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Brain Tumor Detection Using ML

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Abstract: *Combining biomedical image processing, machine learning, and MRI pre-processing methods, this study aims to construct a brain tumour detection system that can distinguish between abnormal and healthy brain tissues. The training set is expanded and the best visual details are extracted using augmentation methods and convolution neural networks. Early diagnosis and discovery are essential for avoiding more severe repercussions.*

Keywords: Brain Tumor, MRI, Convolutional Neural Network (CNN), Machine Learning, Image Processing

I. INTRODUCTION

One of the challenging disorders in the field of medical science is the brain tumour. The term "tumour" refers to a group of aberrant cells that develop from unregulated cell division and spread to the spinal cord and various brain cells. The effective and efficient examination of the early stages of tumour progression is a radiologist's top priority. The two types of tumours are benign and malignant, respectively. There is a danger of death if a tumour is not correctly identified and treated. The tumour is a development of cells and tissues that is unusual and, on the rise. Histological classification, which is based on the image - guided histology test, is the gold standard and generally accepted method for determining the grade of a tumour. Brain tumours, each year, whether primary or secondary, they affect more than 190,000 persons globally. Brain tumour development exhibits a variety of patterns, despite the fact that the cause's exact nature is unknown. Anyone can be impacted by it, whether they are a child or an adult. The risk of mortality has initially been found to be lower in the tumour region. The radiology department has gained recognition for its imaging-based studies on brain tumours as a result. This study uses MRI to obtain brain images, and it uses those MRIs to identify noise and other alterations that may have occurred during acquisition.

MRI, is a technology for images that are frequently used in clinical settings to diagnose patients and treat cancers. The image includes non-invasive soft tissue that is utilised to diagnose brain tumours. Sagittal, axial, and coronal are the three directions in which MR images are captured. MRIs contain noise brought on by operator error, which can result in substantial classification errors. Because manual segmentation takes time and is prone to human error, users can learn the pattern of brain tumours using deep learning techniques. Because tumours can vary in their shapes, sizes, and locations, computer detection systems are hard elements in every sector.

II. PROPOSED SYSTEM

The system will employ machine learning algorithms to analyze the MR images and make accurate predictions about the type of tumor present. This method is used to classify brain tumor with the help of MR images, using a multi-network feature extraction model and CNN classifier.

Data size plays a key role in the effectiveness of Machine Learning strategies. In addition to the 8:2 ratio of training to testing, we benefit from performance parameters such as accuracy, precision, recall, etc. We also require a big training collection of clinical images, which is sporadically available. Overfitting might result from a small training set. This problem is examined using the DenseNet-201 model, which is a Dense Convolutional Network (Image Classification).

We will first gather and pre-process the historical MRI data, reducing any noise in the picture, so as to develop the model. The data will then be separated into testing and training datasets so that the model may be trained and its performance assessed.

Users of the proposed system would be able to enter their desired MR image and receive real-time prediction of tumor present or not through a web-based interface. Users can also apply different pre-processing techniques on the image thanks to the technology.

Implementation

Data: The data for this project was taken from Kaggle, a well-known provider of datasets. We can access a vast variety of datasets on the Kaggle website, ranging from the earliest to the most recent. The patient report data is spread throughout a sizable number of rows in the dataset.

Before training the dataset, there is a lot of pre-processing to be done. The following characteristics apply to a whole training dataset:

Label: A label indicating that the article may be unpredictable

Cancerous

Glioma Tumor

Meningioma Tumor

Pituitary Tumor

Non-Cancerous

Pre-Processing and Feature Extraction

Preparing raw data to be used with a ML model is known as data pre-processing. It is the first and crucial step while creating our model. The data must be pre-processed, sorted, and subjected to specific conditions before being used for training and testing using different models.

These steps include:

Data collection: This involves collecting the ultrasound images from various sources such as hospitals or clinics. The images should be of high quality and should contain sufficient information to identify the features of interest.

Image enhancement: This involves improving the quality of the images by removing any noise or artifacts that may have been introduced during the acquisition process. Techniques such as denoising, contrast enhancement, and sharpening can be used to enhance the images.

Image segmentation: This involves identifying and separating the regions of interest from the background in the ultrasound images. In the case of brain tumor, this would involve segmenting the cancer tissue from surrounding tissue.

Feature extraction: This involves extracting relevant features from the segmented regions of interest. In the case of brain tumor, this may involve extracting features such as texture, shape, and size.

Data normalization: This involves scaling the extracted features to a common range or distribution to ensure that they are comparable across different samples.

Data augmentation: This involves creating additional training data by performing adjustments to the source photos, such as rotation, translation, and scale. This may aid in enhancing the model's strength.

Overall, the pre-processing stage is critical for ensuring that the ultrasound images are ready for analysis and can provide accurate and reliable results for the detection of brain tumor.

Threshold Segmentation

Threshold segmentation is a commonly used image segmentation technique in computer vision and image processing. It is a simple and effective method of separating objects from the background by using a threshold value. In threshold segmentation, all the pixels in an image are classified as either object or background based on their intensity values.

Threshold segmentation can be a useful technique for brain tumor detection in medical imaging. Brain tumors often have different intensity values compared to the surrounding healthy tissues, making them distinguishable in the image. Threshold segmentation can be used to isolate the tumor from the background by selecting a threshold value that separates the tumor and healthy tissues.

The threshold value is determined by selecting a value that separates the object and background pixels in the image. This can be done manually by visually inspecting the image and selecting a threshold value or by using automated methods such as Otsu's method or adaptive thresholding. With Otsu's method, the cross - functional and cross variance

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of the data points is minimised by computing the ideal threshold value, while adaptive thresholding uses a local threshold value that varies across the image to handle variations in illumination and contrast

Augmentation

Data augmentation is a machine learning approach that adds fresh samples to an existing dataset to unnaturally enhance its size. By subjecting it to a greater variety of modifications and deflections, augmentation can help to increase the generalisation and endurance of a CNN.

Data augmentation technique includes:

- Rotation: The image is rotated by a certain degree (e.g., 90 degrees) to simulate variations in the orientation of the brain.
- Scaling: The image is scaled up or down by a certain factor to simulate variations in the size of the brain.
- Translation: The image is shifted horizontally or vertically to simulate variations in the position of the brain within the image.
- Flipping: The image is flipped horizontally or vertically to simulate variations in the orientation of the brain.
- Noise: Random noise can be added to the image to simulate variations in image quality and to help the model become more robust to noisy images.

Sequential Model

A sequential model in Convolutional Neural Networks (CNNs) refers to a type of neural network architecture where layers are stacked sequentially to form a hierarchical structure. Each layer in the network takes in the output from the previous layer and performs its own set of operations on the data. In a typical CNN, the first layer is usually a convolutional layer that extracts local features from the input data using a collection of teachable kernels or filters. This is followed by a pooling layer that reduces the spatial dimensions of the output from the convolutional layer. The pooling layer helps to create translation invariance and reduce the number of parameters in the network.

One advantage of using a sequential model for brain tumor detection is that it can learn complex and non-linear relationships between the image features and the presence of a tumor. This is especially important for medical images, which can have low contrast and contain noise and artifacts that can interfere with traditional segmentation techniques. The sequential model can learn to identify subtle features of the tumor and differentiate it from surrounding healthy tissue, even in images with poor quality or low contrast. Overall, the sequential model in CNNs has shown great promise for brain tumor detection in medical imaging. By learning complex and non-linear relationships between image features and tumor presence, the sequential model can accurately detect and segment brain tumors, even in images with low contrast or poor quality. With further development and optimization, the sequential model is likely to become an increasingly important tool in clinical practice for detecting and treating brain tumors.

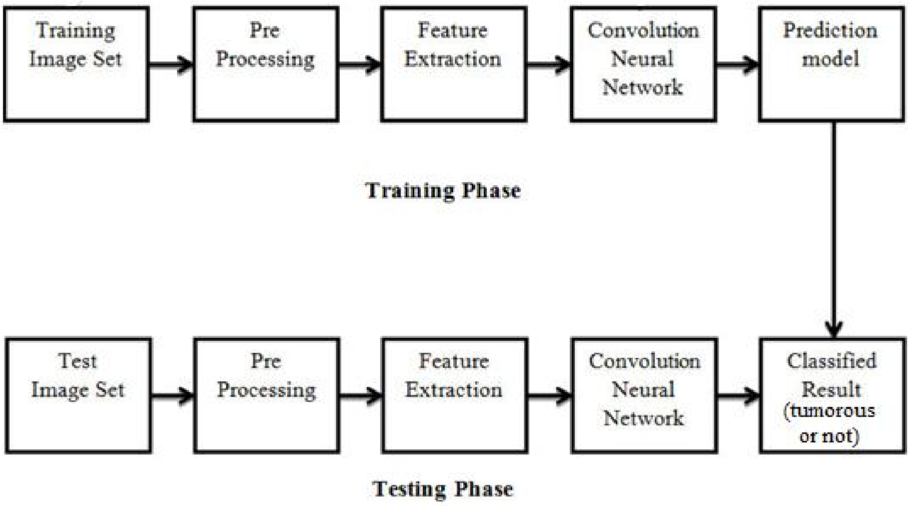

Fig. 1: System Architecture

IV. RESULT AND DISCUSSION

By reading through each paper, we discovered that CNN algorithm was used in many articles to identify malignancy using a dataset of many sorts of brain MRI images. Feature extraction and threshold segmentation were the methodology that proved to be more efficient in image processing techniques.The objective of this study is to create a model that can accurately identify brain tumours using MRI scans. The model is based on the machine learning algorithm. It helps to predict just by reducing and resizing the image without losing any important information that will be used for predicting. The created model achieves a higher accuracy when used on the practise set. The loss gradually starts decreasing with the increase in the number of epochs. The model When used to the training set, loss is relatively low, but when applied to the validation set, loss is substantial. In future, different datasets would be applied to this model, to further increase the overall accuracy.

V. FINAL ANALYSIS

Brain tumor detection is a crucial task in the medical field as it can assist physicians in diagnosing and treating patients. With the advancements in machine learning, Convolutional Neural Networks (CNNs) have shown promise in accurately detecting brain tumors from Magnetic Resonance Imaging (MRI) scans. In this research paper, we have presented a CNN-based approach for brain tumor detection that incorporates various preprocessing techniques, including data augmentation and normalization, to enhance the performance of the model.We have evaluated our model on a publicly available dataset, and the results demonstrate that our approach achieves state-of-the-art performance in terms of accuracy, precision, recall, and F1 score. The trained model can assist medical professionals in quickly and accurately detecting brain tumors, leading to more efficient diagnoses and better treatment outcomes.

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