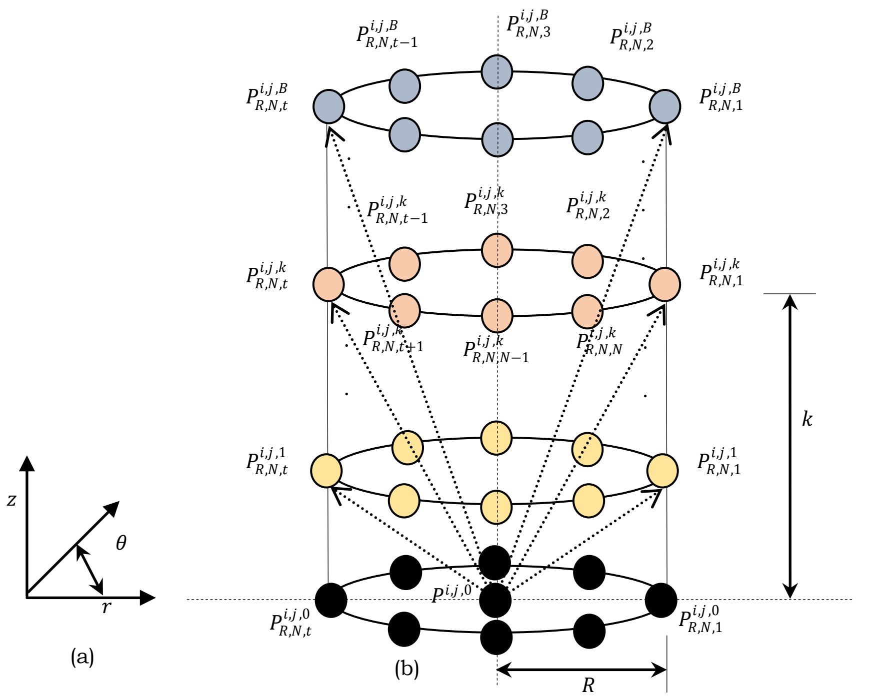

Fig.1. (a) Cylindrical coordinate system axis, (b) the local bit-plane decomposition. The cylinder has $B+1$ horizontal slices. The base slice of the cylinder is composed of the original centre pixel and its neighbors with the centre pixel at the origin. The remaining B slices correspond to the B bit-planes of the local neighbors of base slice. The $(t+1)^{th}$ slice from the base corresponds to the t^{th} bit-plane of the base slice.

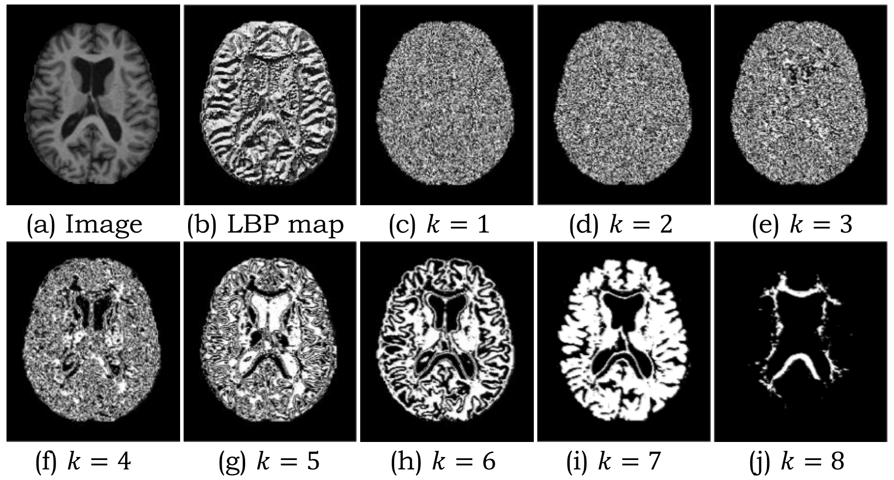

Fig.2. Example of local bit-plane transformed values map for each bit-planes for $N = 8$ and $B = 8$, (a) sample image, (b) LBP map [1] over (a), (c-j) local bit-plane transformed value maps for each bit-plane.

Local bit-plane transformed value for k^{th} bit-plane is defined as,

$$v^{i,j,k}_{R,N} = \sum_{t=1}^{N} I^{i,j,k}_{R,N,t} \times (2)^{(t-1)} \tag{2}$$

Fig. 2 shows the LBP map [1] and local bit-plane transformed value maps for a sample image from OASIS-MRI database [2].

The $LBDP$ pattern for pixel $P^{i,j}$ is given as follows,

$$LBDP^{i,j}_{R,N} = \{LBDP^{i,j,1}_{R,N}, LBDP^{i,j,2}_{R,N}, \dots\dots\dots, LBDP^{i,j,B}_{R,N}\} \tag{3}$$

where $LBDP^{i,j,k}_{R,N}$ is a binary value computed over k^{th} bit-plane as,

$$LBDP^{i,j,k}_{R,N} = \begin{cases} 1, & if\ \hat{v}^{i,j,k}_{R,N} > I^{i,j} \\ 0, & Otherwise \end{cases} \tag{4}$$

where $k \in [1,B]$ and $\hat{v}^{i,j,k}_{R,N}$ is a value obtained after range matching of $v^{i,j,k}_{R,N}$ with the range of center value and defined as follows,

$$\hat{v}^{i,j,k}_{R,N} = \left\lceil \frac{v^{i,j,k}_{R,N} + 1}{2^{(N-B)}} \right\rceil - 1 \tag{5}$$

Finally, the histogram over whole image is computed to find the LBDP descriptor over that image.

Experiments and Results

Databases Used –

Emphysema-CT [3]: Three categories containing 59, 50 and 59 CT images respectively. NEMA-CT [4]: The 499 CT images categorized into 8 categories having 104, 46, 29, 71, 108, 39, 33 and 69 images. OASIS-MRI [2]: Total 421 images from four categories having 106, 89, 102 and 124 images.

Descriptors Compared –

Local binary pattern (LBP) [1], Local ternary pattern (LTP) [5], Peak valley edge pattern (PVEP) [6], Local mesh pattern (LMeP) [7], and Local ternary co-occurrence pattern (LTCoP) [8].

The retrieval results are reported in terms of average retrieval precision (ARP). Fig. 3 illustrates the comparison results over Emphysema-CT, NEMA-CT and OASIS-MRI databases. The total retrieval time in seconds is depicted in Table 1. It is generated using MATLAB software over a computer having Intel(R) Core(TM) i5 CPU 650@3.20 GHz processor, 4 GB RAM, and 32-bit Windows 7 Ultimate operating system. The proposed LBDP descriptor outperforms the state-of-the-art descriptors while maintaining very less retrieval time.

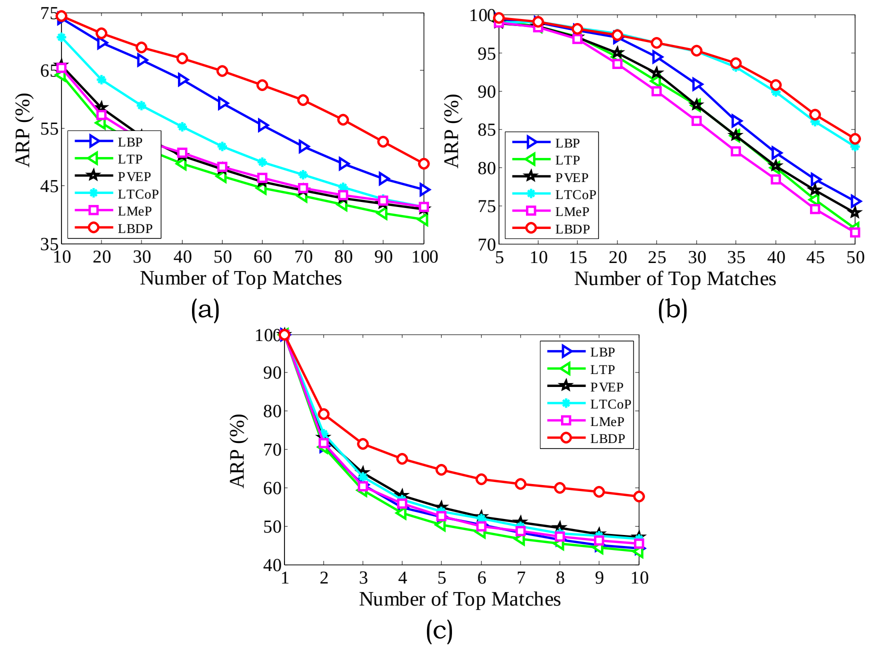

Fig.3. Result over (a) Emphysema-CT, (b) NEMA-CT, and (c) OASIS-MRI databases using LBP, LTP, PVEP, LTCoP, LMeP, and LBDP descriptors.

Table.1. The total retrieval time in seconds over Emphysema-CT, NEMA-CT and OASIS-MRI databases using each descriptor.

Database	LBP	LTP	PVEP	LTCoP	LMeP	LBDP
Emphysema-CT	0.07	0.11	1.45	0.11	0.14	0.06
NEMA-CT	0.46	0.84	12.63	0.85	1.52	0.43
OASIS-MRI	0.34	0.58	9.56	0.61	1.42	0.33

References

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