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STUDY OF PATCHMATCH BASED TREE-SEED FUZZY CLUSTERING FOR ISCHEMIC STROKE LESION

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ABSTRACT

Since the brain manages whole functions of the human body, the brain is considered to be one of the significant organs of the body. Several illnesses like infections, tumors, and strokes affect the brain. In addition, tumor brain may be a noncancerous or cancerous group or abnormal cell growth in the brain. Methods like MRI can be employed for detecting brain tumors. Lately, MRI scans have gained attention due to the requirement for a better evaluation of huge amounts of information (El-Dahshan et al 2014). Obtaining brain samples and automated classification of brain cells from MRI scans is important both in medicine and in experimental studies of common and diseased brain tumors. The most significant step in the fabrication of medical imaging is segmentation, which separates the matters in the image for processing.

Medical imaging is very important in detecting brain tumors because they show different texture of the tissues and do not require surgery. Consequently, it is difficult to spot brain tumors without a medical imaging process. The two most commonly used medical imaging techniques are Computed Tomography (CT) and MRI. Both of these methods play a significant role & have an excessive impact on diagnosis (Vilela P et al 2017).

MRI is a contemporary medical imaging system employed to identify and visualize internal details of the body (Wadhwa A et al 2019). This technique utilizes central principles of Nuclear Magnetic Resonance (NMR)that was examined since the commencement of the twentieth century. MRI do not utilize X-rays, but have a great magnet that transmits radio waves to the body. Images are then displayed on a computer or on photos. MRI is very different than CT, which is very advantageous for neurological illnesses. The benefits of MRI than other imaging systems is the non-invasive nature, exceptional tissue contrast, flow sensitivity, versatility, and scattering (Wilde EA et al 2015).

LITERATURE REVIEW

This section explores the recent research works that are carried out to segment the ischemic lesions in MR brain images.

A Gautam *et al.* 2019 segmented the ISL from the MR images by Random Forest method. It contains two steps: (i) image pre-processing, (ii) Feature extraction, and (ii) segmentation. For the pre-processing of images, wavelet transform is utilized that have the properties of signal decomposition, modelling, analyzing, and reconstruction. Here, the input signal is initially delivered through a Low Pass Filter (LPF) &a High Pass Filter (HPF). After pre-processing, the voxel intensities are extracted from various portions of the brain. Finally, segmentation is then performed by thresholding based on histogram and random forest classifier.

The combination of two techniques gives higher accuracy for their system. The drawback in this method is that is that it fails to identify small lesions and therefore the dataset size should be increased.

A Subudhi *et al*. 2018 incorporated Darwinian particle swarm optimization (DPSO) Delaunay Triangulation (DT) to automatically segment the regions of stroke lesions. Their approach comprises of three phases: pre-processing, segmentation, and classification. At the initial phase, the images are de-noised by using Wiener Filter (WF) and the edges are sharpened by spatial 3×3 mask. At the second phase, non-overlap regions are obtained by applying DT, DPSO was applied to get the binary lesion, and then the unwanted artifacts are removed by morphology. At the final classification phase, the geometrical and statistical features are extracted by random forest algorithm. They validated the performance on 192 MRI images collected from various stroke subjects and concluded with better results. However, this approach failed to estimate the volume of the lesion.

V Rajinikanth *et al*. 2018 introduced a semi-automated technique for the segmentation for stroke lesions by combining Social Group Optimization (SGO) and Fuzzy-Tsallis Entropy (FTE). This framework can be segmented into two segments: pre-processing and post-processing. The images are preprocessed by employing SGO based on FTE. Here, FTE provides solution for multi-level thresholding problem which helps to enhance the image qualities than most of the other techniques. The evaluation conducted under ISLES 2015 dataset proved greater accuracy with better image statistical, quality, and similarity measure. However, the computational time and the error rates are high.

GB Praveen *et al.* 2018 used Stacked Sparse Auto Encoder (SSAE) for the segmentation of ISL. At the pre-processing stage, (i) the intensity is made constant throughout the image by field correction technique, (ii) unit variance and zero mean is obtained by patch normalization, (iii) redundancy in the pixel is removed by making the pixels of the adjacent layer less correlated. After, pre-processing, the patches are extracted from the testing and the training data. Then, the features are learned in an unsupervised fashion by auto encoders which comprises of three layers: input, hidden, and output layer. Here, the input is compacted into latent space and the output is reconstructed. This scheme has the benefit of compressing the data as well as reducing the dimensionality.

Z Liu *et al*. 2018introduced residual Fully Convolutional Network (Res-FCN). Here, the parameters are tuned by gradient based method so that the difference between the predicted and ground truth values are minimum. Initially, all the images are normalized to unit variance and zero mean. During the training process, the patches are extracted using a sliding window scheme. At the testing phase, the intensities of the images are normalized and the patches are extracted. For the extraction of features, they utilized ResNet structure comprising of bottleneck blocks and filters. The Res-FCN incorporated sections: convolutional layer, bottleneck block, and loss function. The convolutional layer learns the features by stochastic gradient descent approach. The bottleneck block comprises of several convolutional layers to shrink the dimensionality of the features, to restore the depth, and to have the output same as the size of input. Finally, the loss function measures the error by dice coefficient. The advantage of this method is that it is sensitive to both small and large lesion. But, stroke classification is not so perfect.

A Subudhi e*t al.* 2018 presented lesion segmentation based on watershed method. This system includes edge detection, filtering, feature extraction, and classification. Initially, the edges in the image detected using fuzzy system in which the RGB image is transmuted into grayscale image. The image is then filtered by gradient filter and the watershed algorithm separates the lesion from the background. Now, the geometrical and statistical features such as autocorrelation, variance, entropy, perimeter, eccentricity etc. are extracted and are given as the input to the random forest classifier. This system has less classification error, low computation time, and higher accuracy. However, this method fails to identify the existence of false positives.

PG Bharathi *et al*. 2019 detected ISL by combining random forest and k-means clustering. At the pre-processing stage, the intensities are made constant throughout the image by bias field correction scheme. The textural features like correlation, variance, entropy, homogeneity, cluster prominence etc. are then extracted by Gray Level Co-occurrence Matrix (GLCM). Due to the occurrence of huge quantity of unlabeled data, the features are learned by k-means clustering. Now, the dimensionality of the features are reduced by Principal Component Analysis (PCA) which discards the irrelevant features and keeps only the relevant features. At the final stage, the random forest scheme classifies the result.

Y Zhang *et al*.2020 introduced a multi-inputs UNet (MI-UNet) for the information of brain parcellation, which consist of white matter (WM), lateral ventricle (LV), and gray matter (GM). By using the algorithm fast large deformation diffeomorphic metric mapping of image, they initially parcellate every T1w MR images into region of multiple whole-brain. Beside WM and GM, they include LV in the location because the lesion of stroke is nearer to the ventricles of brain. To forming two-channels input to the consequent MI-UNet, the brain parcellation is then divided and concatenated with the divided MR images. Finally they suggest an automated stroke lesion segmentation. The advantage of this method is to recognize the particular stroke lesion. However, it takes computation time for registration step.

OBJECTIVES

- To enhance the quality & contrast of the image by a suitable pre-processing technique.
- To accurately segment the ISL from the given MR image by an optimized fuzzy clustering technique.
- To classify the Ischemic lesion region from normal tissue.
- To evaluate & compare the proposed method with the existing technique under various metrics.

METHODOLOGY

For the segmentation of ISL, we propose Patch Match based Tree-Seed Fuzzy Clustering (PM-TSFC). Fuzzy C-means (FCM) clustering is a typical clustering procedure in machine learning and pattern recognition. For proper segmentation of ISL, each pixel should be allotted to the nearest cluster. To do this, we employ FCM to minimize the weighted distance between pixels & cluster centers. Moreover, the inclusion of Tree Seed Optimization algorithm helps to find the nearest optimal cluster center. This makes the proposed PM-TSFC to segment ISL with greater accuracy.

The segmentation of ISL from the MR image involves some steps as illustrated in Figure 1.

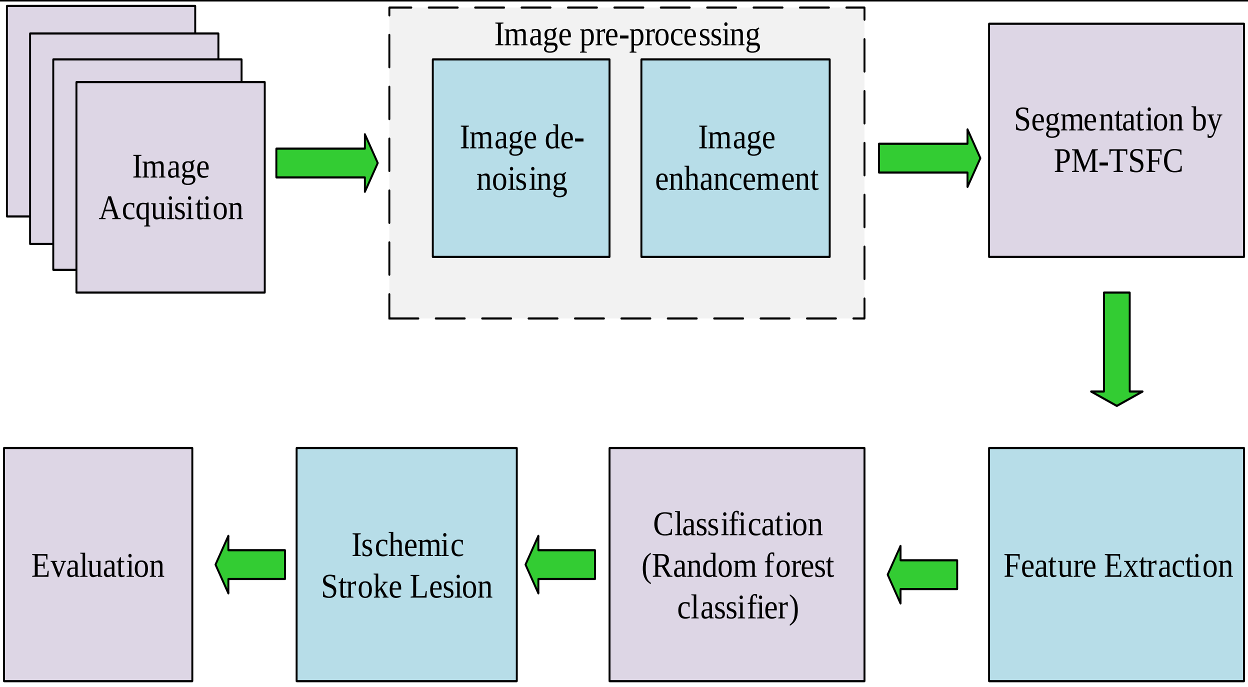

Figure 1: Process Flow for the Proposed System

(i) Image Acquisition:

Initial stage includes collection of MRI samples from ISLES 2015 challenge dataset. This dataset consists of brain MRI with modalities like flair, DW, and T1. This dataset also contains three views, like axial, coronal, and sagittal.

(ii) Pre-processing:

To lessen the imperfections of the image, preprocessing steps are practiced. The accuracy of the MRI image is limited by the noise present in the tumor image. Therefore, the noise present in the image is initially removed by bilateral filter and the intensities are made constant throughout the image by histogram equalization for further analyzing process.

(iii) Segmentation:

After pre-processing, PM-TSFC technique as described in the methodology section segments the image.

(iv) Feature Extraction & Classification:

During this phase, the GLCM features like entropy, energy, etc. are extracted. By training the system, the tissues are classified as stroke lesion (nearly white), cerebrospinal fluid (black), and brain region (gray) by using Random Forest Classifier.

LIMITATIONS

The process of segmenting an image into numerous divisions (collection of pixels) is termed as image segmentation. Typically image segmentation is utilized to detect objects within the image that produces a set of segments that completely cover the whole image. Here, the pixels within a region are identical with respect to certain characteristics such as intensity, color, and texture. Traditional image processing methods like clustering, graph cut and brain symmetry for lesion segmentation have been utilized to detect and segment ischemic injury. However, in various real situations, disputes such as overlapping intensities, poor contrast, and limited spatial resolution make segmentation a challenging task. Therefore, a robust, automated, and accurate lesion delineation is essential to segment the lesion and improve the diagnosis speed for further treatment.

EXPECTED OUTCOME

The simulation will be conducted in MATLAB platform and is expected that the proposed PM-TSFC scheme outperforms the existing techniques. Evaluation metrics such as accuracy, recall, dice, precision, specificity etc. are used to relate the performance of the proposed approach with existing state-of the-art techniques. These metrics are obtained based on the number of True Positives (TP), True Negatives (TN), False Negatives (FN), and False Positives (FP).

REFERENCES

1) Abulnaga SM, Rubin J. Ischemic stroke lesion segmentation in CT perfusion scans using pyramid pooling and focal loss. InInternational MICCAI Brainlesion Workshop 2018 Sep 16 (pp. 352-363). Springer, Cham.
2) Acharya UR, Meiburger KM, Faust O, Koh JE, Oh SL, Ciaccio EJ, Subudhi A, Jahmunah V, Sabut S. Automatic detection of ischemic stroke using higher order spectra features in brain MRI images. Cognitive systems research. 2019 Dec 1;58:134-42.
3) Babu MS, Vijayalakshmi V. A review on acute/sub-acute ischemic stroke lesion seg- mentation and registration challenges. Multimedia Tools and Applications. 2019 Jan 1;78(2):2481-506.
4) Babu MS, Vijayalakshmi V. An Effective Approach for Sub-acute Ischemic Stroke Le- sion Segmentation by Adopting Meta-Heuristics Feature Selection Technique Along with Hybrid Naive Bayes and Sample-Weighted Random Forest Classification. Sensing and Imaging. 2019 Dec 1;20(1):7.
5) Bertels J, Robben D, Vandermeulen D, Suetens P. Contra-lateral information CNN for core lesion segmentation based on native CTP in acute stroke. InInternational MICCAI Brainlesion Workshop 2018 Sep 16 (pp. 263-270). Springer, Cham.
6) Bharathi PG, Agrawal A, Sundaram P, Sardesai S. Combination of hand-crafted and un- supervised learned features for ischemic stroke lesion detection from Magnetic Resonance Images. Biocybernetics and Biomedical Engineering. 2019 Apr 1;39(2):410-25.
7) Binaghi E, Omodei M, Pedoia V, Balbi S, Lattanzi D, Monti E. Automatic Segmentation of MR Brain Tumor Images using Support Vector Machine in Combination with Graph Cut. InIJCCI (NCTA) 2014 Oct 22 (pp. 152-157).
8) Chen W, Liu B, Peng S, Sun J, Qiao X. S3D-UNet: separable 3D U-Net for brain tumor segmentation. InInternational MICCAI Brainlesion Workshop 2018 Sep 16 (pp. 358-368). Springer, Cham.
9) Chen, X., Pan, L. (2018). A survey of graph cuts/graph search based medical image segmentation. IEEE reviews in biomedical engineering, 11, 112-124.
10) Chin CL, Lin BJ, Wu GR, Weng TC, Yang CS, Su RC, Pan YJ. An automated early ischemic stroke detection system using CNN deep learning algorithm. In2017 IEEE 8th International Conference on Awareness Science and Technology (iCAST) 2017 Nov 8 (pp. 368-372). IEEE.
11) Dong H, Yang G, Liu F, Mo Y, Guo Y. Automatic brain tumor detection and segmentation using U-Net based fully convolutional networks. Inannual conference on medical image understanding and analysis 2017 Jul 11 (pp. 506-517). Springer, Cham.
12) El-Dahshan ES, Mohsen HM, Revett K, Salem AB. Computer-aided diagnosis of human brain tumor through MRI: A survey and a new algorithm. Expert systems with Applica- tions. 2014 Sep

1;41(11):5526-45.

13) Feng X, Ye G, Cao R, Qi P, Lu J, Chen J, Wang D. Identification of Predictors for Hemorrhagic Transformation in Patients with Acute Ischemic Stroke After Endovascular Therapy Using the Decision Tree Model. Clinical Interventions in Aging. 2020;15:1611.
14) Gautam, A., Raman, B. (2019). Segmentation of ischemic stroke lesion from 3d mr images using random forest. Multimedia Tools and Applications, 78(6), 6559-6579.
15) Griffis, J. C., Allendorfer, J. B., Szaflarski, J. P. (2016). Voxel-based Gaussian naïve Bayes classification of ischemic stroke lesions in individual T1-weighted MRI scans. Journal of neuroscience methods, 257, 97-108.
16) Gupta, A., Vupputuri, A., Ghosh, N. (2019, July). Delineation of Ischemic Core and Penumbra Volumes from MRI using MSNet Architecture. In 2019 41st Annual Interna- tional Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) (pp. 6730-6733). IEEE.
17) Huber T, Alber G, Bette S, Boeckh-Behrens T, Gempt J, Ringel F, Alberts E, Zim- mer C, Bauer JS. Reliability of semi-automated segmentations in glioblastoma. Clinical neuroradiology. 2017 Jun 1;27(2):153-61.
18) Jiang X, Andjelkovic AV, Zhu L, Yang T, Bennett MV, Chen J, Keep RF, Shi Y. Blood- brain barrier dysfunction and recovery after ischemic stroke. Progress in neurobiology. 2018 Apr 1;163:144-71.
19) Kamnitsas K, Baumgartner C, Ledig C, Newcombe V, Simpson J, Kane A, Menon D, Nori A, Criminisi A, Rueckert D, Glocker B. Unsupervised domain adaptation in brain lesion segmentation with adversarial networks. InInternational conference on information processing in medical imaging 2017 Jun 25 (pp. 597-609). Springer, Cham.
20) Karthik R, Gupta U, Jha A, Rajalakshmi R, Menaka R. A deep supervised approach for ischemic lesion segmentation from multimodal MRI using Fully Convolutional Network. Applied Soft Computing. 2019 Nov 1;84:105685.
21) Khoshnam SE, Winlow W, Farzaneh M, Farbood Y, Moghaddam HF. Pathogenic mech- anisms following ischemic stroke. Neurological Sciences. 2017 Jul 1;38(7):1167-86.
22) Kocak B, Ates E, Durmaz ES, Ulusan MB, Kilickesmez O. Influence of segmentation margin on machine learning–based high-dimensional quantitative CT texture analysis: a reproducibility study on renal clear cell carcinomas. European radiology. 2019 Sep 1;29(9):4765-75.
23) Kumar A, Upadhyay N, Ghosal P, Chowdhury T, Das D, Mukherjee A, Nandi D. CSNet: A New DeepNet Framework for Ischemic Stroke Lesion Segmentation. Computer Methods and Programs in Biomedicine. 2020 May 1:105524.
24) Lakshmi, R. P., Babu, M. S., Vijayalakshmi, V. (2017, March). Voxel based lesion segmentation through SVM classifier for effective brain stroke detection. In 2017 In- ternational Conference on Wireless Communications, Signal Processing and Networking (WiSPNET) (pp. 1064-1067). IEEE.
25) Liu J, Li M, Wang J, Wu F, Liu T, Pan Y. A survey of MRI-based brain tumor segmen- tation methods. Tsinghua science and technology. 2014 Nov 20;19(6):578-95.
26) Liu L, Kurgan L, Wu FX, Wang J. Attention convolutional neural network for accu- rate segmentation and quantification of lesions in ischemic stroke disease. Medical Image Analysis. 2020 Oct 1;65:101791.
27) Liu Z, Chopp M. Astrocytes, therapeutic targets for neuroprotection and neurorestoration in ischemic stroke. Progress in neurobiology. 2016 Sep 1;144:103-20.
28) Liu, J., Guo, L. (2015, September). A new brain MRI image segmentation strategy based on wavelet transform and K-means clustering. In 2015 IEEE International Conference on Signal

Processing, Communications and Computing (ICSPCC) (pp. 1-4). IEEE.

29) Liu, Z., Cao, C., Ding, S., Liu, Z., Han, T., Liu, S. (2018). Towards clinical diagnosis: Automated stroke lesion segmentation on multi-spectral MR image using convolutional neural network. IEEE Access, 6, 57006-57016.

30) Mahmoudi K, Garvey KL, Bouras A, Cramer G, Stepp H, Raj JJ, Bozec D, Busch TM, Hadjipanayis CG. 5-aminolevulinic acid photodynamic therapy for the treatment of high- grade gliomas. Journal of Neuro-oncology. 2019 Feb;141(3):595-607.

31) Maier, O., Menze, B. H., von der Gablentz, J., Hähni, L., Heinrich, M. P., Liebrand, M., ... Christiaens, D. (2017). ISLES 2015-A public evaluation benchmark for ischemic stroke lesion segmentation from multispectral MRI. Medical image analysis, 35, 250-269.

32) Min H, Jia W, Wang XF, Zhao Y, Hu RX, Luo YT, Xue F, Lu JT. An intensity-texture model based level set method for image segmentation. Pattern Recognition. 2015 Apr 1;48(4):1547-62.

33) Mirajkar, P. R., Bhagwat, K. A., Singh, A., Ashalatha, M. E. (2015, August). Acute ischemic stroke detection using wavelet based fusion of CT and MRI images. In 2015 International Conference on Advances in Computing, Communications and Informatics (ICACCI) (pp. 1123-1130). IEEE.

34) Mohammad MH, Chavredakis E, Zakaria R, Brodbelt A, Jenkinson MD. A national survey of the management of patients with incidental meningioma in the United Kingdom. British journal of neurosurgery. 2017 Jul 4;31(4):459-63.

35) Mohan G, Subashini MM. MRI based medical image analysis: Survey on brain tumor grade classification. Biomedical Signal Processing and Control. 2018 Jan 1;39:139-61.

36) Mohsen H, El-Dahshan ES, El-Horbaty ES, Salem AB. Classification using deep learning neural networks for brain tumors. Future Computing and Informatics Journal. 2018 Jun 1;3(1):68-71.

37) Nandi, A. (2015, November). Detection of human brain tumour using MRI image segmen- tation and morphological operators. In 2015 IEEE International Conference on Computer Graphics, Vision and Information Security (CGVIS) (pp. 55-60). IEEE.

38) Praveen, G. B., Agrawal, A., Sundaram, P., Sardesai, S. (2018). Ischemic stroke lesion segmentation using stacked sparse autoencoder. Computers in biology and medicine, 99, 38-52.