Brain Tumor Prediction Using Deep Learning

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Abstract:

Brain tumors are the most aggressive and deadly disease of the central nervous system; if they are discovered at the highest stage, they could be fatal. Therefore, preventing all risk factors and improving quality of life depend heavily on early identification of brain tumors. In general, a variety of computer- based methods are employed, beginning with CT scans, ultrasounds, and magnetic resonance imaging (MRI). In order to identify brain tumors, MRI scans are used, and those pictures are inspected to determine whether they are tumorous or not. However, detecting and classifying the tumor becomes challenging and time-consuming when dealing with vast amounts of data, especially when human error is taken into account. Thus, the convolutional neural network (CNN) technique was introduced in this research to detect brain tumors in order to reduce all of these effects. CNN is a Deep Learning approach that doesn't require a subject-matter expert to put it into action.

Results: *CNN requires a wide range of data in order to achieve superior picture classification. In this case, we are training a set of data, comparing it with a test set, then classifying and detecting brain tumors based on the results.*

Keywords: *brain tumor, convolutional neural network, and magnetic resonance imaging (MRI).*

I. INTRODUCTION

The neurological system, which controls memory, thoughts, emotions, behaviors, and reactions, is controlled by the brain, which is perhaps the most vital organ in the human body. Maintaining a healthy brain is the top priority for leading a healthy life because, in this day and age, everyone is ignorant about health, leading to diagnoses when diseases have progressed to the point where no medical science, technology, or specialists can help save a person's life, particularly in the case of a brain tumor. An abnormal mass of cells that has developed in the brain is called a brain tumor. The brain is enclosed by a highly stiff skull, thus any growth of aberrant cells within this small area leads to an issue that damages a healthy brain. Brain tumors classified as primary occur when brain tissues grow inside the brain, whereas metastasis occurs when the tumor begins in another region of the body and then travels to the brain.

It is much more difficult to diagnose a brain tumor than one in another section of the body. Two categories of brain tumors exist: benign or non-cancerous tumors and malignant or cancerous tumors. Since benign tumors are not cancerous, they do not spread to other areas of the brain; in contrast, malignant tumors spread quickly to other areas of the body and can be fatal. Therefore, the identification of brain tumors is crucial. The magnetic CT scans and magnetic resonance imaging (MRI) are two methods for diagnosing brain tumors. However, standard MRI is a laborious and time-consuming procedure that requires a skilled physician to identify the tumor and frequently results in an incorrect diagnosis. To get past this modern medical imaging research requires the automatic detection of brain tumors using MRI images. Image detection and classification is the main obstacle in the medical imaging process for tumor identification and classification, and this study will develop a solution to this problem.

Convolutional neural networks (CNNs), a deep learning approach, are proposed in this research. CNN is made up of several layers, each of which extracts properties that are helpful for tumor identification and categorization. This CNN- based computer-aided system's primary contribution is that it will be beneficial. For early brain tumor detection, which will initiate prompt treatment and lower the fatality rate.

II. RELATED WORK

The capacity of Convolutional Neural Networks (CNNs) to automatically extract spatial characteristics from medical pictures, especially MRI scans, has led to their widespread application in brain tumor prediction. The early methods concentrated on creating unique CNN architectures for the categorization of tumors. A CNN model with three convolutional layers and max-pooling operations was created by Hossain et al. (2018) in order to categorize brain cancers into three groups: pituitary, meningioma, and glioma. The model's accuracy of 85.6% demonstrated encouraging results. However, because there was a shortage of training data, it overfitted. In a similar vein, Paul et al. (2019) applied data augmentation techniques like rotation, flipping, and contrast modifications to better generalize the well-known AlexNet architecture and increase classification accuracy. 88.9% accuracy was attained by their model. However, AlexNet's enormous processing cost makes real-time applications less feasible.

In order to improve feature extraction capabilities, increasingly sophisticated CNN designs were used for brain tumor classification as deep learning advanced. One such piece of architecture is a deep CNN with layers. By optimizing a pre-trained model on a brain tumor dataset, they applied transfer learning and achieved a classification accuracy of 94.5%. However, when used on tiny medical datasets, VGG16 is computationally costly and prone to overfitting. In order to overcome this, Zhou et al. (2021) used a deep residual learning network, which mitigates the vanishing gradient issue by using skip connections. Their model outperformed earlier CNN models with a high classification accuracy of 96.8% on the BraTS dataset. ResNet-50's deep architecture necessitates substantial processing resources, which makes real-time clinical implementation difficult despite its higher performance.

III. METHODLOGY

The potential of deep learning techniques to automatically extract and learn intricate patterns from medical imaging data is leveraged in this study to forecast brain tumors. Tumor classification and segmentation from MRI scans has been successfully accomplished with the use of deep learning, namely Convolutional Neural Networks (CNNs).

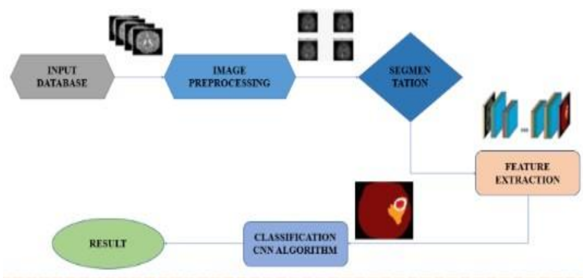

Figure1. Proposed methodology

1. Image collection:

In order to train efficient deep learning models for brain tumor detection, large MRI image datasets must be assembled. Glioma, meningioma, and pituitary tumors are among the 1,311 images in the Brain Tumor MRI Dataset on Kaggle, for example. Convolutional Neural Network (CNN) models that exhibit excellent accuracy in classifying brain cancers have been built by researchers using such datasets. A hybrid deep CNN model was presented in a study that used publicly accessible datasets to multi-classify brain cancers.

2. Image Preprocessing:

Preprocessing is essential for improving image quality and guaranteeing the efficiency of later processing steps. In the first place, grayscale picture conversion minimizes computing effort by concentrating on important intensity information, which reduces complexity. After that, noise reduction methods like bilateral filtering and Gaussian smoothing are used to get rid of undesired artifacts and enhance image clarity. The resilience and generalization capabilities of the model are further improved by picture augmentation, which uses modifications like rotation, scaling, and flipping to artificially enlarge the dataset. For the development of precise and trustworthy deep learning models for brain tumor prediction.

3. Image Segmentation:

Following image pre-processing, the surrounding MR images were isolated from the brain tumor area. The contrast of a black-and-white photograph was altered to enhance segmentation.

4. Feature Extraction:

Feature extraction is essential for obtaining information from an image. We are using GLCM for this texture image analysis. GLCM is used to record the spatial dependency between picture pixels. GLCM uses the gray level image matrix to capture the most common properties, such as contrast, entropy, energy, homogeneity, correlation, ASM, and cluster-shade. Feature extraction (GLCM) seeks to suppress the original picture data set by measuring particular values or characteristics that help distinguish different images from one another.

5. Classification:

The binary classifier known as a convolution neural network makes use of the hyper-plane, which is sometimes referred to as the decision boundary between two classes. Among the problems are pattern recognition problems, such as texture classification using CNN. CNN produces accurate classification by mapping non- linear input data to linear data in high dimensional space. CNN makes the most of the minimum, the separation of different classes.

IV. CONVOLUTION NEURAL NETWORK

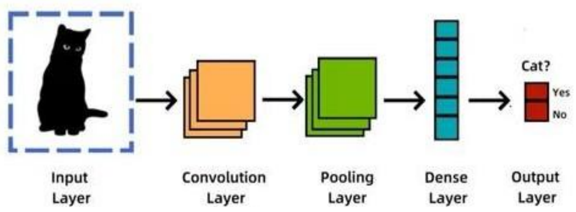

Figure 2. convolution neural network

In medical image analysis, convolutional neural networks, or CNNs, have emerged as a key component, especially for the identification and categorization of brain cancers. Their layered architecture makes it possible for MRI scans to automatically learn hierarchical information, which makes it easier to accurately identify tumor characteristics. CNNs have proven to be effective in this field in recent studies. A proposed 2D CNN model, for example, demonstrates the promise of CNNs in medical diagnostics by achieving optimum accuracy in diagnosing brain cancers. Using a publicly accessible brain tumor dataset, a different study presented a novel CNN- based Graph Neural Network model, highlighting the versatility and efficiency of CNN architectures in managing challenging medical imaging tasks. These developments highlight how important CNNs are for improving diagnostic precision and assisting with clinical judgment in neuro-oncology.

V.RESULT:

In brain MR imaging, the location of brain tumors is identified. A subset of brain MR images including malignancies were obtained for algorithmic testing.

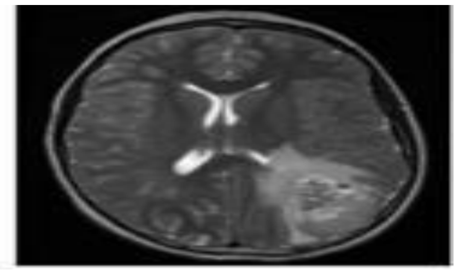

Figure: (a) Input original image

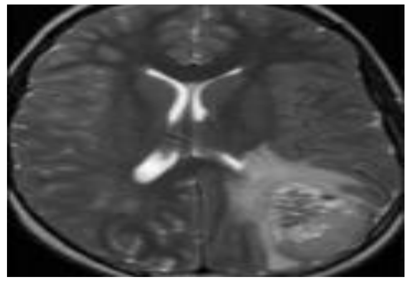

Figure: (b) cropped image

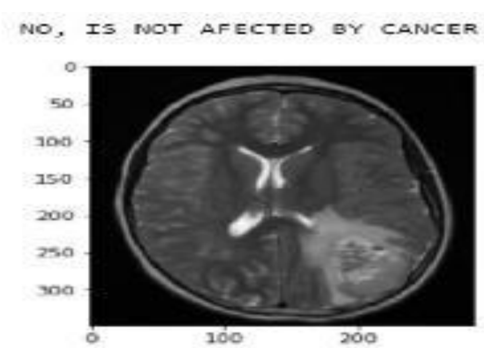

Figure: (c) output image

VI. CONCLUSION:

MR images are read from the device and transformed to grayscale images, after which the tumor location is determined using Convolutional Neural Network (CNN) segmentation. By improving contrast and streamlining the input data, this preprocessing step helps the model's ability to accurately identify tumor locations. After using several convolutional layers to extract important characteristics from the images, the CNN model uses pooling layers to help lower dimensionality while preserving crucial spatial information. The patterns, borders, and textures that differentiate tumor areas from healthy tissues are found by these layers working together.

Once the input MR pictures have been read from the device and converted to grayscale images, the tumor location in the images is determined using Convolution Neural Network segmentation. The proposed model will attain an accuracy of 86% with minimal errors and computing effort.

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