IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10322

Brain Tumour Prediction System

Prof.Biju Balakrishnan[1], Meldone Jose[2], Muhammed Shemeem P[3], Muhammed Jasir C[4], Dileep D[5]

Department of Computer Science and Engineering, JCT College of Engineering and Technology, Coimbatore,Tamil Nadu, India[1-5]

Abstract: Brain Tumour segmentation is one of the most crucial and arduous tasks in the terrain of medical image processing as a human-assisted manual classification can result in inaccurate prediction and diagnosis. Moreover, it is an aggravating task when there is a large amount of data present to be assisted. Brain tumours have high diversity in appearance and there is a similarity between tumour and normal tissues and thus the extraction of tumour regions from images becomes unyielding. In this paper, we proposed a method to extract brain tumour from 2D Magnetic Resonance brain Images (MRI) by Fuzzy C-Means clustering algorithm which was followed by traditional classifiers and convolutional neural network. The experimental study was carried on a real-time dataset with diverse tumour sizes, locations, shapes, and different image intensities. In traditional classifier part, we applied six traditional classifiers namely Support Vector Machine (SVM), K-Nearest Neighbour (KNN), Multilayer Perceptron (MLP), Logistic Regression, Naïve Bayes and Random Forest which was implemented in sickest-learn. Afterward, we moved on to Convolutional Neural Network (CNN) which is implemented using Keras and Tensor flow because it yields to a better performance than the traditional ones. In our work, CNN gained an accuracy of 97.87%, which is very compelling. The main aim of this paper is to distinguish between normal and abnormal pixels, based on texture based and statistical based features.

INTRODUCTION

Medical imaging refers to a number of techniques that can be used as non-invasive methods of looking inside the body [1]. Medical image encompasses different image modalities and processes to image the human body for treatment and diagnostic purposes and hence plays a paramount and decisive role in taking actions for the betterment of the health of the people. Image segmentation is a crucial and essential step in image processing which determines the success of a higher level of image processing [2]. The primary goal of image segmentation in medical image processing is mainly tumour or lesion detection, efficient machine vision and attaining satisfactory result for further diagnosis. Improving the sensitivity and specificity of tumour or lesion has become a core problem in medical images with the help of Computer Aided Diagnostic (CAD) systems. According to [3], Brain and other nervous system cancer is the 10th leading cause of death, and the five-year survival rate for people with a cancerous brain is 34% for men and 36% for women. Moreover, the World Health Organization (WHO) states that around 400,000 people in the world are affected by the brain tumour and quality of images. The contrast adjustment and threshold techniques are used for highlighting the features of MRI images. The Edge detection, Histogram, Segmentation and Morphological operations play a vital role for classification and detecting the tumour of brain. The main objective of this paper is too studied and reviewed the different research papers to find the various filters and segmentation techniques, algorithms to brain tumour detection. The various steps of MR imaging like; pre-processing, feature extraction, segmentation, post-processing, etc. which is used for finding the tumour area of MRI-images 120,000 people have died in the previous years [4]. Moreover, An estimated 86,970 new cases of primary malignant and non-malignant brain and other Central Nervous System (CNS) tumours are expected to be diagnosed in the United States in 2019 [5]. A brain tumour occurs when abnormal cells form within the brain [6]. There are two main types of tumours- Malignant and Benign. Malignant brain tumours originate in the brain, grows faster and aggressively invades the surrounding tissues. It can spread to other parts of the brain and affect the central nervous system. Cancerous tumours can be divided into primary tumours, which start within the brain, and secondary tumours, which have spread from elsewhere, are known as brain metastasis tumours. On the other hand, a benign brain tumour is a mass of cells that grow relatively slowly in the brain. Hence, early detection of brain tumours can play an indispensable role in improving the treatment possibilities, and a higher gain of survival possibility can be accomplished. But manual segmentation of tumours or lesions is a time consuming, challenging and burdensome task as a large number of MRI images are generated in medical routine. MRI, also known as Magnetic Resonance Imaging is mostly used for brain tumour or lesion detection. Brain tumour segmentation from MRI is one of the most crucial tasks in medical image processing as it generally involves a considerable amount of data. Moreover,

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10322

the tumours can be illdefined with soft tissue boundaries. So it is a very extensive task to obtain the accurate segmentation of tumours from the human brain.

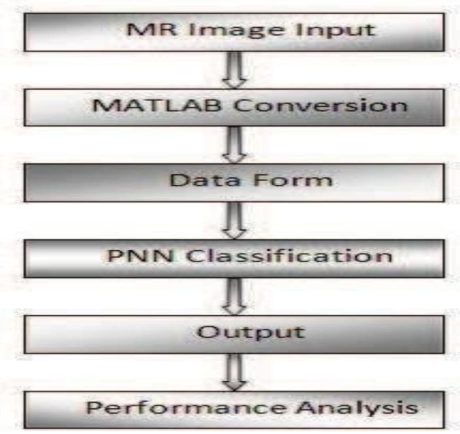
PROBLEM ANALYSIS

Image segmentation has been identified as the key problem of medical image analysis and remains a popular and challenging area of research. Image segmentation is increasingly used in many clinical and research applications to analyse medical imaging datasets; which motivated us to present a snapshot of dynamically changing field of medical image segmentation.

A computer system has been design to recognize the typical feature of the tumour from the digital images of the brain. The basic concept is that local texture in the images can reveal the typical regularities of the biological structures. Thus, the textual features have been extracted using a co-occurrence matrix approach. The level of recognition, among three possible types of image areas are: tumour, non-tumour, non-tumour and back ground. We are focusing on tumour image segmentation.

RELATED WORK

In recent years, interest in designing tools for diagnosing brain tumors has been increasing. The work of Gopal and Karnan [1] uses image processing clustering algorithms to classify images into a group that has a brain tumor and another group which does not. The dataset used in this work is composed of 42 MRI images obtained from the KG hospital database. In the preprocessing phase, the authors remove the film artefact‘s (labels and X-ray marks). They also use the filter Median to remove high frequency components in the MRI image. The authors then use an algorithm called Fuzzy C Means (FCM) as an image clustering algorithm, in addition to using a Genetic Algorithm (GA) as an intelligent optimization tool. The results of the experiments showed that, the classification algorithm FCM achieved a classification accuracy of 74.6% with less than 0.4% error rate. To enhance the accuracy, the authors used an optimization technique called Particle Swarm Optimization (PSO). They managed to reach an accuracy level of 92%. In [3], Othman and Ariffanan propose a new system for brain tumour automatic diagnosis (shown in Figure 1). The Probabilistic Neural Network (PNN) provides a solution to pattern classification problems [4]. The paper uses a dataset from University Teknologi Malaysia (UTK) and the dataset goes through a pre-processing phase as follows. The MRI images are first converted to matrices by using MATLAB. Then, the classification algorithm PNN is used to classify the MRI images. The results show that the proposed system achieves a diagnosis accuracy of more than 73%. The accuracy level can even be higher than that depending on what the authors call ―a smoothing factor‖ [3]. Finally, Najadat at al. [2] design a classifier to detect abnormalities in CT brain images caused by the following diseases/cases: Atrophic, Hemorrhage, Hematoma, Infract and Craniotomy



PROPOSED SYSTEM

The brain tumour is cancerous or maybe non-cancerous mass or abnormal cell growth in the brain. Abnormal cell growth in the brain results in the brain tumour and affect a person‘s life. The early and accurate detection of such disease can help the patient in medical healing. Imaging is an important side of bioscience is to picture the diagnosed structures or shape of the human body, which helps in medical diagnosis. This project is divided into two main parts:

Proposed Methodology of Tumor Segmentation and Classification Using Traditional Classifiers In our first prospective model, brain tumor segmentation and detection using machine learning algorithm had been done, and a comparison of the classifiers for our model is delineated. Our proposed Brain image segmentation system consists of seven stages: skull stripping, filtering and enhancement, segmentation by

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10322

Fuzzy C Means algorithm, morphological operations, tumor contouring, feature extraction and classification by traditional classifiers. The results of our work accomplished satisfactory results. The main stages of our proposed model (Fig. 2) will be illustrated in the following sections.

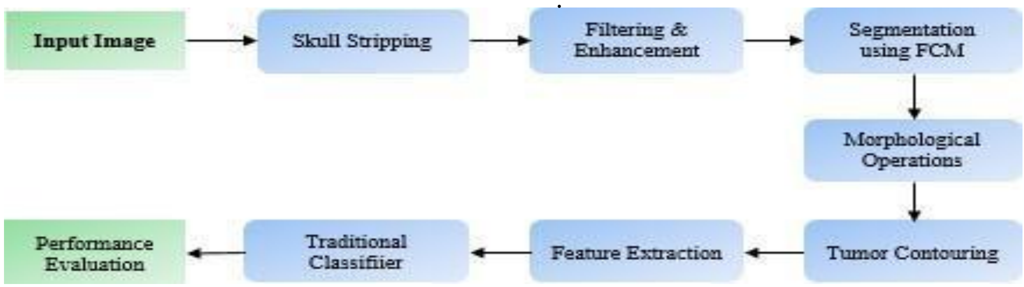


Fig. 2. Proposed methodology for classification using Traditional Classifiers

Proposed Methodology of Tumor Segmentation and Classification Using Traditional Classifiers

In our first prospective model, brain tumor segmentation and detection using machine learning algorithm had been done, and a comparison of the classifiers for our model is delineated. Our proposed Brain image segmentation system consists of seven stages: skull stripping, filtering and enhancement, segmentation by Fuzzy C Means algorithm, morphological operations, tumor contouring, feature extraction and classification by traditional classifiers. The results of our work accomplished satisfactory results. The main stages of our proposed model (Fig. 2) will be illustrated in the following sections.

1) Skull Stripping: Skull stripping is a very important step in medical image processing because of the background of the MRI image not containing any useful information, and it only increases the processing time. In our work, we removed the skull portion from the MRI images in three steps. These three steps are:

Otsu Thresholding*:* For skull removal, at first we used Otsu's Thresholding method which automatically calculates the threshold value and segments the image into background and foreground. In this method, the threshold that is selected minimizes the intra-class variance, defined as a weighted sum of deviations of the two classes.

Connected Component Analysis: At the last stage of our skull stripping step, we used connected component analysis to extract only the brain region and as a consequence the skull part was removed.11

2) Filtering and Enhancement: For better segmentation, we need to maximize the MRI image quality with minimized noise as brain MRI images are more sensitive to noise than any other medical image. Gaussian blur filter was used in our work for Gaussian noise reduction existing in Brain MRI which prevailed the performance of the segmentation.

3) Segmentation using *FCM:* Fuzzy C-Means clustering algorithm was used for segmentation, which allows one piece of data to belong to two or more clusters. We got the fuzzy clustered segmented image at this stage, which ensured a better segmentation.

4) Morphological Operation: To segment the tumor, we only need the brain part rather than the skull part. For this, we applied morphological operations in our images. At first, erosion was done to separate weakly connected regions of the MRI image. After erosion, we will get multiple disconnected regions in our images. Dilation was applied afterwards.

5) Tumor Contouring: Tumor cluster extraction was done by an intensity based approach which is thresholding. The output of this image is the highlighted tumor area with a dark background.

6) Feature Extaction: Two types of features were extracted for classification. Texture-based features such as-Dissimilarity, Homogeneity, Energy, Correlation, ASM and Statistical based features including- Mean, Entropy, Centroid, Standard Deviation, Skewness, Kurtosis were extracted from the segmented MRI Images.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10322

7)Traditional Classifiers*:* We used six traditional machine learning classifiers which are K-Nearest Neighbor, Logistic Regression, Multilayer Perceptron, Naïve Bayes, Random Forest, and Support Vector Machine to get the accuracy of tumor detection of our proposed model.

*8)*Evaluation Stage: Implementing other region-based segmentation methods and comparing it to our proposed segmentation technique, our model segments the ROI and segregates the tumor portion most accurately. An illustration of the whole process is depicted in Fig. 5. After segmentation and feature extraction from the tumor, we applied six classification techniques. Among them, we got the best result from SVM and obtained an accuracy of 92.42%.

Proposed Methodology Using CNN:

Convolutional Neural Network is broadly used in the field of Medical image processing. Over the years lots of researchers tried to build a model which can detect the tumor more efficiently. We tried to come up with an exemplary which can accurately classify the tumour from 2D Brain MRI images. A fully-connected neural network

A Five-Layer Convolutional Neural Network is introduced and implemented for tumor detection. The aggregated model consisting of seven stages including the hidden layers provides us with the most prominent result for the apprehension of the tumor. Following is the proposed methodology with a brief narration-

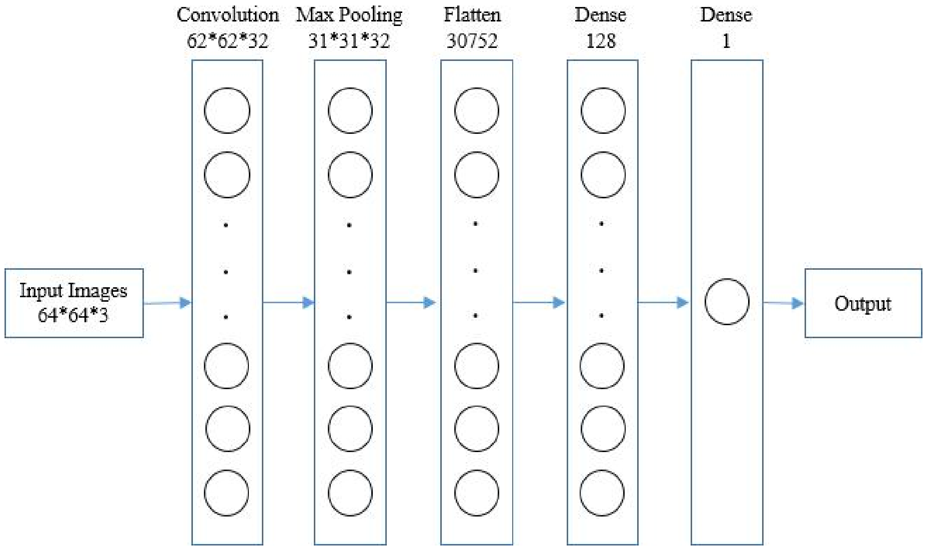
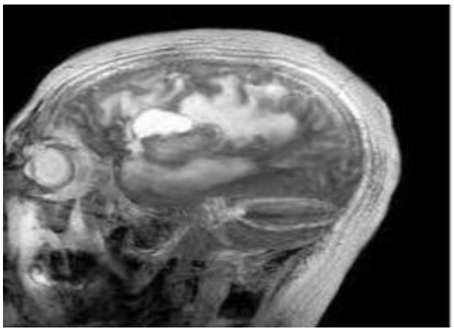


Fig. 3. Proposed Methodology for tumour detection using 5-Layer Convolutional Neural Network

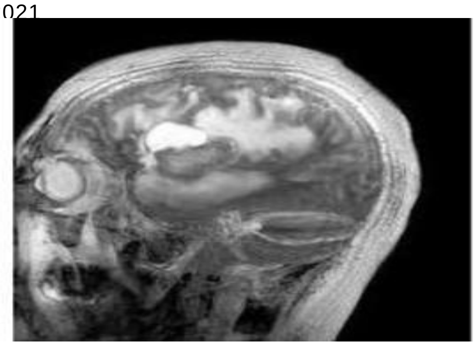
Experimental Dataset

For Performance Evaluation of our proposed model, we used the benchmark dataset in the field of Brain Tumour Segmentation, and that is BRATS dataset [16], consisting two classes'— class-0 and class-1 represents the Non-Tumour and Tumour MRI images. 187 and 30 MRI Images containing tumour and non-tumour respectively classified as class-1 and class-0. All the images are MRI images from different modalities like- T1, T2, and FLAIR. For traditional machine learning classifiers, we obtained the superlative result splitting the dataset by 70 to 30 in terms of training to testing images, and for CNN, we divided the dataset in both 70 to 30 and 80 to 20 formations and compared the Segmentation using Image processing techniques

Based on our proposed methodology, we segmented the tumour without loss of any subtle information. We removed the skull because for tumour segmentation the role of skull is approximately null and ambiguous in this process.

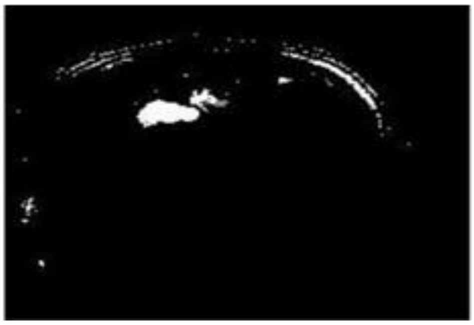


Mri image of tumour



Grayscale image

Median Filtered



Threshold Segmented

Morphological operation applied image

Final tumor detected image

Classification Using Machine Learning

Texture and Statistical based features are more popular for detecting the Region of Interest (ROI). Based on these features we can segregate the tumorous and non-tumorous MRI. We used texture and statistical based features for classification. Texture-based features like- Dissimilarity, Homogeneity, Energy, Correlation, ASM and Statistical based features including- Mean, Entropy, Centroid, Standard Deviation, Skewness, Kurtosis were extracted from the segmented Brain tumour. Further, we extracted the Area, Convex Hull Area and Diameter of the tumour. Extrapolating Convex Hull Area and Diameter of the tumour. Extrapolating these features from the segmented MRI, we classified the image as the existence of normal and abnormal tissue.

Classification Using CNN

The five-layer proposed methodology gives us the commendable result for the detection of the tumor. Convolution, Max Pooling, Flatten, and two dense layers are the proposed five layer CNN model. Data augmentation had been done before fitting the model as CNN is translation invariance.

We evaluate the performance in two ways based on splitting the dataset. We accomplish 92.98% of accuracy for 70:30 splitting ratio where the training accuracy is 99.01%. Then at the second iteration, 80% of the images assigned for training and the rest of the images accredited for testing where we concluded 97.87% of accuracy and 98.47% of training accuracy. So our proposed model gives the best result when the division is 80:20.

We got 97.87% as accuracy which is remarkable in terms of using five-layer CNN. We analyzed with a different number of layers but the divergent of the outcomes were not very significant in terms of using this five-layer CNN model. Some of the aspects that we obtained when we increase the number of layers is-

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10322

computation time, the complexity of the method batch size and steps per was immensely high. Further, we used 0.2 as the dropout value but did not commensurate the model as the accuracy flattened.

FUTURE ENHANCEMENT

Gaussian reduces the noise; enhance the image quality and computationally more efficient than other filtering methodology. After the several image quality improvement and noise reduction discussion here, some possible segmentation methodology like intensity based binarized segmentation, Region based, classification based, texture based, clustered based, neural network based, fuzzy, edge based, atlas, knowledge based, fusion, probabilistic segmentation has been described above with short description, advantage and disadvantage to detect or segment a brain tumor from MRI of brain image. In the threshold intensity based binnarized segmentation Kapur method is best methods and produce very effective results. Most of the binarized fails due to large intensity difference of foreground and background i.e. the black background of MRI image.

CONCLUSION

In this paper, we present a machine learning approach to detect whether an MRI image of a brain contains tumour or not. This has to be done with no human intervention. Here, several existing brain tumor segmentation and detection methodology has been discussed for MRI of brain image. All the steps for detecting brain tumour have been discussed including pre-processing steps. Pre-processing involves several operations like non local, Analytic correction methods, Markov random field methods and wavelet based methods has been discussed. Quality enhancement and filtering are important because edge sharpening, enhancement, noise removal and undesirable background removal are improved the image quality as well as the detection procedure. Among the different filtering technique discussed above, median filter suppressed the noise without blurring the edges and it is better outlier without reducing sharpness of the images, mean filter are much greater sensitive than that of median filter in the context of smoothing the image.

REFERENCES

1. Kasban, Hany & El-bendary, Mohsen & Salama, Dina. (2019). ―A Comparative Study of Medical Imaging Techniques‖. International Journal of Information Science and Intelligent System. 4. 37-58.J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68 –73.
2. D. Surya Prabha and J. Satheesh Kumar, ―Performance Evaluation of Image Segmentation using Objective Methods‖, Indian Journal of Science and Technology, Vol 9(8).
3. Kavitha Angamuthu Rajasekaran and Chellamuthu Chinna Gounde r, Advanced Brain Tumour Segmentation from MRI Images, 2018.
4. General Information About Adult Brain Tumors". NCI. 14 April 2014. Archived from the original on 5 July 2014. Retrieved 8 June 2014. (Accessed on 11th January 2019).
5.M. Young, The Technical Writer‘s Handbook. Mill Valley, CA: University Science,1989.
6. B. Devkota, Abeer Alsadoon, P.W.C. Prasad, A. K. Singh, A. Elchouemi, ―Image Segmentation for Early Stage Brain Tumor Detection using Mathematical Morphological Reconstruction,‖ 6th Intern ational Conference on Smart Computing and Communications, ICSCC 2017, 7-8 December 2017, Kurukshetra, India.
7. Song, Yantao & Ji, Zexuan & Sun, Quansen & Yuhui, Zheng. (2016). ―A Novel Brain Tumor Segmentation from Multi-Modality MRI via A Level-Set-Based Model‖. Journal of Signal Processing Systems. 87. 10.1007/s11265 - 016-1188-4.
8. Ehab F. Badran, Esraa Galal Mahmoud, Nadder Hamdy, ―An Algorithm for Detecting Brain Tumors in MRI Images‖, 7th International Conference on Cloud Computing, Data Science & Engineering - Confluence, 2017.
9. Pei L, Reza SMS, Li W, Davatzikos C, Iftekharuddin KM. ―Improved brain tumor segmentation by utilizing tumor growth model in longitudinal brain MRI‖. Proc SPIE Int Soc Opt Eng. 2017.