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BrainTumor Detection Using Transfer Learning-based Convolution Neural Networks

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ABSTRACT

A brain tumor is one of the most dangerous diseases that impact the human brain, which can make it impossible for a person to function normally, read, write, communicate, think, and do many other things. The brain is the main component of the human body, and it is responsible for controlling the operation of the other parts and organs of the body. The biggest issue is finding and removing the tumor region from the MRI, which is a fairly time-consuming task depending on the radiologist. Tumor identification using MRI scans is a difficult task that costs a lot of time, money, and effort. According to this study, a deep learning-based method may recognize brain tumors from MRI scans far more rapidly and precisely, allowing clinicians to begin caring for patients directly as soon as possible. Radiologists also have a faster decision-making process when choosing the appropriate treatment options.

Keywords: Brain Tumor, Machine learning, convolution neural networks, transfer learning

I. Introduction

Machine learning-based brain tumor identification is a relatively young area of research that is attracting more interest with time. This technology has found, identified, and treated different types of brain cancers. Machine learning is a subset of artificial intelligence that uses data analysis to predict outcomes and render conclusions. To use machine learning to identify brain tumors, various algorithms, and methods must be used to recognize and classify different tumor forms. With the help of this technology, results can be more precise, and the root causes of brain tumors can be more clearly identified.

Additionally, it may help researchers and healthcare providers better understand when the disease develops. The disease can be perilous since there are many different forms of brain tumors, some cancerous while others are healthy [1]. These can also be classified as malignant, which is cancer, and benign, which is non-cancerous. They typically occur in the brain, and because they are so dangerous, they spread to other brain areas.

The fundamental issue is that the nervous system's ability to operate depends on how quickly the tumor may grow. The type of the tumor, where it is located, and how it is treated all affect how it is treated. There are additionally many cases when the source of the tumor remains unknown. Therefore some of the ways it might happen are through radiation exposure or if there is a family history of brain tumors and it is passed down through the genes. Modern computerized approaches like machine learning and deep learning play an essential part in identifying the disease and help in the prediction at an early stage where the brain tumor can be prevented and kept to be a typical tumor. Machine learning has developed into a crucial tool for finding brain tumors. With better knowledge of the underlying causes of brain cancers, this technology can offer more precise tumor diagnosis and treatment. Algorithms for machine learning can also be used to observe changes in tumor size and morphological characteristics. When it comes to identifying and treating brain tumors, physicians and researchers can make more effective decisions with the help of machine learning [2].

II. Related Work

The primary objective was to support the average dice similarity index of 0.82, which was better because it revealed better overlap between the extracted tumor region and the manually extracted tumor by the radiologists. The author tests with ResNet, DenseNet, and Mobile Net deep learning methods, and after analyzing all of them while running the models, he achieved accuracy values of 91.8, 92.8, and 92.9, respectively [3]. The AdaBoost classification system for identifying and segmenting brain tumors was improved by using a novel multi-feature feature (Multi FD). The architecture of brain tumor tissue was retrieved using the Multi FD feature extraction method. Advanced AdaBoost was used to classify the donated brain tissue as a tumor. Discusses the classification of brain voxels using a Local Independent Projection (LIPC)-based classifier. This method was also used to fetch the path function. The primary objective of [4] is to determine the listener's region using various ensemble approaches, such as KNN-RF-DT combined and used to generate a choice, making a suitable voting method. With a dataset of 2556 images, they obtained a 97.3% accuracy.

III. Methodology

1. Convolutional Neural Network

A typical neural network type for image recognition and classification is known as CNN. CNN has three classes. Le Net, Alex Net, and Google Net are these. CNN specializes in classifying images. When we input an image, the computer transforms it into an array of pixels. In the CNN model, the convolution layer's function is to extract the features of an input image. It has several filters in a convolution layer that perform convolutional processes. In order to collect the feature map, a filter is slid over the input greyscale image. Another feature map will result from the convolution of another filter on the same image.

A. Pooling Layer

Every element in the map's dimension decreases with the dimensionality reduction process pooling. Multiple forms of pooling exist. Max pooling, Average pooling, and Sum pooling are the three. The pooling function substitutes the adjacent outputs for the net value. In maximum pooling, the most prominent element from the window is picked, modified for that window's near elements, and then replaced [5]. The average or sum of all the components in the specific timeframe may also be considered. Max pooling is used in this model because it produces superior results.

B. Fully Connected Layer

It functions as an MLP that can be utilized as an activation function to determine the layer's output. The activation function of the node determines the output of the specified input node. The SoftMax function is the activation function that is most frequently utilized. Many of the elements of the input image are represented in the output of both the convolution and pooling layers [6]. Using various datasets, we used a convolution neural network to train our model as part of our approach.

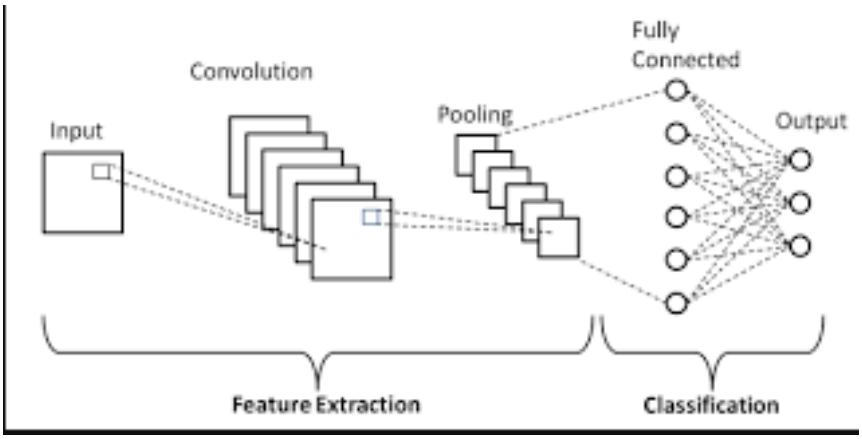

Figure 1: CNN's flowchart

2. Data Preparation

Data, the essential element of the overall model, must be run and carefully gathered or taken. It is preferable to use a dataset that is already publicly available because the collection procedure is a challenging undertaking. The dataset used in this study is derived from brain MRI images used to identify brain tumors. The dataset consists of excellent MRI scan images that were obtained from patients, and the database's classification is based on the two classes, no tumor-0 or tumor-1. Figure 2 gives us a brief overview of the dataset, which includes two kinds of tumors and no tumors [7].

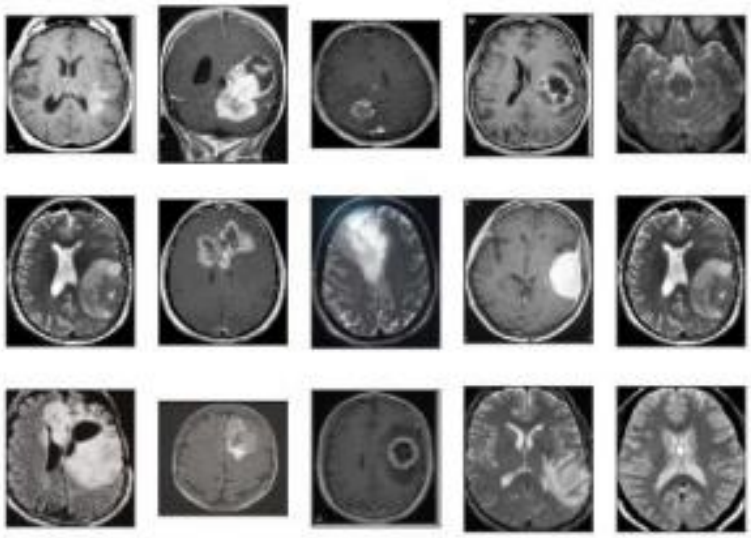

Figure 2: Dataset Overview

3. Data Preprocessing

The preprocessing is crucial in deciding the model's output or the model's correctness. To create a perfect dataset, the features and attributes may have some noise and variations that must be identified and adjusted. The size of the dataset images used by the authors is increased using data augmentation, which helps the model extract features from the photos and perform better. In our scenario, data augmentation enhances the dataset image size by making slightly modified copies of existing or freshly created data. Data augmentation is typically used to increase the amount of data.

Additionally, it acts as a regularizer and lessens overfitting during training. Figure 2 gives an overview of the enhancement of one image. The dataset would then be divided into training and testing datasets in the following phase. The main objective to achieve this is to enhance the algorithm's learning so that it can deliver precise outcomes on the testing data unknown information that is, is given to the model [8].

4. Data Extraction

The essential components upon which the model operates; with features, there would be no basis to make predictions, and as a result, accuracy would be extremely low. Consequently, more features equate to higher accuracy and better model performance. In order to determine which feature or attribute is more significant in deciding the model's success, visualization plays an essential role in this process. The entire feature extraction process is shown in Figure 3, starting with capturing the original image, then moving on to steps 2 and 3, where the most extensive contour is located, extreme points are identified, and cropping is completed [9].

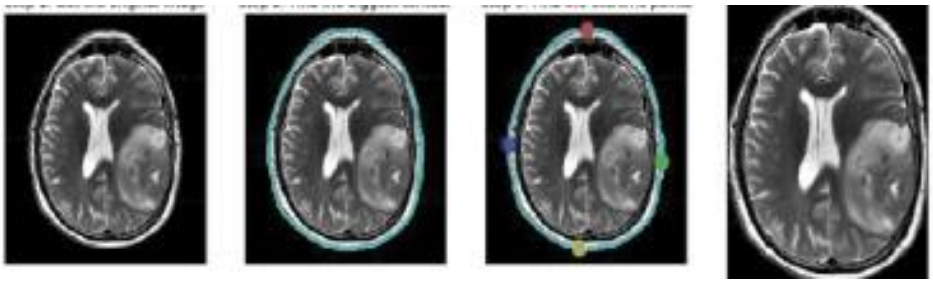

Figure 3: Data Extraction Images

5. Artificial Neural Network(ANN)

Artificial neural networks are created using the structure and operations of biological brain networks. This is the primary force behind the design of artificial neural network architecture. It frequently consists of neurons that are layered and similar to the neurons present in the human brain. A processing unit absorbs the incoming signal, and the output layer outputs to the network. The input and output layers are always present in these linked setups, as they are in all network topologies. The third layer, the Hidden layer, prevents neurons from entering the input and output layers [10]. These neurons function as a "black box" hidden from anyone interacting with the system. More hidden layers containing neurons can be added to the system to boost its computing and processing power, but doing so also makes the system's training phenomenon more complex. The ANN is run using TensorFlow, and we would first use the sequential function to initialize the ANN. An activation function decides whether a neural network's output is yes or no. It transforms values from -1 to 1, 0 to 1, etc. The process would be repeated for the four hidden layers, and the activation function for the output layer would then be the sigmoid.

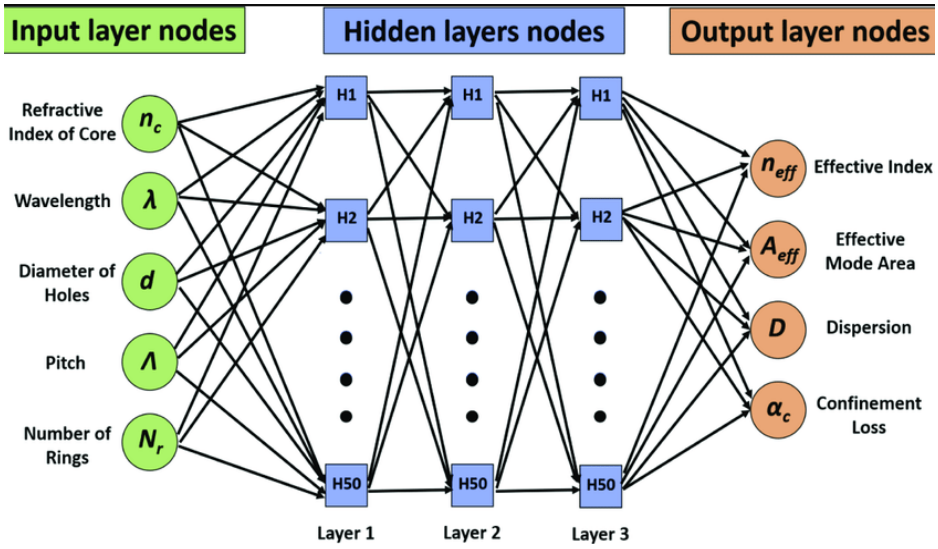

Figure 4: Structure of Artificial Neural Network

IV. Experimental Results

The greyscale images from the brain tumor dataset we obtained online were used as the model's input. The dataset's photos are divided into training and testing sets. 450 of the 550 images are used to train the model, while the rest are used to test it. Both images with and without tumors are present in the examples. This study examines the efficacy of CNN and ANN models for brain tumor identification.

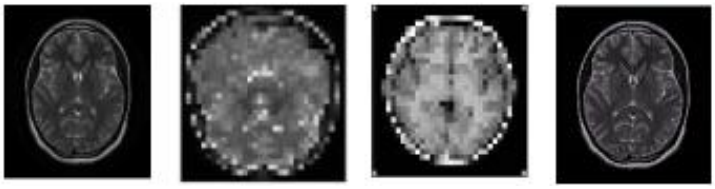

Figure 5: Output images of CNN and ANN

After 100 epochs and using artificial neural networks, we achieve an accuracy of 97 percent. The more epochs we are familiar with, the easier it will be to train the dataset, and finally, testing the dataset on the test cases that were not removed from the dataset allows us to determine the model's correctness.

Table 1: Accuracy, Precision, and Sensitivity values

Method	Accuracy	Precision	Sensitivity
ANN	90.1	90.5	89.5
CNN	93.3	96.2	93.6

V. Conclusion

The current work used machine learning techniques to provide a comparative analysis of brain tumor identification. The model is given the greyscale images dataset in enhanced and unaugmented forms to examine the better outcome. The main flaw of ANN is that it can only be used for one layer, so we also incorporated it to see how accurate it is. ANN models' accuracy, precision, and sensitivity are lower because they only have one layer. One technique that uses a series of feed-forward layers is CNN.

For classification, an image net database is used. It belongs to the group of trained models. As a consequence, the training only takes place for the top layer. Artificial Neural Networks were utilized to analyze a particular dataset, which is a fantastic result in terms of science and creativity and can help us save more people from cancer by offering needed assistance earlier.

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