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Classification Analysis for Local Mesh Patterns using Medical Image Segmentation

Dr. Nookala Venu
Professor, Department of Electronics and Communication Engineering, Balaji Institute of Technology and Science, Warangal-506 331, Telangana, India
Corresponding Author Mail id: venunookala@gmail.com

Abstract:
The objective of this paper is to develop an effective robust fuzzy c-means clustering brain images. Local mesh patterns feature extractor is proposed for medical image segmentation. The local region of image is represented by dataset, which are evaluated by taking into consideration the magnitude of local difference between the center pixel and its neighbors. First, image split in to sub blocks and novelobjectivefunction features are extracted from each given dataset.. Once the image has been split into blocks of roughly homogeneous texture, we apply an agglomerative procedure to merge similar adjacent regions until one of the two stopping criteria is satis1ed. At each stage we merge the pair of adjacent regions which have the largest merger importance value. Based on merger importance the regions are merged and then form the segmented regions for medical image segmentation application. Experimental results are tested on benchmark MRI database for medical image segmentation application. Results after being investigated, proposed method shows a significant improvement for segmentation of images.

Keywords: *MRI, LBP, Classiication, Texture.*

1. Introduction

Nowadays lot of medical images is available and this data need to be stored for particular time period to maintain the medical data about the patient [1-2]. But with data medical hospitals are not getting any benefit from the storage. From this an idea of using this data for automatic medical applications like medical image segmentation, medical image retrieval etc. In medical image segmentation, we will segment the certain regions for analysis purpose [3-5].Initially, cluster based medical segmentation like k-mean, fuzzy c-mans algorithms are proposed for medical image segmentation. In recent years, researchers using the feature based algorithms for medical image segmentation. Based on the literature, we motivated to work in the direction of medical image segmentation using feature descriptors [5-8]. Now, a concise review of the related literature available, targeted for development of our algorithms is given here. Local binary pattern features have emerged as a silver lining in the field of texture retrieval. Ojala et al. proposed LBP [11-12] which are converted to rotational invariant for texture classification in [13-15]. Rotational invariant texture classification using feature distributions is proposed in [16-18]. The combination of Gabor filter and LBP for texture segmentation [19-21] and rotational invariant texture classification using LBP variance with global matching [22-24] has also been reported. Liao et al. proposed the dominant local binary patterns (DLBP) for texture classification [25]. Guo et al. developed the completed LBP scheme for texture classification [26]. LBP operator on facial expression analysis and recognition is successfully reported in [27] and [9]. Xi Li et al. proposed multi-scale heat kernel based face representation, for heat kernels that performs well in characterizing the topological structural information of face appearance [28-29]. Further, the local binary pattern (LBP) descriptor is incorporated into the multistate heat kernel face representation for capturing texture information of face appearance [30]. Face recognition under different lighting conditions by the use of local ternary patterns is discussed in [31-33] where emphasis lays on the issue of robustness of the local patterns. The background modeling and detection using LBP, extended LBP for shape localization and LBP for interest region description has been reported in [34-38] and [39-42] respectively. Zhao et al. proposed the local spatiotemporal descriptors using LBP to represent and recognize spoken isolated phrases based solely on visual input [43-46]. Spatiotemporal local binary patterns extracted from mouth regions are used for describing isolated phrase sequences. Unay et al. proposed the local structure-based region-of-interest retrieval in brain MR images [47-51]. Yao and Chen proposed the local edge patterns for texture retrieval [52-54] where LEP value is computed using an edge obtained by applying the Sobel edge detector to intensity gray level and then LEP feature are extracted to describe the spatial structure of the local texture according to the organization of the edge pixels in a neighborhood [55-57]. The LBP operator was introduced by Ojala *et al.* [58-59] for texture classification. Success in terms of speed (no need to tune any parameters) and performance is reported in many research areas such as texture classification [60-62], face recognition [63-65], object tracking, bio-medical image retrieval and finger print recognition. Given a center pixel in the 3×3 pattern, LBP value is computed by comparing its gray scale value with its neighborhoods based on Eq. (1) and Eq. (2):

$$LBP_{P,R} = \sum_{i=1}^{P} 2^{(i-1)} \times f(I(g_i) - I(g_c)) \qquad (1)$$

$$f(x) = \begin{cases} 1 & x \geq 0 \\ 0 & else \end{cases} \qquad (2)$$

Where $I(g_c)$ denotes the gray value of the center pixel, $I(g_i)$ is the gray value of its neighbors, P stands for the number of neighbors and R, the radius of the neighborhood [66].

Fig. 1 shows an example of obtaining an LBP from a given 3×3 pattern. The histograms of these patterns extract the distribution of edges in an image [67].

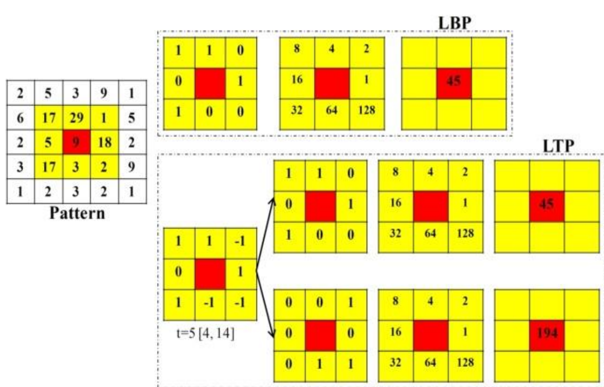

Fig. 1: Example of obtaining LBP and LTP for the 3×3 pattern

Tan and Triggs [11] extended the LBP to three valued code called local ternary patterns (LTP), in which gray values in the zone of width ±*t* around g_c are quantized to zero, those above (g_c+t) are quantized to *+1* and those below (g_c-t) are quantized to *-1*, i.e., the indicator $f(x)$ is replaced with 3-valued function (Eq. 3) and binary LBP code is replaced by a ternary LTP code as shown in Fig. 1.

$$\vec{f}(x, g_c, t) = \begin{cases} +1, & x \geq g_c + t \\ 0, & |x - g_c| < t \\ -1, & x \leq g_c - t \end{cases} \Bigg|_{x=(g_p - g_c)} \qquad (3)$$

More details about LTP can be found in [68].

After computing the LP (LBP or LTP) for each pixel *(j, k)*, the whole image is represented by building a histogram as shown in Eq. (4).

$$H_{LP}(l) = \sum_{j=1}^{N_1}\sum_{k=1}^{N_2} f(LP(j,k), l);\ l \in [0, (2^P - 1)] \qquad (4)$$

$$f(x, y) = \begin{cases} 1 & x = y \\ 0 & else \end{cases} \qquad (5)$$

Where the size of input image is $N_1 \times N_2$.

For the local pattern with P neighboring pixels, there are 2^P (0 to 2^P-1) possible values for both LBP and LMeP, resulting in a feature vector of length 2^P. A high computational cost is involved in extracting such a feature vector. Thus, uniform patterns [69] are considered to reduce the computational cost. A uniform pattern refers to a circular binary representation having limited discontinuities. In this paper, patterns with two or less discontinuities in the circular binary representation are termed as uniform while rest of the patterns are termed as non-uniform. Thus, the distinct uniform patterns for a given query image would be $P(P-1)+2$. The possible uniform patterns for P=8 can be seen in [70].

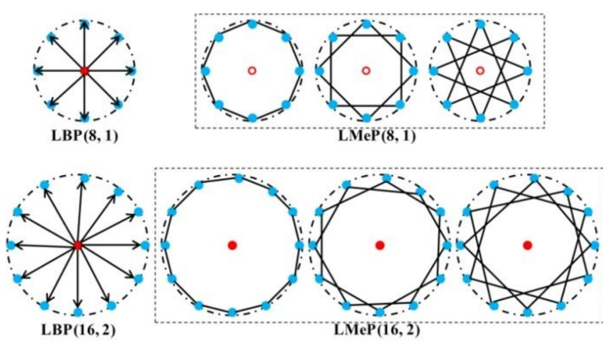

Fig. 2: The LBP and the first three LMeP calculations for a given (P, R).

After identifying the local pattern, *PTN* (the LBP or the first three LMePs) the whole image is represented by building a histogram using Eq. (4)

$$H_S(l) = \frac{1}{N_1 \times N_2}\sum_{j=1}^{N_1}\sum_{k=1}^{N_2} f_2(PTN(j,k), l);\ l \in [0, P(P-1)+2] \qquad (7)$$

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$$f_2(x,y) = \begin{cases} 1 & if\ x = y \\ 0 & else \end{cases} \qquad (8)$$

Where, $N_1 \times N_2$ represents the size of input image.

Fig.2 illustrates the feature maps obtained by applying the LBP and the first three LMePs operators on referenced MR image [71]. The experimental results demonstrate that the proposed LMeP shows better performance as compared to LBP, indicating that it can capture more edge information than LBP for biomedical image retrieval [72].

3. Proposed Algorithm

Algorithm:

Input: Image; Output: Retrieval result

1. Load the gray scale image
2. Calculate the LMeP features from an image.
3. Divide the LMeP map in to sub blocks.
4. Apply the similarity between the sub blocks.
5. Based on the similarity merge the sub blocks.
6. Form the regions (segments) for final segmentation.

4. Results and Discussions

In order to verify the effectiveness of the proposed algorithm, experiments were conducted on two brain MRIs [19]. The performance of the proposed algorithm is compared with the other existing FCM variant methods in terms of score, number of iterations (NI) and computational time (CT) on OASIS-MRI dataset.

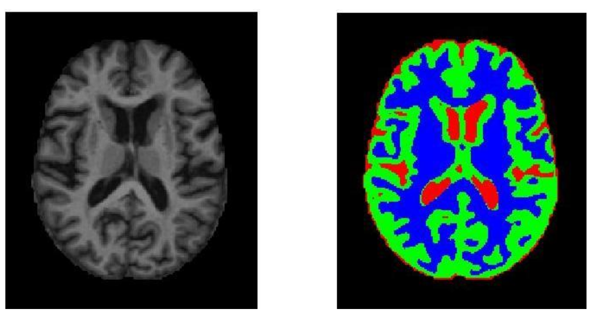

Fig. 3: Segmentation results of proposed method.

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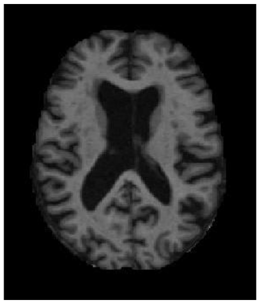

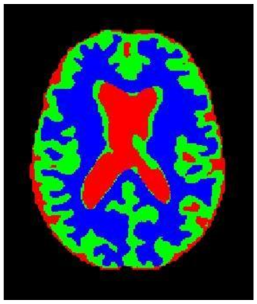

Fig. 4: Segmentation results of proposed method.

Fig. 3 and Fig. 4 illustrate the segmentation results of the proposed algorithm. Table 1 to table 6 illustrates the results of proposed algorithm for image segmentation. The results after being investigated, the proposed method outperforms the other existing method in terms of score, number of iterations and time on benchmark database.

Table 1: Comparison of various techniques in terms of score on Image (a) at different Gaussian noise
Cl: Cluster

Method	Gaussian Noise (%)											
	5%			10%			15%			20%		
	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3
LBP	0.66	0.79	0.86	0.58	0.72	0.81	0.53	0.69	0.80	0.49	0.65	0.78
LMeP	0.68	0.82	0.88	0.59	0.74	0.84	0.56	0.72	0.82	0.53	0.68	0.81

Table 2: Comparison of various techniques in terms of score on Image (b) at different Gaussian noise
Cl: Cluster

Method	Gaussian Noise (%)											
	5%			10%			15%			20%		
	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3
LBP	0.73	0.80	0.87	0.58	0.66	0.80	0.54	0.69	0.80	0.51	0.66	0.78
LMeP	0.78	0.84	0.89	0.59	0.68	0.82	0.58	0.74	0.83	0.54	0.67	0.80

Table 3: Comparison of various techniques in terms of score on Image (a) at different Salt-Pepper noise
Cl: Cluster

Method	Salt-Pepper Noise (%)											
	5%			10%			15%			20%		
	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3
LBP	0.72	0.76	0.82	0.62	0.69	0.74	0.56	0.66	0.77	0.54	0.68	0.74
LMeP	0.76	0.79	0.84	0.64	0.73	0.77	0.58	0.69	0.79	0.57	0.69	0.76

Table 4: Comparison of various techniques in terms of score on Image (b) at different Salt-Pepper noise
Cl: Cluster

Method	Salt-Pepper Noise (%)											
	5%			10%			15%			20%		
	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3	Cl-1	Cl-2	Cl-3

LBP	0.76	0.79	0.85	0.56	0.66	0.77	0.51	0.62	0.77	0.50	0.63	0.72
LMeP	0.79	0.82	0.88	0.59	0.69	0.81	0.56	0.66	0.80	0.54	0.66	0.74

Table 5: Comparison of various techniques in terms of number of iterations and execution time at different Gaussian noise on Image (a)

NI: Number of iterations; TM: Execution Time (Sec.)

Method	Gaussian Noise							
	5%		10%		15%		20%	
	NI	TM	NI	TM	NI	TM	NI	TM
LBP	28	0.65	30	0.68	24	0.50	23	0.48
LMeP	22	0.57	23	0.65	23	0.60	30	0.81

Table 6: Comparison of various techniques in terms of number of iterations and execution time at different Salt-Pepper Noise on Image (a)

NI: Number of iterations; TM: Execution Time (Sec.)

Method	Salt-Pepper Noise							
	5%		10%		15%		20%	
	NI	TM	NI	TM	NI	TM	NI	TM
LBP	31	0.62	35	0.60	26	0.49	26	0.46
LMeP	26	0.52	22	0.54	21	0.36	21	0.36

5. Conclusions

A novel methodology based on feature descriptors is proposed for medical image retrieval application. For feature extraction LMeP is used and then merging of sub blocks concept is used for segmentation. The performance of the proposed method is tested on benchmark database. The results after being investigated proposed method outperforms the other existing methods in terms of segmentation score.

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