DETECTION OF BRAIN TUMOR USING TRANSFER LEARNING

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Abstract
A brain tumour is an abnormal mass or growth of abnormal cells in the brain which can prove to be fatal to the infected patient. The first step in the diagnosis is locating and confirming the presence of the tumour. The faster the presence and location of the tumour is confirmed, easier and efficient treatment can be carried out. So, diagnosis plays a major role in treating brain tumors. The diagnosis is carried out by analyzing the images of different sections of the brains and segmenting the tumors in these images. These images can be obtained from CT scans, PET scans and MRI scans. CT scans and PET scans tend to harm the patients due to prolonged exposure to radiation. Once these MRI images are obtained, they are analyzed by experienced neurologists who manually locate the position of the tumour. The best approach to maximize the treatment window and increase the odds of successful recovery of the patient from the brain tumors is automating the tedious manual tasks carried out by radiologists and doctors. The use of machine learning algorithms and present technological advancements in the field of medical science we can automate the entire process of brain tumor detection. A Computer aided system can be designed for accurate brain tumour detection from MRI images using Transfer Learning.

Keywords: MRI Scans, Transfer learning, brain tumour.

I. Introduction

Brain tumors can affect brain function if they grow large enough to press on surrounding nerves, blood vessels and tissue. This project attempts to solve one of the most glaring problems in this world, that is, the detection of brain tumor at an early stage to take necessary precautions.

The first step towards treatment is the diagnosis and locating the brain tumor in the sections of the brain. The system must be able to distinguish between the healthy brain tissue and the abnormal mass lying within the brain tissues. On closely comparing the advantages and disadvantages of each of these practices, it is found that MRI scans provide high resolution images of the brain sections and are also proven to be less harmful to the patients. CT scans and PET scans tend to harm the patients due to prolonged exposure to radiation. Once these MRI images are obtained, they are analyzed by experienced neurologists who manually locate the position of the tumour. Accurately labelling a brain tumour is a very time-consuming task, and considerable variation is observed between doctors.

The automation of this segmentation process will speed up the diagnosis process and help the doctors devise a treatment plan to cure the tumour. The automation of this process is done by building a model using machine learning technique namely transfer leaning which can accurately label the case as healthy or brain tumor by carefully diagnosing the input brain image. Transfer learning is a machine learning technique where a model trained on one task is re-purposed on a second related task i.e., a model developed for a task is reused as the starting point for a model on a second task. Transfer learning is an optimization that allows rapid progress or improved performance when modelling the second task [9]. The model is made to learn by a pre-determined dataset which consists of labeled yes and no brain tumor classifications and the learnt model will be able to accurately predict the class to which the input brain MRI image belongs. This method of diagnosis eliminates the problems in the existing manual system such as the time factor involved and the patient health put at risk due to radiation exposure [8]. We have implemented one-shot learning method to train our model. One-shot learning is a variant of transfer learning where we try to infer the required output based on just one or a few training examples. This is essentially helpful in real-world scenarios where it is not possible to have labeled data for every possible class (if it is a classification task) and in scenarios where new classes can be added often.

Our method is to provide an effective computer-based approach to detect brain tumors. We use deep learning techniques such as transfer learning to train our model and classifiers such as convolution neural network to classify MRI images into classes brain tumor and non-brain tumor thus automating the detection process for faster diagnosis. Our methodology comprises of three stages as follows:

A. Data Augmentation and Preprocessing

We are using inbuilt functionalities to perform data augmentation, that is to add more training data by applying a series of operations like rotation, cropping, resizing, etc. to each image in the batch. We use ImageDataGenerator which augments our images in real-time, which basically reduces unwanted distortions and enhances the image features.

B. Feature Selection and Extraction

Main aim of this process is to enhance the performance by getting rid of redundant and irrelevant features.Convolution puts the images through a set of convolutional filters, each of which activates and extracts certain features from the images.Pooling simplifies our output by doing non-linear down sampling, thus reducing the number of parameters the network will have to learn.

C. Image Classification

At the end of a CNN, the output of the last pooling layer acts as an input to the fully connected layer and this layer contains an activation function, ReLU.Finally, the last layer is prediction layer which categorizes the input into either of the two outputs (which are Brain tumour or not).

We have implemented a predictor module that provides opportunity to detect brain tumour from test images.

II. Literature Survey

[1] Dr. Ashish Negi et al. [1] proposed, A Deep Learning for Brain Tumor MRI Images Semantic Segmentation Using FCN. The paper proposes a combination of deep learning and machine learning using 3D segmentation to detect brain tumor more effectively and accurately. Using FCN smoothing, enhancing and segmentation is done. Limitations: FCN to CONV layer reduces the parameter but results in loss of flexibility. Loss of flexibility doesn't show impact in this paper because of small dataset but it surely makes a bigger impact in the long run.

[2] Iram Shahzadi et al. [2] proposed, CNN-LSTM: Cascaded Framework for Brain Tumour Classification. The paper implements a cascade of CNN with Long Short-Term Memory (LSTM) Network for classification of 3D brain tumor MR images into High Grade and Low-Grade Brain Tumor. The paper implements Pre-trained VGG-16 were extracted and fed into LSTM network for learning high-level feature representations to classify the 3D brain tumor volumes into HG and LG using ResNet and AlexNet. Limitation: With limited amount of training data predicting the pixel labels for a brain tumor accurately becomes a major task.

[3] Madhupriya G et al. [3] proposed, Brain Tumor Segmentation with Deep Learning Technique. They present a Deep learning technique which is a deep neural network and probabilistic neural network to detect unwanted masses in the brain. The Brats data set lacks resolution in 3- Dimension so the input image is divided into slices thus it is necessary to

partition an input into two subdivisions, a two-path architecture is taken with CNN and PNN. Limitation: The proposed system uses dataset for brain image from BRATS and the BRATS dataset has a poor resolution in 3D.

[4] Masoumeh Siar et al. [4] proposed, Brain Tumor Detection Using Deep Neural Network and Machine Learning Algorithm. The proposed system uses a Convolutional Neural Network (CNN) to detect a tumor through brain Magnetic Resonance Imaging (MRI) images. A Clustering algorithm for feature extraction and CNN is proposed. This algorithm has a duplicate procedure that is iterative, for a constant number of clusters, it attempts to obtain points as cluster centers, which are in fact the same mean points belonging to each cluster. Limitation: In few cases, some areas of fat in the pictures are mistakenly detected as tumor.

[5] Gunasekaran Manogaran et al. [5] proposed, Machine Learning Approach-Based Gamma Distribution for Brain Tumor Detection and Data Sample Imbalance Analysis. The proposed system gives an improved orthogonal gamma distribution-based machine-learning approach to analyze the under- segments and over-segments of brain tumor regions to automatically detect abnormalities in the region of interest (ROI). Coordinate matching using orthogonal gamma distribution and edge enhancement with identification were computed using the machine learning approach Orthogonal gamma distribution model was implemented with a machine learning approach for this edge-based image segmentation.

[6] Bhagyashri H et al. [6] proposed, Brain Tumor analysis Based on Shape Features of MRI using Machine Learning. The authors implement a brain tumor classification system based on shape feature with machine learning using MRI images. Segmented brain tumor images are used to extract the shape feature like center of gravity, circularity ratio, rectangularity, convexity, solidity of tumor region. These shape features are used to classify the tumor as benign and malignant brain Tumor. Support Vector Machine is supervised learning algorithm and Random Forest works on decision tree. Limitation: Proposed method achieved 86.66% accuracy with random forest algorithm which can probably be increased by using other techniques.

[7] Mingchao Xie et al. [7] proposed, A Deep Convolutional Neural Network Learning Transfer to SVM-Based Segmentation Method for Brain Tumor. The proposed system suggests a convolutional neural network-based learning transfer to support vector machine classifier method for brain tumor segmentation. CNN is trained to learn the mapping from the image space to the tumor label space using N4ITK method. Limitations: The loss of function (is a function to measure the error of the training model) which was large. The accuracy of the MRI brain tumor segmentation is debatable since it is just done is limited scans.

[8] G. Hemanth et al. [8] proposed, Design and implementing brain tumor detection using machine learning approach. The paper contributes an automatic segmentation method that relies upon CNN (Convolution Neutral Networks), determining small 3x3 kernels. CNN directly extracts features from pixel images with least pre-processing involved it possess fewer specific tasks in contrast to the conventional methods and helps in thoroughly extracting features. Limitations To detect brain tumor detection there exist different classical approaches but the present work utilizes the traditional neural network approach for detecting brain tumor since the brain tumor detection images relies upon the neighborhood pixels.

[9] Sinan Alkassar et al. [9] proposed, Automatic Brain Tumour Segmentation Using Fully Convolution Network and Transfer Learning. The system proposed by the paper employs transfer learning and fully convolution network to achieve robust tumour segmentation using the pre-trained VGG-16 network. The proposed FCN architecture of VGG-16 network consists of three parts including the encoder network, decoder network, and classification layer which is the final layer achieving the pixel-wise classification. The encoder and decoder network produce a feature map which is fed to the classification layer for label classification. Limitation: Segmentation of specific tumor regions like segmentation of the active tumor areas is not considered here.

[10] Ranjeet Kaur et al. [10] proposed, Localization and Classification of Brain Tumor using Machine Learning & Deep Learning Techniques. The proposed system has discussed the different techniques that are used for tumor pre-processing, segmentation, localization, extraction of features and classification. 5 different image pre-processing techniques were used each having their own advantages and disadvantages, Adaptive Histogram Equalization (AHE), Median Filter, Adaptive Median Filter, Weiner Filter, Gaussian Filter. The various images classification techniques are Artificial Neural Network (ANN), Convolutional Neural Network, Decision Tree (DT), Support Vector Machine (SVM).

[11] Hasan Ucuza et al. [11] proposed, A Deep Convolutional Neural Network Learning Transfer to SVM-Based Segmentation Method for Brain Tumor. The Proposed System is to develop a user-friendly, free web-based software that can classify brain tumors (glioma, meningioma, pituitary) and enable experts to make fast and accurate decisions. Keras/Auto Keras is used in image pre-processing (image rotation, changing width and length, truncating images, rescaling, etc.). Bayesian optimization technique is used to tune the hyperparameters of the model. Limitation: The paper fails to develop a system that can classify the data sets containing brain images of healthy individuals in addition to the images of the brain tumors of patients examined in this study.

[12] Sakshi Ahuja et al. [12] proposed, Transfer Learning Based Brain Tumour Detection and Segmentation using Superpixel Technique. The paper proposes an automatic brain tumour detection system using VGG-19 Transfer learning model and segmenting into LGG and HGG using Superpixel technique. The methodology consists of two phases. The first phase detects and classifies the tumour using a transfer learning model. The second phase segments the region where the tumour is located based on colour contrast using Superpixel technique. Limitations: Small sized tumours are difficult to identify by the Superpixel technique because it gives less dice coefficient. The proposed model here has not been implemented in real time scenarios.

[13] Komal Sharma et al. [13] proposed, Brain Tumor Detection based on Machined Learning Algorithms. The MRI brain images are acquired and are given as input to pre-processing stage. Edges are detected from filtered image using canny edge detection. Watershed segmentation is done for finding the location of the tumor in the brain image. The important features needed for image classification are extracted using Gray Level Co-occurrence Matrix. The Machine learning algorithms are used for classification of MR brain image either as normal or abnormal. Limitations: The maximum accuracy 98.6% and 91.6% is achieved by considering 212 samples of brain MR images. This accuracy can probably be increased by considering a large data set and extracting intensity-based features in addition to the texture-based features.

[14] Zheshu Jia et al. [14] proposed, Brain Tumor Identification and Classification of MRI images using deep learning techniques. The system proposes the separation of the whole cerebral venous system into MRI imaging with the addition of a new, fully automatic algorithm based on structural, morphological, and relaxometry details. A Fully Automatic Heterogeneous Segmentation using Support vector machine (FAHS-SVM) is used for brain tumor detection and segmentation. Its architecture is shown in the figure. The primary operation of pre-processing is to enhance the quality of the Magnetic Resonance images and to make them suitable for further processing. Limitations: Tumor size affects the accuracy of segmentation, and tumor boundaries are usual errors, due to which large brain tumors are defined by a high number of misclassified image pixels. Large tumors probably enter the brain and make it challenging to determine the boundary of the tumor accurately.

[15] Yakub Bhanothu et al. [15] proposed, Detection and Classification of Brain Tumour in MRI Images using Deep Convolutional Network. The proposed system suggests using a fast R-CNN algorithm to detect the tumour regions and classifying them into three categories: glioma, meningioma and pituitary tumor. This method uses VGG-16 model as its base layer. The Faster R-CNN architecture consists of three main blocks: RPN, ROI pooling and R-CNN for object detection. Limitation: The proposed method at its optimal

accuracy rate provided the least accuracy for detection of pituitary tumour (68%).

III. Conclusion

The focus of this paper is to help the radiologists and doctors by detecting the tumor in a short interval of time and also by deriving most accurate results with very small window of doubt. This gives the doctors ample time to assess the situation and take necessary actions towards its treatment. With the help of transfer learning, we achieved an accuracy rate of 96% which is comparatively good but there is room for improvement.

The methodology implemented in this paper can be improved further to categorize and predict the type of tumour even more specifically, maybe into benign and malignant or further specific categories as well. Our approach, although had a good accuracy rate, could have been improved if we had used a larger dataset in the training phase.

IV. References

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