Automated Brain Abnormality Detection through MR Images

Vijendra Prasad

Department of Computer Science and Engineering
National Institute of Technology Rourkela

Automated Brain Abnormality Detection through MR Images

Thesis submitted in partial fulfillment

of the requirements of the degree of

Master of Technology

in

Computer Science and Engineering
(*Specialization*: *Computer Science*)

by

Vijendra Prasad

(Roll Number: 214CS1127)

based on research carried out

under the supervision of

Prof. Banshidhar Majhi

May, 2016

Department of Computer Science and Engineering
National Institute of Technology Rourkela

Department of Computer Science and Engineering
National Institute of Technology Rourkela

Prof. Banshidhar Majhi
Professor

May 20, 2016

Supervisor's Certificate

This is to certify that the work presented in the dissertation entitled *Automated Brain Abnormality Detection through MR Images* submitted by *Vijendra Prasad*, Roll Number 214CS1127, is a record of original research carried out by him under my supervision and guidance in partial fulfillment of the requirements of the degree of *Master of Technology* in *Computer Science and Engineering*. Neither this thesis nor any part of it has been submitted earlier for any degree or diploma to any institute or university in India or abroad.

_____
Banshidhar Majhi

Dedication

This work is dedicated to my loving parents...
also my friends.

Declaration of Originality

I, *Vijendra Prasad*, Roll Number *214CS1127* hereby declare that this dissertation entitled *Automated Brain Abnormality Detection through MR Images* presents my original work carried out as a postgraduate student of NIT Rourkela and, to the best of my knowledge, contains no material previously published or written by another person, nor any material presented by me for the award of any degree or diploma of NIT Rourkela or any other institution. Any contribution made to this research by others, with whom I have worked at NIT Rourkela or elsewhere, is explicitly acknowledged in the dissertation. Works of other authors cited in this dissertation have been duly acknowledged under the sections "Reference" or "Bibliography". I have also submitted my original research records to the scrutiny committee for evaluation of my dissertation.

I am fully aware that in case of any non-compliance detected in future, the Senate of NIT Rourkela may withdraw the degree awarded to me on the basis of the present dissertation.

May 20, 2016
NIT Rourkela

Vijendra Prasad

Acknowledgment

It is a great pleasure to express my sincere gratitude to quite a number of people involved. I want to thanks my supervisor Dr. Banshidhar Majhi for his direction, inspiration and backing over the span of this work. It was a precious learning background for me to be one of his understudies. I want to thanks Prof. Santanu Kr. Rath, Head of Department of Computer Science for extending some facilities towards completion of this thesis. I might likewise want to recognize the whole instructing and non-showing staff of the Computer Science and Engineering Department for building up a workplace. I would like to thank Deepak Ranjan Nayak (Phd scholar), Dibyasundar Das (Phd scholar), for his help in simulation of the results. I also like to extend thanks to my friends: Ranita, Punya, Ravi, Lokesh, Govind, Sandeep, Kiran and all other batchmates who made this part of my life's journey joyful and a memorable one.

May 24, 2016 *Vijendra Prasad*
NIT Rourkela Roll Number: 214CS1127

Abstract

Brain diseases is one of the major cause of cancer related death among children and adults in the world. Brain diseases like brain tumor is characterized as a gathering of abnormal cells that becomes inside the brain and around the brain. There are various imaging techniques which are used for brain tumor detection. Among all imaging technique, MRI (Magnetic Resonance Imaging) is widely used for the brain tumor detection. MRI is safe, fast and non-invasive imaging technique. The early detection of brain diseases is very important, for that CAD (Computer-aided-diagnosis) systems are used. The proposed scheme develops a new CAD system in which pulse-coupled neural network is used for the brain tumor segmentation from MRI images. After segmentation, for feature extraction the Discrete Wavelet Transform and Curvelet Transform are employed separately. Subsequently, both PCA (Principal Componenet Analysis) and LDA (Linear Discriminant Analysis) have been applied individually for feature reduction. A standard dataset of 101 brain MRI images (14 normal and 87 abnormal) is utilized to validate the proposed scheme. The experimental results show that the suggested scheme achieves better result than the state-of-the-art techniques with a very less number of features.

Keywords: PCNN, DWT, Curvelet, PCA, LDA.

Contents

Chapter 1

Introduction

Based on the survey, it has been observed that brain diseases are the second cancer related death in children whose are age is 20 or less than 20. As well as in adults (males) whose are the age is between 20 to 39. Brain disease like tumor are the numbered as fifth tumor related death in womens whose are in the between 20 to 39. So this observation has increased the significance of the researches in the field of brain disease identification.

Brain diseases like tumors are the one of the major mainsprings for the increase in fatality among the children, male and female. The one can define the brain tumor as the growth of the abnormal cells in the human brain or around the human brain. Based on the survey it has been observed that there are many brain tumors in which some of brain tumor are cancerous or malignant and some of the brain tumor are noncancerous or benign. The NBTF (National Brain Tumor Foundation) of United States has been observed that the brain tumor is the reason for one-fourth of all cancer deaths in children [1]. Early recognition of the brain diseases is the imperative and the inspiration for further studies.The brain images generated by the MRI (Magnetic resonance imaging) is more accurate for the examination of the brain diseases if any are present and for the further analysis of tumor area the physician also needs the help of computer and image processing techniques.

On the other side, the quick development of an automatic system are taken place last few decades. The example of the such system is CAD (Computer-aided diagnostic) system. The main motive or idea of the CAD system is to facilitate the radiologists in the analysis of the medical images with the help of dedicated computers. Basically, the CAD systems are used to enhance the diagnostic accuracy of the radiologists. The CAD system helps to reduce the workload, chance of miss classification due to fatigue [1]. But the final decision is made by the radiologists. Subsequently, radiologists expect that CAD system can enhance their analytic capacities in light of synergistic impacts between the radiologist and the computer with medical image investigation and machine learning methods [2]. Along these, the CAD system ought to have the capacities like doctors and radiologist as far as in terms of learning and identification of the brain diseases. Hence for the improvement of the CAD system pattern recognition techniques like machine learning play the important roles.

Chapter 2

Literature Review

In recent years, for the feature extraction and classification of the brain MR images various technique have been suggested by different researchers. Extracting essential feature from brain MR image is very important for further analysis and classification.

Chaplot et al. [3] have introduced a scheme for feature extraction and classification. To validate the introduced system they are taken a standard dataset of 52 brain MRI images. For feature extraction, they consider coefficient of level-2 approximation subband of 2D DWT. Daubechies-4 (DAUB4) filter is used as decomposition filter. After getting the features they employed self organizing map (SOM) and support vector machine (SVM) as classifier and they achieved higher classification rate for SVM with radial basis function (RBF) classifier i.e. 98% compared to the self-organizing map i.e. 94%.

Maitra and Chatterjee [4] have proposed a scheme for feature extraction and classification. For the feature extraction they have used slantlet transform (ST) and for the classification they used back-propagation neural network (BPNN) and archived ideal result. In [5] they introduced a scheme, they used ST for feature extraction and fuzzy c-means for classification and from the experimental result they observed that the proposed scheme outperformed.

Selvaraj et al. [6] suggested a system for brain MR image classification. For classification they have used many classifier i.e. SVM classifier, Neural classifier, statistical classifier. Among all these classifier LS-SVM outperformed with 98% of success rate.

El-Dahshan et al. [7] suggested a technique. The suggested technique comprises three stages i.e. feature extraction, feature reduction and classification. For feature extraction the approximation subband of DWT is considered. Principal component analysis (PCA) is used for feature reduction and for the classification feed forward back-propagation neural network (FP-ANN) and k-nearest neighbor (k-NN) used as classifier and they achieved

97% and 98% accuracy, respectively.

Zhang et al. [8] have proposed a scheme for classification. They have taken 160 images (20 normal,140 abnormal) to validate the scheme. For feature extraction level-3 approximation component using Haar wavelet is used. After feature extraction, PCA is used for feature reduction and for the classification forward neural network is used and they achieved 98.75% classification accuracy.

Saritha et al. [9] suggested a scheme, in which they have used entropy of wavelet approximation component at level-8 computed along with SWP for feature extraction. For the classification they used Probabilistic neural network (PNN) and their results indicate that they achieve high success rate.

El-Dahshan et al.[1] suggested a hybrid technique,in which feed forward pulse-coupled neural network is applied for the segmentation of the brain images. For feature extraction they consider approximation component of DWT. For feature reductuion they used PCA and for the classification they used back propagation neural network and achieved 99% accuracy.

Yang et al. [10] suggested a wavelet-energy based approach for brain MR image classification. For feature extraction they have used 2D DWT. For brain image classification SVM classifier was employed and BBO method was utilized to optimize the weights of the SVM. They noticed that their scheme was superior then KSVM, PSO-KSVM and BPNN.

Nayak et al. [11] have proposed hybrid technique for brain MR image classification. For feature extraction through brain MR images they utilizes the approximation coefficient of level-3 of discrete wavelet transform (DWT). To reduce the large set of extracted features from brain MR images they have employed kernel principal component analysis (KPCA). After getting the reduced set of features they have employed least square support vector machine (LS-SVM) as a classifier with different kernel function and they have reported that proposed scheme outperform with high accuracy.

Chapter 3

DWT based Brain Abnormality Detection

The paper related to this chapter is under publication process. So details can not be written for the shake of plagiarism.

References

[1] E.-S. A. El-Dahshan, H. M. Mohsen, K. Revett, and A.-B. M. Salem, "Computer-aided diagnosis of human brain tumor through mri: A survey and a new algorithm," *Expert systems with Applications*, vol. 41, no. 11, pp. 5526–5545, 2014.

[2] H. Arimura, C. Tokunaga, Y. Yamashita, and J. Kuwazuru, "Magnetic resonance image analysis for brain cad systems with machine learning," *Machine Learning in Computer-Aided Diagnosis: Medical Imaging Intelligence and Analysis: Medical Imaging Intelligence and Analysis*, p. 258, 2012.

[3] S. Chaplot, L. Patnaik, and N. Jagannathan, "Classification of magnetic resonance brain images using wavelets as input to support vector machine and neural network," *Biomedical Signal Processing and Control*, vol. 1, no. 1, pp. 86–92, 2006.

[4] M. Maitra and A. Chatterjee, "A slantlet transform based intelligent system for magnetic resonance brain image classification," *Biomedical Signal Processing and Control*, vol. 1, no. 4, pp. 299–306, 2006.

[5] ——, "Hybrid multiresolution slantlet transform and fuzzy c-means clustering approach for normal-pathological brain mr image segregation," *Medical engineering & physics*, vol. 30, no. 5, pp. 615–623, 2008.

[6] H. Selvaraj, S. T. Selvi, D. Selvathi, and L. Gewali, "Brain mri slices classification using least squares support vector machine," *International Journal of Intelligent Computing in Medical Sciences & Image Processing*, vol. 1, no. 1, pp. 21–33, 2007.

[7] E.-S. A. El-Dahshan, T. Hosny, and A.-B. M. Salem, "Hybrid intelligent techniques for mri brain images classification," *Digital Signal Processing*, vol. 20, no. 2, pp. 433–441, 2010.

[8] Y. Zhang, S. Wang, and L. Wu, "A novel method for magnetic resonance brain image classification based on adaptive chaotic pso," *Progress In Electromagnetics Research*, vol. 109, pp. 325–343, 2010.

[9] M. Saritha, K. P. Joseph, and A. T. Mathew, "Classification of mri brain images using combined wavelet entropy based spider web plots and probabilistic neural network," *Pattern Recognition Letters*, vol. 34, no. 16, pp. 2151–2156, 2013.

[10] G. Yang, Y. Zhang, J. Yang, G. Ji, Z. Dong, S. Wang, C. Feng, and Q. Wang, "Automated classification of brain images using wavelet-energy and biogeography-based optimization," *Multimedia Tools and Applications*, pp. 1–17, 2015.

[11] D. R. Nayak, R. Dash, and B. Majhi, "Least squares svm approach for abnormal brain detection in mri using multiresolution analysis," in *Computing, Communication and Security (ICCCS), 2015 International Conference on*. IEEE, 2015, pp. 1–6.