JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

A Literature Review on Classification methods of MR brain images

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Abstract : An automated and accurate classification of MR brain images is extremely important for medical analysis and interpretation. Lot of methods have already been proposed. In this paper, we have given review on classification on a given MR brain images with different methods. There are methods which are first employed segmentation by thresholding and morphological operations. In this article, a comprehensive overview of recent automatic brain tumor segmentation techniques of MRI, PET, CT, and multimodal imaging techniques has been provided. The methods, techniques, their working principle, advantages, their limitations, and their future challenges are discussed in this article.

I. INTRODUCTION

Automated and accurate classification of MR brain images is extremely important for medical analysis and interpretation. Over the last decade numerous methods have already been proposed. Clinical decisions regarding the treatment of brain neoplasms rely, in part, on MRI at various stages of the treatment process. Radiological diagnosis is based on the multi- parametric imaging profile (CT, conventional MRI, advanced MRI). Tumour characterization is difficult, because neoplastic tissue is often heterogeneous in spatial and imaging profiles [1], and for some imaging techniques often overlaps with normal tissue (especially the infiltrating part) [2][3]. Gliomas might show mixed characteristics, for example demonstrating both low and high grade features. The reference standard for characterizing brain neoplasms is currently based on histopathology analysis following surgical biopsy or resection, but this also has limitations including sampling error and variability in interpretation [1][4].

Magnetic resonance imaging (MRI) is an imaging technique that produces high quality images of the anatomical structures of the human body, especially in the brain, and provides rich information for clinical diagnosis and biomedical research [1-5]. The diagnostic values of MRI are greatly magnified by the automated and accurate classification of the MRI images [6-8]. Wavelet transform is an effective tool for feature extraction from MR brain images, because they allow analysis of images at various levels of resolution due to its multiresolution analytic property. However, this technique requires large storage and is computationally expensive [1]. In order to reduce the feature vector dimensions and increase the discriminative power, the principal component analysis (PCA) has been used. PCA is appealing since it effectively reduces the dimensionality of the data and therefore reduces the computational cost of analysing new data [2]. Then, the problem of how to classify on the input data comes. The brain is a complex organ that contains 50–100 billion neurons. It is made up of a large number of cells, and each cell has a specific function. Most of the cells that are generated in the body partition to form new cells for appropriate functioning of the human body. When new natural cells grow, aged or damaged cells die. Then, new cells take their place. Sometimes, new cells are generated when the body does not need them. Moreover, aged or damaged cells do not die as they should. The body produces extra cells that construct a lump of tissue called a tumour. A tumour inlaid in the brain region causes the sensitive functioning of the body to be malformed. It is very difficult and perilous to treat due to its location and spreading capability [3–5]. Brain tumours are primarily categorized into two types: benign and malignant. Benign tumours are those tumours which are non-cancerous, and malignant ones are those which contain cancerous cells [6]. The early detection and recognition of brain tumours is very crucial. Presently, computer-aided diagnosis (CAD) systems are usually used for systematic and specific detection of brain abnormalities [7]. A brain tumour is the unnatural growth of tissue or central spine that can interrupt the proper function of the brain.
In recent years, researchers have proposed a lot of approaches for this goal, which fall into two categories. One category is supervised classification, including support vector machine (SVM) [3] and k-nearest neighbours (k-NN) [4]. The other category is unsupervised classification, including self-organization feature map (SOFM) [3] and fuzzy c-means [5].

While all these methods achieved good results, yet the supervised classifier performs better than unsupervised classifier in terms of classification accuracy (success classification rate) [6]. Among supervised classification methods, the SVMs are state-of-the-art classification methods based on machine learning theory [7]. Compared with other methods such as artificial neural network, decision tree, and Bayesian network, SVMs have significant advantages of high accuracy, elegant mathematical tractability, and direct geometric interpretation. Besides, it does not need a large number of training samples to avoid over fitting [8]. Electromagnetics Research, Vol. 130, 2012 371 dimensional feature space, it may be nonlinear in the original input space. The structure of the rest of this paper is organized as follows. Next gives the detailed procedures of pre-processing, including the discrete wavelet transform (DWT) and principle component analysis (PCA). It introduces the motivation and SVM, and then turns to the kernel SVM. And also introduces protecting the classifier from over fitting. Experiments used totally 160 images as the dataset, showing the results of feature extraction and reduction. Afterwards, we compare our method with different kernels to the latest methods in the decade. The clearest appearance of the changes between the different textures represented by the sub-band whose histogram has the maximum variance. J. Huang, J. Lu, C., X. Ling at al explained the process of the wavelet transforms. One of the most powerful methods for extraction is Wavelet transform. This is an effective tool for 2D image feature extraction because it allows for the analysis of images at various levels of resolution. The main advantage of the wavelet is that it affords localized frequency information about the function of a signal, which is particularly beneficial for classification.

2. LITERATURE SURVEY

[1] MRI Fuzzy Segmentation of Brain Tissue Using Neighborhood Attraction With Neural- Network Optimization. Shan Shen, William Sandham, Member, IEEE, Malcolm Granat, and Annette Sterr. Image segmentation is an indispensable process in the visualization of human tissues, particularly during clinical analysis of magnetic resonance (MR) images. Unfortunately, MR images always contain a significant amount of noise caused by operator performance, equipment, and the environment, which can lead to serious inaccuracies with segmentation. A robust segmentation technique based on an extension to the traditional fuzzy c-means (FCM) clustering algorithm is proposed in this paper. A neighborhood attraction, which is dependent on the relative location and features of neighboring pixels, is shown to improve the segmentation performance dramatically. The degree of attraction is optimized by a neural- network model. Simulated and real brain MR images with different noise levels are segmented to demonstrate the superiority of the proposed technique compared to other FCM- based methods. This segmentation method is a key component of an MR image-based classification system for brain tumors, currently being developed.

[2] Classification of brain MRI using the LH and HL wavelet transform sub-bands Lahmiri, S. Boukadoum, M. Circuits and Systems (ISCAS), 2011 IEEE International Symposium The problem of automatic classification of brain images obtained by magnetic resonance imaging (MRI) is considered. In order to design the classification system, a three- stage approach is used. It consists of wavelet decomposition of the image under study, feature extraction from the LH and HL sub- bands using first order statistics, and final classification by support vector machines (SVM). The proposed approach shows higher performance than when using features extracted from the LL sub-band. It is concluded that the horizontal and vertical sub- bands of the wavelet transform can effectively encode the discriminating features of normal and pathological images.

[3] Brain MRI classification using an ensemble system and LH and HL wavelet sub-bands features Lahmiri, S. Boukadoum, M. Computational Intelligence In Medical Imaging (CIMI), 2011 IEEE Third International Workshop.

A new classification system for brain images obtained by magnetic resonance imaging (MRI) is presented. A three-stage approach is used for its design. It consists of second-level discrete wavelet transform decomposition of the image under study, feature extraction from the LH and HL sub-bands using first order statistics, and subsequent classification with the k-nearest neighbor (k-NN), learning vector quantization (LVQ), and probabilistic neural networks (PNN) algorithms. Then, an ensemble classifier system is developed where the previous machines form the base classifiers and support vector machines (SVM) are employed to aggregate decisions. The proposed approach was tested on a bank of normal and pathological MRIs and the obtained results show a higher performance overall than when using features extracted from the LL sub-band, as usually done, leading to the conclusion that the horizontal and vertical sub-bands of the wavelet transform can effectively and efficiently encode the discriminating features of normal and pathological images. The experimental results also show that using an ensemble classifier improves the correct classification rates.

[4] MRI brain cancer classification using Support Vector Machine Nandpuru, H.B. Salankar, S.S. ; Bora, V.R. Electrical, Electronics and Computer Science (SCEECS), 2014 IEEE Students' Conference. This research paper proposes an intelligent classification technique to recognize normal and abnormal MRI brain image. Medical image like ECG, MRI and CT-scan images are important way to diagnose disease of human being efficiently. The manual analysis of tumor based on visual inspection by radiologist/physician is the conventional method, which may lead to wrong classification when a large number of MRIs are to be analyzed. To avoid the human error, an automated intelligent classification system is proposed which caters the need for classification of image. One of the major causes of death among people is Brain tumor. The chances of survival can be increased if the tumor is detected correctly at its early stage. Magnetic resonance imaging (MRI) technique is used for the study of the human brain. In this research work, classification techniques based on Support Vector Machines (SVM) are proposed and applied to brain image classification. In this paper feature extraction from MRI Images will be carried out by gray scale, symmetrical and texture features.

The main objective of this paper is to give an excellent outcome (i.e. higher accuracy rate and lower error rate) of MRI brain cancer classification using SVM.

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[5] MRI brain image classification using neural networks Ibrahim, W.H. Osman, A.A.A. ; Mohamed, Y.I. Computing, Electrical and Electronics Engineering (ICCEEE), 2013 International Conference. Classification of brain tumor using Magnetic resonance Imaging (MRI) is a difficult task due to the variance and complexity of tumors. This paper presents Neural Network techniques for the classification of the magnetic resonance human brain images. The proposed Neural Network technique consists of three stages, preprocessing, dimensionality reduction, and classification. In the first stage, we The MR image will obtain and convert it to data form (encoded information that can be stored, manipulated and transmitted by digital devices), in the second stage have obtained the dimensionally reduction using principles component analysis (PCA), then In the classification stage the Back-Propagation Neural Network has been used as a classifier to classify subjects as normal or abnormal MRI brain images. In the experiment 3×58 datasets of MRI Brain sagittal images.

[6] Hasan, S. K and Ahmad, M. et al., 2018 [6] proposed research on two-stage authenticated technique for detection of brain tumor. In this research, the proposed technique is authenticated scheme for detection of brain tumor, called a watershed matched approach. The segmentation of brain tumor area was done through classification approach of the watershed algorithm. In addition, scale invariant feature transform technique was also used to extract feature regions and matching divided area of brain tumor with an actual picture. Along with that, compute dimensions of the tumor using various approaches. They implemented an approach through free surfer system software to search the width of cortical and the compute variance among benign and malignant.

Table -1: Sample Table format

Sr. No.	Method proposed by	Method used	Year of publication
1	Shan Shen, William Sandham, Member, IEEE, Malcolm Granat, and Annette Sterr	MRI Fuzzy Segmentation of Brain Tissue Using Neighborhood Attraction With Neural- Network Optimization.	2013
2	Lahmiri, S.; Boukadoum, M. Circuits and Systems (ISCAS), IEEE International Symposium	Classification of brain MRI using the LH and HL wavelet transform sub-bands	2011
3	Lahmiri, S. ; Boukadoum, M. Computational Intelligence In Medical Imaging (CIMI), IEEE Third International Workshop	Brain MRI classification using an ensemble system and LH and HL wavelet sub-bands features	2011
4	Machine Nandpuru, H.B. ; Salankar, S.S. ; Bora, V.R. Electrical, Electronics and Computer Science (SCEECS), IEEE Students' Conference	MRI brain cancer classification using Support Vector	2014
5	Ibrahim, W.H. ; Osman, A.A.A. ; Mohamed, Y.I. Computing, Electrical and Electronics Engineering (ICCEEE), International Conference.	MRI brain image classification using neural networks	2013
6	Hasan, S. K and Ahmad, M. et al.,	Two-stage authenticated technique for detection of brain tumor	2018

3. CONCLUSIONS

In this article, various automated brain tumor segmentation techniques of MRI, CT, PET, and multimodal images have been reviewed. The methods, advantages, their limitations, and future challenges are discussed to provide insight into various techniques. MRI-based brain tumour segmentation methods are employed more for brain tumor segmentation due to the good soft tissue contrast and noninvasive of MRI. However, percentages of clinical application of automated brain tumor segmentation methods are significantly very low due to lack of interaction between developers and physicians. Technically sound algorithms are difficult to use in real time applications. In spite of the existence of many tools for tumor segmentation, manual segmentation is preferred in the day today life. Automatic segmentation performed in few minutes is not accepted clinically due to the lack of interpretability and easy handling of the tools. Hence more user-friendly tools should be embedded in the clinical environment in future. The failure of the system even for less number of times also affects clinical applicability. Hence, robustness and accuracy of the system are also another important factor to improve the confidence in the automated system.

The improvement in advanced tumour assessment, such as tumour volume estimation, tumour progression estimation in future, and multiclass tumour classification, will improve achievements in current techniques. The brain tumour segmentation techniques will undoubtedly show great potential in future, along with all specified remarkable advancement in this area.

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