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DETECTION OF BRAIN TUMOR USING DEEP NEURAL NETWORK

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ABSTRACT
A Brain Tumor (BT) is an unusual growth of brain cells. It is possible for tumours to begin in the brain or to spread from malignancies in other regions of the body into the brain. Swelling headaches, impaired vision, and balance issues are among the most common symptoms of brain tumours. Surgery, radiation therapy, and chemotherapy are all options for treating brain tumours. Analysis of brain tumours is somewhat problematic as the varied shape, size, tumor location, and the presence and appearance of tumours in the brain. It's hard to detect brain tumours in the beginning stage because the accurate measurement of the tumor can't be found. The proper identification of the brain tumours in the beginning stage provides proper treatment and increase the life time of the patients. Deep learning and Image processing techniques can be used for brain tumor determination from MRI images. This paper provides a comprehensive review of work done in the field of identification of Brain tumours from MRI images using Deep Neural Network (DNN). A brief overview of technique which can be used to detect brain tumours using image segmentation and DNN is also proposed in this paper.
Keywords: - Brain Tumor, MRI images, Deep Neural Network (DNN), Image Processing, Image segmentation

1. Introduction about Cancer

In cancer, cells in the body proliferate uncontrolled, causing the disease to spread throughout the entire body. Cancer can begin in any one of the billions of cells in the human body. When a person's body needs additional cells, they divide into new ones and this process is known as cell division. New cells are used to replace any damaged or ageing cells. Sometimes, during this process, damaged or abnormal cells start to duplicate and grow in ways they shouldn't. Tumours, which are bloated lumps of tissue, may develop from such cells. These tumours can be cancerous or non-cancerous. Spreading cancerous tumours can create new tumours in other parts of the body, as well as in distant tissues (a process called metastasis). Cancerous tumours are also known as malignant tumours. Non-cancerous tumours also called as benign tumours do not spread or infiltrate other bodily areas. In contrast to cancerous tumours, benign tumours rarely reappear following excision but they can cause serious symptoms and can even be life-threatening. Some of the benign tumours also have tendency to grow in size.

1.1 Brain Tumours

A mass of aberrant brain cells is referred to as a tumour. The structure of the skull, which protects the brain, is extremely hard. A difficulty might arise if there is any development inside such a small area. It is possible for tumours in the brain to be cancerous or benign. Whether the tumour is benign or cancerous, it can raise the pressure in the skull. This has the potential to harm the brain and could be deadly. Primary and secondary are the two main varieties of brain tumours:

Primary brain tumours

The brain is the main source of origination for such types of tumours. They have the ability to grow from:

- cells in the brain
- the meninges, which are the membranes that surround your brain.
- Nerve cells
- glands, such as the pituitary and pineal

Primary tumours can be cancerous or benign. Gliomas and meningiomas are the most prevalent forms of brain tumours in adults.

Secondary brain tumours

The vast majority of cases of brain tumours are secondary ones. They steadily transit from one part of the body to the rest and then culminate in the brain. The brain can develop cancerous tumour from any of the following:

- lung cancer
- breast cancer
- kidney cancer
- skin cancer

The cancerous nature of secondary brain tumours is a surety. There is no spread of benign tumours in the body.

1.2 Diagnostic Techniques of Brain Tumour

Various sorts of new imaging techniques are causing a major shift in the medical field. The most frequently used imaging techniques today are ultrasound, X-ray, computed tomography (CT), positron emission tomography (PET), single-photon emission computed tomography (SPECT), and magnetic resonance imaging (MRI) [2]. In evaluating the structure of the tumours, Computed Tomography (CT) and MRI could be performed. When it comes to brain imaging, MRI provides a more detailed view of the brain's architecture than CT scans, which use radiation that could be harmful to the patient's health. MRI creates detailed images of tissues and organs by using radio waves and magnetic fields. As a result, MRI is an excellent therapeutic imaging technique, particularly for imaging the brain [4]. Pregnant women, children, and adults of all ages can benefit from this procedure since it provides accurate image of the human body's anatomical structure, particularly the brain's soft tissues (Alam et al., 2019). Detecting brain tumours from MR images is becoming increasingly more difficult.

2. Literature Review:

Using CT Brain images, Marcin Wozniak et al. [1] used deep learning techniques to predict the presence of brain tumours. In order to more efficiently identify brain tumours, they created a novel correlation learning mechanism (CLM) for deep neural network designs that blends a convolutional neural network (CNN) with a traditional architecture. The support neural network allowed CNN to determine what filter was best for the pooling and convolution layers. As a result, the primary neural classifier gains efficiency and learns more rapidly.

M. Khairul Islam et al. [2] suggested an enhanced method for diagnosing brain lesions in a faster execution time based on a template-based K-means algorithm with super pixels and principle components analysis (PCA).

In order to categorise and segment brain tumours, Daizy Deb and Sudipta Roy [3] developed a novel algorithm. In order to discriminate between normal and diseased MRI pictures, the team used an adaptive fuzzy deep neural network with frog leap optimization.

According to Maruthi Kumar et al. [4], who submitted their findings in this journal, an MRI brain tumour categorization system may be automated. The planned job included pre-processing, feature extraction, classification, and segmentation. The Median Filter is used to eliminate noise from an input image. The next step is to extract texture features from the pre-processed image. The adaptive k-nearest neighbour classifier is then used to assess whether an image is normal or abnormal after feature extraction. To locate the tumour regions, fuzzy C-means clustering is used.

Preethi and Aishwarya [5] proposed an effective approach for segmenting tumours from PET and MRI data. Their suggested technique first fuses an input picture using a discrete wavelet transform (DWT), and then utilises the Spider Monkey Optimization (SMO) algorithm to choose the network weights of DNN. Following the categorization procedure, aberrant brain images are processed using the weighted K-means algorithm to isolate the tumour region.

Diyuan Lu et al. [6] advocated deep learning with data distillation and augmentation.

Muhammad Irfan Sharif et al. [7] suggested a four-step method to identify tumours. To eliminate noise from MRI images, a non-dominated sorting evolutionary method initially uses the homomorphic wavelet filer, followed by the pre-trained inceptionv3 model (NSGA). It is possible to identify the infected area using the depth-concatenation (mixed-5) layer and the YOLOv2 model after classification. Using Kapur entropy, a 3D-segmentation of the tumour is generated from the localised images.

Using a combination of CNN and SVM, the researchers, M.O. Khairandish et al. [8] were able to classify benign and malignant tumours in brain MRI images.

Anil Kumar et.al. [18] proposed a method for brain tumour segmentation and classification using K-means clustering for segmentation and Kernel based support vector machine (KSVM) method for classification.

3. Research Gaps

- Brain tumours are difficult to study because of their wide range of shapes, sizes, locations, and appearances in the brain. Brain tumours are difficult to identify in the early stages due to the lack of a reliable tumour measuring [5].
- A noisy image from the imaging system makes it difficult to determine where the stroke occurred in the images produced. [9].
- In image segmentation, the most difficult problem is to group several feature vectors that have similar characteristics. As a result, the most important component in segmenting an image is a precise extraction of features [8].
- Data loss is more probable when an image's pixel count is reduced from hundreds of thousands to just a few hundred "super pixels."[2].
- Some of the deep learning classifier provides low accurate solution due to improper hyper parameter tuning. Hence, an optimization algorithm is needed for the proper tuning of the classifier, which increases the accuracy of the brain tumour detection model.

4. Problem statement

It is difficult to conduct an accurate analysis of tumours in the brain because of the wide range of tumour characteristics, including size, shape, location, and appearance. Because of the difficulty in obtaining a precise measurement of the tumour, early detection of brain tumours is hard. The proper identification of the brain tumours in the beginning stage provides proper treatment and increase the life time of the patients. Thus, main aim of research is to develop a brain tumour detection technique, which accurately determines the tumours in the brain. This research intends to use deep learning and image processing techniques for brain tumour determination. Further some of the deep learning classifier provides low accurate solution due to improper hyper parameter tuning. As a result, the goal of this study is to devise a method for increasing the classifier's accuracy so that it can better identify brain tumours.

5. Techniques Used

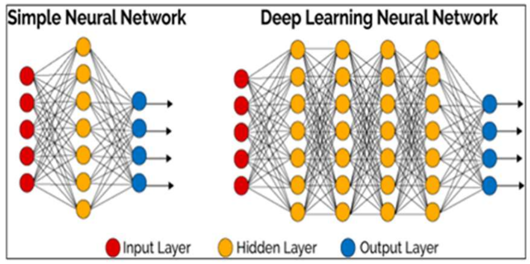
Image Segmentation and clustering

In modern medical imaging techniques like MRI and CT scans, the images generated are so large that they cannot be processed manually. In order to make it easier to convey and understand images, they must be broken down into smaller parts. Image segmentation is one option for doing this. As a result, accurate medical picture analysis and interpretation rely heavily on image segmentation. The word "segmentation" refers to a digital imaging process that divides an image into numerous sections (basically groups of pixels, also termed as Super pixels). It's a method for dividing up an image into smaller, more manageable chunks, each with their own unique set of attributes, such as colour, texture, contrast, brightness, and even the degree of grey. Pixels are given labels during in the segmentation process. Each and every visual component and pixel that starts to fall under the same classification is given the same label. Thus further processing or analysis can be simplified by lowering the image's complexity by segmenting it. Instead of processing whole image by detector, a segmentation method can be used to pick a portion of interest of an image to be processed by the detector. Thus processing time will be reduced as a result of this action.

Image segmentation has made extensive use of clustering, a potent technique. An image data collection may be partitioned into a number of distinct groups or clusters using cluster analysis. Various types of imaging modalities such as MRI are used to separate tumour tissues and dead cells from healthy brain tissues by a process known as brain tumour segmentation. It is feasible to use K-Means and Fuzzy–C-Means (FCM) to segment and cluster images using a different algorithm.

Deep Neural Networks

Artificial intelligence's "deep learning," sometimes called "hierarchical learning," is a subset of machine learning that may replicate the computational capabilities of the human brain and build patterns that are comparable to those utilised by the brain to make choices. The human brain serves as a model for neural networks since it is the most complicated thing in the universe. Neurons are the basic building blocks of the human brain. Any neural network, including the brain, starts with a single neuron. To get to the Output Layer, the processed data must first travel through the network's various hidden layers, where it is passed on to other neurons. The input, output, and hidden layers are all that an Artificial Neural Network (ANN) needs to operate. As the title suggests, the term "deep" in Deep Learning refers to the neural network's hidden layers. A deep learning model is any neural network with more than three layers, including input and output. Deep learning algorithms can be used to train and predict output from complex data.

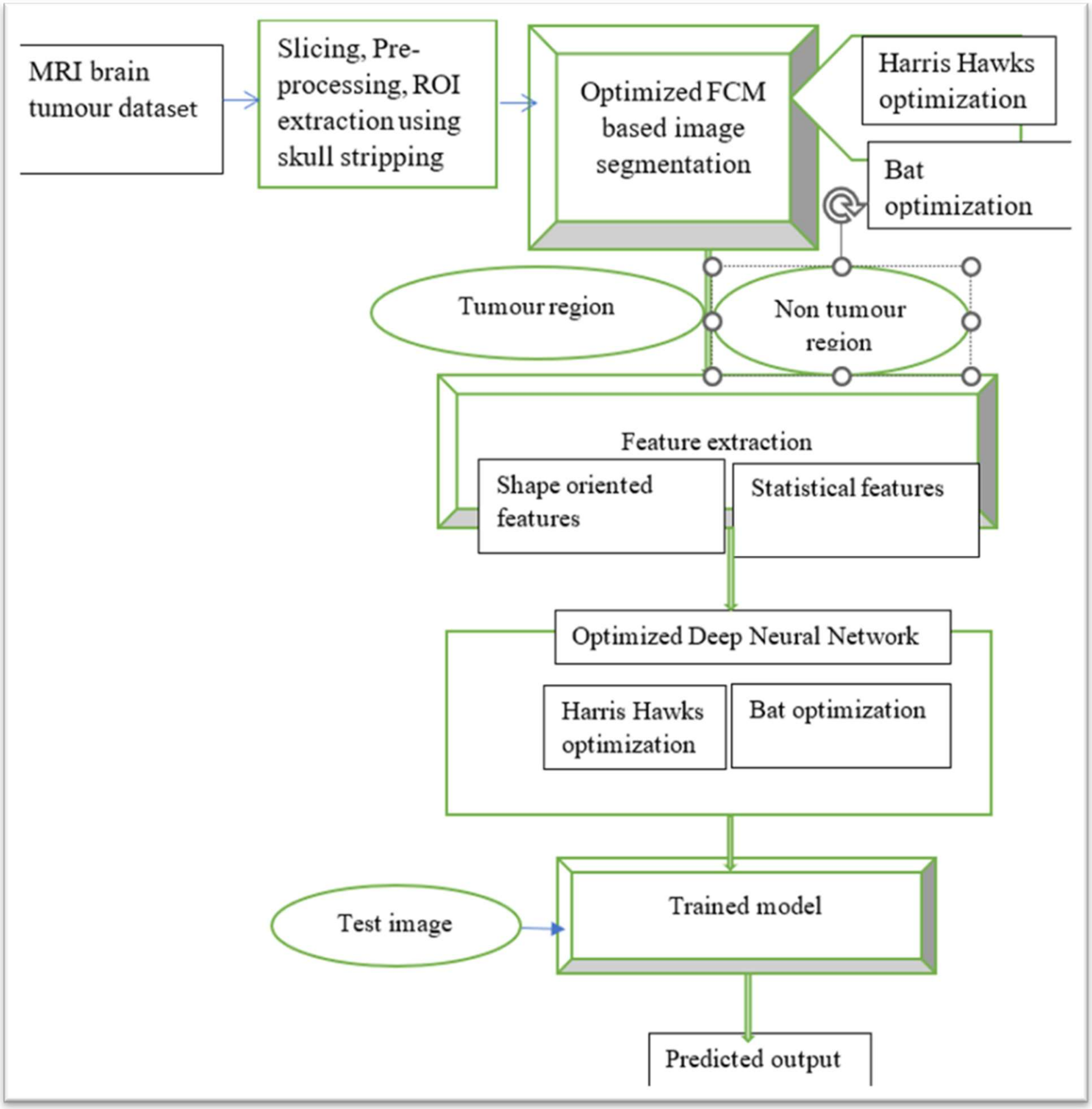


6. Proposed Methodology

The proposed methodology will employ a number of steps to discover and categorize Brain Tumours based on MRI images.

1. The first stage is to do some pre-processing to MRI images to improve quality of image and remove noise from image. Several approaches can be used such as gray-scale conversion, applying Gaussian or Median filter to remove noise etc.
2. Next step will be to extract the ROI (Region of Interest) from the given image. This is done by skull stripping. This step will remove that part of brain from image that is not of concern.
3. The extracted ROI from the brain image will be fed forward to the clustering algorithm to perform segmentation. Various commonly used segmentation techniques are K-Means, Fuzzy C-means clustering etc. After this the image data is divided into tumour and non-tumour region.
4. Next step is to fine tune the clustering algorithm's parameters by using some optimization algorithms like Echo-chasing and Harris hawks (HHO).
5. From the segmented image, the shape-oriented characteristics and statistical features will be input into the optimal Deep Neural Network classifier.
6. An optimization approach like Echo-chasing may be used to fine-tune the classifier's hyper-parameters. The test image is will then be input into the trained model in order to foresee the brain tumour
7. Then the proposed methodology will be compared with existing methods, such as [1], [2] and [3].

The proposed methodology is shown in the diagram shown below:



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