IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-5, May 2019 E-ISSN: 2347-2693

An Investigation on Brain Tumour Segmentation using Various Machine Learning Approaches

W. JaiSingh[1*], Preethi Nanjundan[2]

[1]Department of Computer Applications, Kumaraguru College of Technology, Coimbatore, Tamilnadu, India
[2]Researcher in computer science, BTM Layout, Bangalore, India

Corresponding Author: jaisinghw@gmail.com

DOI: https://doi.org/10.26438/ijcse/v7i5.600603 | Available online at: www.ijcseonline.org

Accepted: 11/May/2019, Published: 31/May/2019

***Abstract*—** Medical diagnosis via image processing and machine learning is considered one of the most important issues of artificial intelligence systems. In this paper, we present a machine learning approach to detect whether an MRI image of a brain contains a tumour or not. The results show that such an approach is very promising. Automated detection of tumor in Magnetic Resonance Imaging (MRI) is very crucial as it provides information about abnormal tissues, which is necessary for planning treatment. Deep Learning is a new machine-learning arena that increased a lot of attention over the earlier few ages. It was extensively useful to numerous bids and established to be an influential machine-learning tool for many of the complex difficulties. In this paper, we used Deep Neural Network classifier, which is one of the DL architectures for classifying a dataset of 66 brain MRIs into four classes e.g. normal, glioblastoma, sarcoma and metastatic bronchogenic carcinoma tumours. The classifier was combined with the discrete wavelet transform (DWT) the powerful feature extraction tool and principal components analysis (PCA) and the assessment of the presentation was quite good over all the presentation measures**.**

***Keywords*—** Machine learning, Deep learning, Deep neural network, Discrete wavelet transform, Principle component analysis, Fuzzy c-means, Magnetic resonance images.

I. INTRODUCTION

Brain is one of the most intricate organs in the human body that works with billions of cells. A brain tumour ascend when there is abandoned partition of cells forming an irregular group of cells around or inside the brain. That group of cells can disturb the usual functionality of the brain action and end the healthy cells [1][2]. Brain tumours classified to benign or low-grade (grade I and II) and malicious tumours or high-grade (grade III and IV). Benevolent tumours are non-progressive (non-cancerous) so measured to be less ferocious, they created in the brain and raises slowly; also it cannot blowout to anywhere else in the body. However, malicious tumours are cancerous and grow swiftly with undefined limitations. They can be initiated in the brain itself, which called primary malicious tumour, or to be initiated elsewhere in the body and blowout to the brain which called secondary malicious tumour [3], [4], [5].

The MR human brain images are classified by using supervised techniques like artificial neural networks, support vector machine, and unsupervised techniques like self-organization map (SOM), fuzzy c-means when combined with feature extraction techniques. Other supervised classification techniques, such as k-nearest neighbours (k-NN) also group pixels based on their similarities in each feature [11]. Classification of MR images either as normal or abnormal can be done via both supervised and unsupervised techniques.

Brain magnetic resonance imaging (MRI) is one of the finest imaging methods that researchers trusted on for sensing the brain tumours and modelling of the tumour evolution in both the finding and the conduct phases. MRI images have a big effect in the automatic medical image learning field for its capability to offer a lot of data about the brain structure and anomalies within the brain tissues due to the high resolution of the images [3], [6], [7], [8]. In fact, Researchers offered different robotic tactics for brain tumours finding and type organization using brain MRI images since it became likely to scan and load medical images to the computer. However, Support Vector Machine (SVM) and Neural Networks (NN) are the widely used methods for their good routine over the last few decades [9]. But recently, deep learning (DL) models set an thrilling trend in machine learning as the deep architecture can efficiently represent complex relationships without requiring a huge number of nodes like in the shallow architectures e.g. SVM and K-nearest neighbour (KNN). For that reason, they grew rapidly to become the state of the art in different health informatics areas such as bioinformatics, medical informatics and medical image analysis [7], [9], [10].

Rest of the paper is organized as follows, Section I contains the introduction of Brain Tumors, Section II contain the related work of segmentation and classification of Brain Tumors. Section III contain the proposed methodology, Section IV describes experimental results and discussions and Section V concludes research work with future directions.

II. RELATED WORK

Deep learning (DL) is a subfield of machine learning based on learning numerous levels of representations by making a hierarchy of features where the higher levels are defined from the lower levels and the same lower level features can help in defining many higher level features [11]. DL structure extends the old neural networks (NN) by adding more hidden layers to the network architecture between the input and output layers to model more complex and nonlinear relationships. This concept gained the researchers interest in the recent years for its good performance to become the best solution in many problems in medical image analysis applications such as image denoising, division, registration and classification [7], [10], [11], [12].

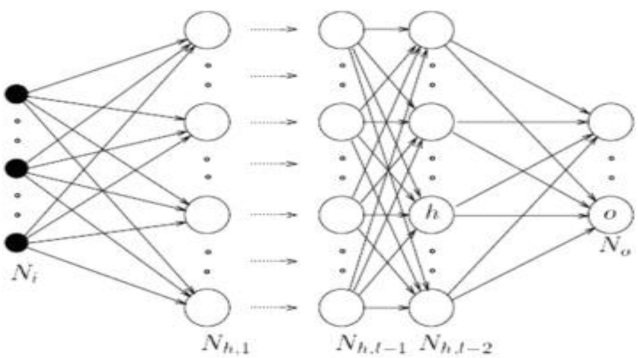


Fig. 1. DNNs architecture

Deep Neural Network (DNN) is another DL architecture that is widely used for classification or regression with success in many areas. It's a typical feed forward network which the input flows from the input layer to the output layer through number of hidden layers which are more than two layers [12]. Fig. 1 shows the typical architecture for DNNs where Ni is the input layer encompasses of neurons for the input features, No is the output layer contains neurons for the output classes and Nh,l are the hidden layers.

III. METHODOLOGY

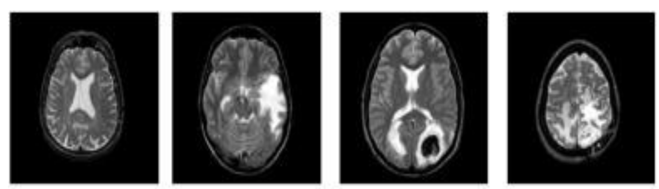
Our projected methodology based on the DNN learning architecture for classification where the classifier is identifying the brain tumours in brain MRIs. The proposed methodology for classifying the brain tumours in brain MRIs is as follows:

Step 1: Brain MRIs Dataset gaining
Step 2: Image breakdown using Fuzzy C-means
Step3:Feature extraction using discrete wavelet transform (DWT) and reduction using Principle component analysis (PCA) technique
Step 4: Classification using DNN

3.1. Data acquisition

According to the World Health Organization (WHO) classification system to identify brain tumours, there are more than 120 types of brain tumours, which differ in origin, location, size, characteristics of the tumour tissues [11], [12]. In this paper, we were concerning with three types of malignant tumours, which are:

- Glioblastoma: primary malicious brain tumours that are classified as Grade IV and settled from star-shaped cells called astrocytes. It usually starts in the cerebrum.
- Sarcoma: has different grades that vary from grade I to grade IV and it ascends in the connective tissues like blood vessels.
- Metastatic bronchogenic carcinoma: secondary malignant brain tumours that was spread to the brain from bronchogenic carcinoma lung tumour.



(a) Normal (b) Metastatic bronchogenic carcinoma (c) Sarcoma (d) Glioblastoma

Fig. 2. Brain MRIs dataset sample

The dataset consists of 66 real human brain MRIs with 22 normal and 44 irregular images, which are glioblastoma, sarcoma and metastatic bronchogenic carcinoma tumours, collected from Harvard Medical School website (http://med.harvard.edu/AANLIB/) [12]. All the brain MRIs was in axial plane, T2-weighted and 256 × 256 pixel. A model of the dataset is illustrated in Fig. 2.

3.2. Image subdivision

Image subdivision is the non-trivial task of unscrambling the different normal brain tissues such as gray matter (GM), white matter (WM) and cerebrospinal fluid (CSF) and the skull from the tumour tissues in brain MR images [11] as the resulted segmented tumour part only would be used in the next steps. In this work, we used the Fuzzy C-means clustering technique to segment the image into 5 sections as it had good results in our previous work and also for comparison purposes. Fig. 3 shows the results of segmenting a sample image using Fuzzy C-means.

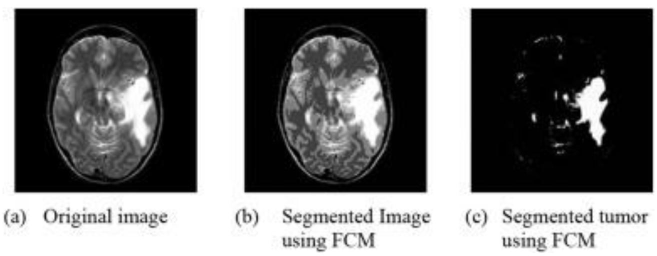


Fig. 3. A sample image segmented using FCM

3.4. Classification

After the features are removed and selected, the classification step using DNN is performed on the resulted feature vector. Classification is performed by using 7-fold cross validation technique for building and training the DNN of 7 hidden layers structure. Also for evaluating the performance of the selected classifier, we active other machine learning classification algorithms from WEKA [20]using the same criteria. The selected classification algorithms are KNN with K = 1 and 3, Linear discriminant analysis (LDA) and SMO-SVM.

IV. RESULTS AND DISCUSSION

The experiment took place using two tools:

- We equipped the brain MRI dataset and performed the first three steps of the methodology using MATLAB R2015a
- Weka 3.9 tool was used for performing the classifications and the calculation of the designated classifiers.

The valuation of the performance for the strategic method was measured in terms of regular classification rate, regular recall, regular precision, regular F-Measure and average area under the ROC curve (AUC) of all the four classes (normal, glioblastoma, sarcoma and metastatic bronchogenic carcinoma tumours) and compared to the performance of other classifiers in the same terms.

As seen from Table 1 and the chart in Fig. 1, the DNN classifier gave good results combined with the DWT feature extraction tool in all the performance measures over all other classifiers.

Table 1. Performance of DNN, KNN K = 1 and 3, LDA and SMO classifiers

Algorithm	Classification rate	Recall	Precision	F-Measure	AUC (ROC)
DNN	95.86%	0.96	0.96	0.96	0.968
KNN K = 1	94.23%	0.942	0.943	0.942	0.943
KNN K = 3	85.25%	0.852	0.853	0.854	0.854
LDA	93.35%	0.935	0.936	0.936	0.937
SMO	92.14%	0.921	0.931	0.924	0.943

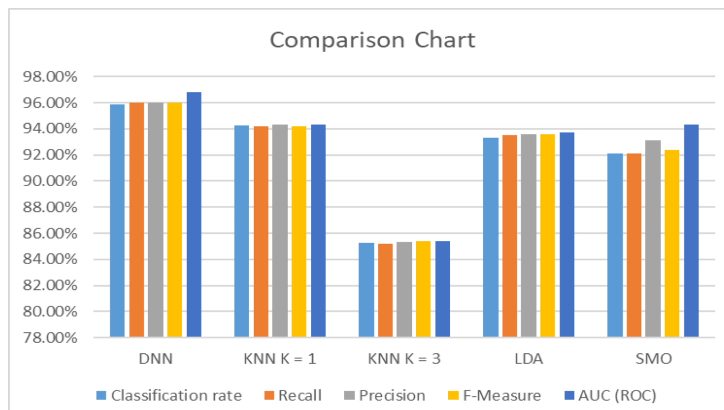


Fig. 4. Assessment graph for the recital of DNN, KNN K = 1 and 3, LDA and SMO classifiers

V. CONCLUSION AND FUTURE SCOPE

Algorithms for analysing and classifying medical images have increased a great level of consideration newly. The trials that existing in this work display that after pre-processing MRI images, neural network classification algorithm was the best. Performance of DNN, KNN K = 1 and 3, LDA and SMO classifiers are shown above .The future an effective methodology which combines the discrete wavelet transform (DWT) with the Deep Neural Network (DNN) to categorize the brain MRIs into Standard and 3 types of malicious brain tumours: glioblastoma, sarcoma and metastatic bronchogenic carcinoma. The procedure architecture bear a similarity to the Deep neural networks (DNN) architecture but requires less hardware specifications and takes a appropriate time of dispensation for fat size images (256 × 256). In count using the

DNN classifier shows high precision related to traditional classifiers. The virtuous results realized using the DWT could be hired with the DNN in the imminent and link the results.

REFERENCES

[1] A.R. Kavitha, L. Chitra, R. kanaga "Brain tumor segmentation using genetic algorithm with SVM classifier", Int J Adv Res Electr Electron Instrum Eng, 5 (3) (2016).

[2] V.S. Ramachandran, (Sandra Blakeslee), "Phantoms in the Brain: Human Nature and the Architecture of the Mind Fourth Dimension Publications ISBN: 1857028953, 1999.

[3] Kruti G. Khambhata, Sandip R. Panchal, "Multiclass classification of brain tumor in MR Images", Int J Innov Res Comput Commun Eng, 4 (5), 2016, pp. 8982-8992.

[4] G. Kaur, J. Rani, "MRI brain tumor segmentation methods-a review", Int J Comput Eng Technol (IJCET), 6 (3), 2016, pp. 760-764.

[5] V. Das, J. Rajan, "Techniques for MRI brain tumor detection: a survey", Int J Res Comput Appl Inf Tech, 4 (3), 2016, pp. 53-56.

[6] E.I Zacharaki, S. Wang, S. Chawla, D. Soo Yoo R. Wolf, E.R. Melhem, "Classification of brain tumor type and grade using MRI texture and shape in machine learning scheme", Magn Reson Med, 62, 2009, pp. 1609-1618.

[7] G.Litjens, T. Kooi, B.E. Bejnordi, A.A. Setio, F. Ciompi, M. Ghafoorian, "A survey on deep learning in medical image analysis", Med Image Anal, 42, 2017, pp. 60-88.

[8] L. Singh, G. Chetty, D. Sharma, "A novel machine learning approach for detecting the brain abnormalities from MRI structural images" IAPR international conference on pattern recognition in bioinformatics, Springer, Berlin Heidelberg (2012), pp. 94-105

[9] Y. Pan, W. Huang, Z. Lin, W. Zhu, J. Zhou, J. Wong, et al "Brain tumor grading based on neural networks and convolutional neural networks Engineering in medicine and biology society (EMBC), 37th annual international conference of the IEEE (2015), pp. 699-702.

[10] Ravì, C. Wong, F. Deligianni, M. Berthelot, J. Andreu-Perez, B. Lo, et al, "Deep learning for health informatics", IEEE J Biomed Health Inf, 21 (1) (2017), pp. 4-21