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Brain Tumor identification and classification using Machine Learning

Nakul R S1RV18CS097, PGunavantha1RV18CS109
RV College of Engineering Bengaluru ,India
email:{nakulrs.cs18,pgunavantha.cs18 }@rvce.edu.in

Abstract – *Brain Cancer (Tumor) can be characterized as an abnormal and unrestrained development in the synapses. Research has shown that the identification of these tumors at an early stage can help deal with the severity in a significant manner. Taking into the account the number of undetected brain tumors, there is a strong need for improvement in this field of identifying and understanding the formation of the tumor. This not only helps in detection of plausible problem in patients, but also helps the doctors, by increasing the ease and time take for the same. The main motive of the paper is to find a generalized technique to detect brain tumors more efficiently and classify the images*
based on the stages of growth. Using these images we can establish growth parameters like the type of tumor, severity of growth and treatment elimination. Doctors can use these data to eliminate certain unnecessary procedures which can save a lot of lives. The paper uses Machine Learning through Tensor Flow and Keras to train efficient models for detection, localization and classification of brain tumors using predefined dataset.

Keywords – *object detection, deep learning, MLP, CNN, ResNets, transfer learning, ML, DL*

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I. Introduction

A brain tumor is a mass of abnormal cells in the brain. The brain is very rigid and any growth in such a restricted space can cause problems. Brain tumors can be malignant or cancerous, or benign or noncancerous. There is often a misconception that brain tumors are caused due to hereditary. But only about 5 to 10 percent of all the cancers are genetically inherited, or hereditary. It's often rare for a brain tumor to be genetically inherited. Brain tumor and its risk increases with age. Also, they are generally more common among Caucasians. However, African-American people are likely to meningiomas. The nuclear power plant in Chernobyl is an example of widespread radiation which has lasted even to this day. Study has shown that people who do not have a history with chicken-pox also have an increased risk of tumor detection in their entire lifetime.

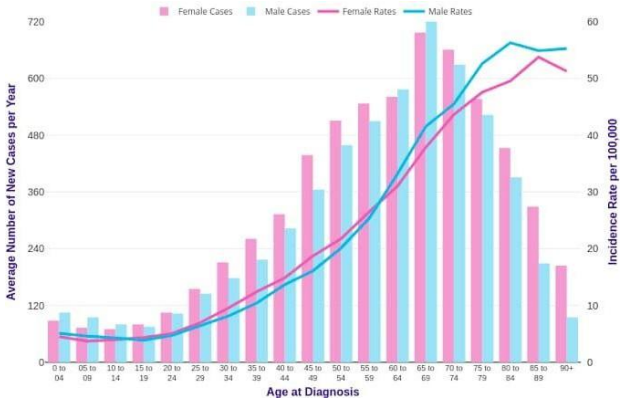

Fig1:Tumor risk based on age

Brain tumor often goes undetected due to the restriction in the skull and no obvious symptoms. The tradition systems or MRI and other scans are not that accurate in detection them. In this era of technological advancement, machine learning and deep learning techniques have shown promising results in several day-to-day problems. Recent improvement in deep learning libraries like TensorFlow have increased the robustness in object-detection. Using residual nets and transfer learning, we can build a highly accurate model to localize tumors in MRI scans.

ResUNets, as the name suggests takes in data and makes a copy of it. It then uses this copy along with the processed data to classify images. This in fact is a trustworthy and highly efficient model for classification. The data derived from these models can be used to establish various parameters like rate of growth, severity and treatment and procedure. This can indeed be used to adapt to various other forms of scans like manual works, deep-medic and to even the simplest X-rays. Most importantly, the advancement in tumor detection can be used to prevent patients from further being exposed to radiation. Radiation is in fact the main causes of brain tumor.

II. Literature Survey

[1] Most of these advancements employ machine learning and deep learning. This usage of the present technology helps in faster and more efficient ways of diagnosis, and with the advancement of training models we achieve a great accuracy as well. This paper deals with the usage of ML and DL in detection of small abnormalities in objects.

[2] A model on Image Analysis for MRI Based Brain Tumor Detection and Feature Extraction was made in order to improve the performance and reduce the complexity involves in the medical image segmentation process by using Berkeley wavelet transformation (BWT). Segmentation starts off with image pre-processing and skull stripping. Segmentation and morphological operations form the key of algorithm and learning. Features are then extracted and SVM is followed. The model achieved 96 percent efficiency for classifying brain tumors. More work has to be done on widening dataset and classifying the different stages of the tumor itself.

[3] Another model on Deep learning-based approach on brain tumor classification using magnetic resonance imaging was formed. The model aims to classify different forms of Tumor. Classify the images based in the forms it can take over the skull. RNN is used for classification with image enchantment and feature extraction. The model was only able to classify the dataset at 80 percent accuracy. More over the different stages on tumor was undetected.

[4] There have also been many different works in the field of classification of brain tumor post the detection process. A model was constructed to Multimodal Brain Tumor Classification Using Deep Learning. This model intended to classify the images based on benign and cancerous brain tumors. Linear contrast stretching, deep learning features extraction using transfer learning, a correntropy- based joint learning approach along with ELM for best features selection, the PLS-based fusion of the selected features, and finally the ELM- based classification. The model was able to classify part of the test set accurately. The gap was that the model was not able to classify MRI scans with varying colour gradients.

III. Proposed Work

Primarily, the paper proposes a novel method to identify and classify brain tumors based on their level of formation and shape around the skull. By level, the paper suggests the rate at which the tumors have grown and classify them based on the severity. Therefore, the two models of identification and classification are built from a machine learning, namely multi-layer perceptron neural network, which is built at the highest efficiency. The dataset being used comprises of a variety of brain tumor growth which will diversify both the models as a whole.

Once the tumors are detected and classified in the newer images, the model dynamically suggest the course of treatment based on the particular tumor detected. This is done using a transfer learning mechanism where the knowledge from the previous ML base is transferred accordingly.

IV. Methodology

The paper proposes a novel method to identify and classify brain tumors based on their formation. Unlike other models, both the sub-models of the paper are integrated into one transfer learning model which will eventually classify them tumors as its primary output. The data-set of the model can be classified primarily into two sub classes, i.e, tumors and non-tumors MRI images taken from various sources.

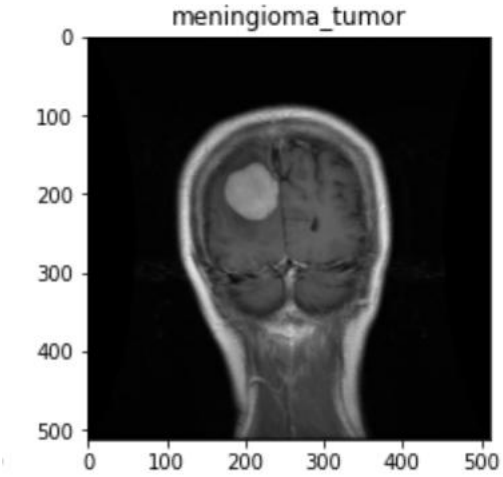

Fig 2: Class – 1 dataset

Within the above class, the tumors are further classified into three sub classes. Altogether, a sample of 5000 images are being used to train the model.

To train the model to accurately classify the images, a highly dense neural network is built. However, since the paper aims to approach this method differently, the images are first processed into high-definition pictures. Therefore, they under go a series of linear and non-linear transformation all the way to the pixel level to establish a clear cut boundary of the tumor in the MRI images. For large amount of data and different specific types of brain tumors, this method is time consuming and prone to human errors. In this study, we attempted to train a Convolutional Neural Network (CNN) to recognize the three most common types of brain tumors, i.e. the Glioma, Meningioma, and Pituitary. We implemented the simplest possible architecture of CNN; i.e. one each of convolution, max-pooling, and flattening layers, followed by a full connection from one hidden layer.

```
effnet = EfficientNetB1(weights="imagenet",include_top=False,input_shape=(224,224,3))
model = effnet.output
model = GlobalAveragePooling2D()(model)
model = Dropout(0.5)(model)
model = Dense(4, activation="softmax")(model)
model = Model(inputs= effnet.input, outputs= model)

model.summary()
```

Fig 3: Transfer-learning model summary

V. Results

The model was trained with the highest efficiency possible and the results obtained are summarized below.

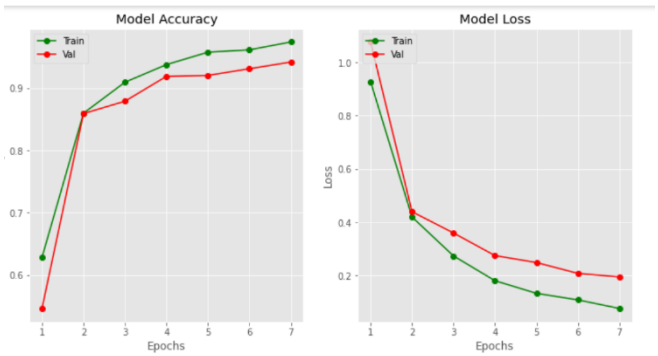

Fig 4: Model Accuracy and Loss

The trained model achieved an efficiency of 93% and testing on random 1000 MRI images gained an efficiency of 98%.

VI. Future Enhancement

The paper mainly focuses on the two- dimensional(2D) aspects of tumor detection and localization. Medical advancements have now shown that a simple MRI scan now be done on three-dimensions(3D) as well. Such parameters can help detect and classify the tumors much more accurately. This concept can further be enhanced by using ML and AI, by predicting the exact size of the tumor and the environment of its surroundings. The concept of object detection is not new. If fact there is already a widespread application over various industry. However, the usage on ML and AI remains restricted in medical advancements due to the lack of trusts amongst doctors. The model used in the paper can further be extended to localization of other tumors, abnormal growth, disorders and so on. Apart from the archaic methods, the attribute and parameters can be established as a separate dataset which can be fed to the same system. These sequences can be used on newer data and will eliminate various drugs and treatments which would have otherwise been used as protocols of treatment.

Object detection and classification can further be applied to satellite imagery where certain localized areas can be detected based on a knowledge base. The US military have developed a fully-fledged software for detection war grounds and places of on-going violence based on these Machine Learning concepts. Taxonomy is another important field of ML which has barely crossed the surface when it comes to development. Until a few years, taxonomy remained a topic of research and algorithm. But machine learning has now shown to be highly accurate in designing a user specific classification. This vast field of machine learning and artificial intelligence is universe yet to be explored and we have barely crossed the horizon when it comes to development. But research and applicability continue to grow at an exponential rate since the new era of modernization.

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