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A Bird Eye View on Brain Tumor Detection Using Artificial Intelligent: A Review

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***Abstract*— A major health concern, brain tumors affect a large number of individuals. Either benign or malignant, this form of tumor may be lethal if malignant cells are not found in time. Brain tumors are currently the ninth most prevalent cause of mortality in the most recent survey of health care for humans, reflecting a sharp increase in their incidence. Thus, prompt and correct diagnosis of brain tumors aids in the patient's recovery. In this study, we describe a complete method based on machine learning and enhanced medical imaging for brain tumor diagnosis. Medical imaging methods, including Positron Emission Tomography (PET), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI), are useful in providing comprehensive anatomical and functional details about the brain. These imaging methods allow for the detection, localization, sizing, and characterization of brain tumors. When brain tumors are diagnosed and treated early, deep learning may improve the classification accuracy and reduce the fatality rate.**

Keywords*— *Brain Tumor, Detection, Medical Imaging, Machine Learning, Deep Learning, Convolutional Neural Networks, MRI, CT, PET.

1. Introduction

People in this modern era don't care about their bodies; they are only concerned with making money. People getting brain tumors are becoming more commonplace every day. It rose to become the world's tenth most prevalent cause of death [1]. By 2023, the National Cancer Institute (US government) projects that there will be over 24,000 new cases and over 18,000 fatalities [2]. In the first subsections, we discuss the brain, brain tumors, and MRI brain imaging:

A. Overview of Brain and Brain Tumor:

The central organ of the human nervous system is the brain. It is located in the human head and is shielded by the skull [3-5]. The human brain is in charge of all bodily functions. It's a particular kind of organ that lets humans adjust to and endure any kind of environment. The brains of humans enable them to act and express their emotions and ideas [6]. We go over how the brain is structured to understand the most basic ideas in this part. Basic Human Brain Morphology (Fig. 1) Brain tumors may be broadly classified into two categories: primary brain tumors, also known as benign tumors, and secondary brain tumors, often known as malignant tumors [7].

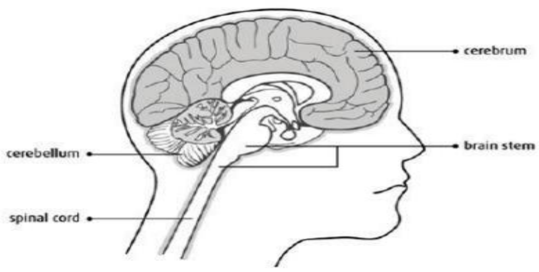

Fig. 1.1: Basic Structure of Human Brain

Gliomas are a benign kind of brain tumor that grow slowly inside the brain. It originates from brain cells known as atrocities, which are not neurons. Primary tumors are often less aggressive, but the brain becomes dysfunctional as a result of the strain they create [8]. The secondary tumors are more swiftly spreading and aggressively encroaching into nearby tissues. Other bodily organs may give rise to secondary brain tumors [10]. Metastatic cancer cells that have spread to other regions of the body, including the brain and lungs, are the source of these tumors. A recurrent brain tumor is very malignant. The main causes of secondary brain tumors include malignancies of the lung, kidney, and bladder [11].

B. MRI Brain Imaging

It is by no means unique that thoughts are one of the main reasons of rising newborn and adult mortality worldwide. Tumors may also arise from tissue that grows uncontrollably, defying the usual forced regulation of growth [12]. The bulk of studies from high-tier countries indicate that during the course of more than three decades, the number of persons who acquire brain tumors and die from them has probably grown by 300. The leader In the United States, the most frequent malignant brain tumors occur 6–7 times per 100,000 individuals, whereas preferred brain cancers occur 11–12 times per 100,000 people yearly. Radiologists anticipate that cad structures may enhance their diagnosis abilities because to the collaborative effects of several radiologists as well as the computer's scientific picture evaluation and device mastery approaches [13].[14]. Neuron imaging is a modern method of understanding the human mind that allows scientists to examine the realistic or structural components of a device that causes dread. In addition to employing accessible practical measures for neuroscience research, there are other considerations that need to be made, such as spatial selection. It is basically the length of the vital size, and it is the exact location and temporal selection of the sign supply. A musical melody is often characterized in this manner because it is processed in terms of gorgeous one-based total connections [16–20].

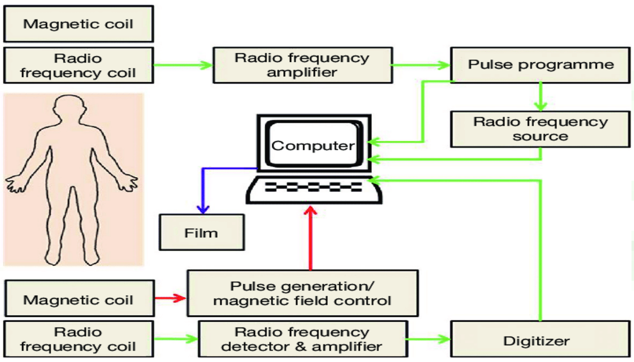

Fig 2 MRI Brain Imaging [21]

As a result, the melody notion highlights the cognitive function of the human mind, showing how the listener's belief is necessary to demand a series of sounds and appropriately change them into a comprehensive intellectual experience [22]. In this way, the many facets of melody—even in simple songs—use a number of advanced methods to distinguish between members of the tonal family. To "tap into the on-the-spot-to-2d statistics of intellectual interaction with the track," is what the neuroscience of melody aims to evoke. Apart from assessing impairments in melodic idea in individuals with localized brain injury, the harem dynamic methodology enhanced by techniques like as magnetic resonance imaging is a suggested approach to pinpoint the brain areas implicated in melody notion [24].

Unfortunately, due to the spatial extending of bioelectric current caused by the skull and Scalp, the mental contents are difficult to localize [25]. The terrible spatial yearning makes localization incorrect, not like. The example above shows how specific brain imaging techniques can result in focused studies on particular regions of the brain. The assessment tested how different brain regions responded to complete tone sequences while also using and examining temporal records of brain reactions to individual tones [26]. Brain tumor detection using machine learning is an emerging field of research that focuses on developing computer algorithms capable of accurately detecting brain tumors from medical images. This is done by training machine learning models on a large dataset of brain scans, which enables the models to identify patterns and features that are indicative of tumors [30].

II. LITERATURE REVIEW

In this section, we have discussed a literature review of different Brain tumor detection techniques using machine learning and deep learning.

Javeria Amin et.al (2024) An automated technique for the segmentation and discrimination of brain tumor is presented in this manuscript. This method is tested on five benchmark data sets such as BRATS 2012, BRATS 2013, BRATS 2014, BRATS 2015 and ISLES 2015. The proposed method is evaluated on DWI, FLAIR, T2, T1 and T1c MRI modalities. The evaluation is performed in two experiments such as feature based results and pixel based results. In pixel based results, the proposed technique achieved better experimental outcomes on BRATS 2015 in terms of 0.91 complete, 0.89 non-enhancing and 0.90 enhancing dice similarity coefficient. The presented approach obtained 0.93 avg Q value on BRATS 2013 and 2014 data sets. Similarly in feature based results, 100% sensitivity is achieved on BRATS 2012, 2013, 2014 and ISLES 2015 data sets. The proposed method provides accurate segmentation outcomes that are compared with manual ground truth annotations and other existing methods [01].

Soheila Saeedi et.al (2023) One of the areas of use for artifcial intelligence and machine learning is the health domain. Deep networks are currently being designed and developed to detect diseases based on imaging. In order to do this, we have proposed computational-oriented methods to classify brain tumors. In our study, a novel 2D CNN architecture, a convolutional auto-encoder network, and six common machine-learning techniques were developed for brain tumor detection. Tis classifcation was conducted using a T1-weighted, contrast-enhanced MRI dataset, which includes three types of tumors and a healthy brain with no tumors. MRI image features and classifying them into three types of tumors and one class of healthy brain. Te training accuracy of the proposed 2D CNN was found to be 96.47%, and the training accuracy of the proposed auto-encoder network was found to be 95.63%. In addition to the twodeep networks used in our study, six machine-learning techniques were also developed to classify brain tumors. Te highest accuracies of 86%, 82% and 80% were attained for KNN, RF, and SVM, respectively [02].

M.O. Khairandish, et. al., (2022) one of the world's non-death-causing diseases is brain tumor identification and categorization owing to aberrant cell proliferation or portable progression across the body. This research work has applied a hybrid technique on brain MRI images to identify and categorize the tumor utilizing the BRATS database. The system in place uses supervised hybrid CNN and SVM algorithms to categorize brain pictures as benign or malignant tumors. The input pictures were first normalized using the main preprocessing processes, and then relevant features were extracted using the maximum stable extremely regions (MSER) approach and segmented using a threshold-based segmentation algorithm. To categorize brain MRI images, labeled segmentation features are supplied as input to hybrid CNN and SVM algorithms. [03].

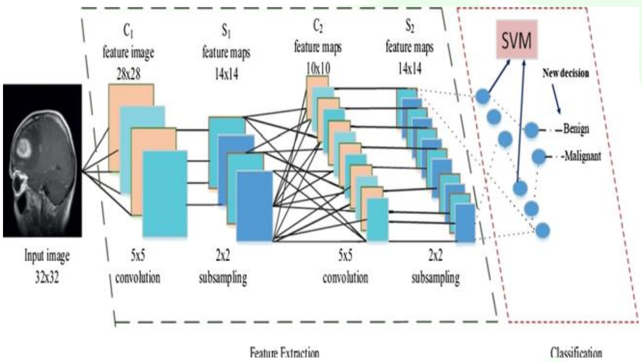

Fig. 3: Hybrid CNN-SVM Threshold Segmentation [03]

Overall, it achieved 98.4959% properly categorized the hybrid model, compared to 72.5536% for SVM alone and 97.4394% for CNN. The result showed the highest correctly classified with PPV and the lowest of FPV. A quick glance revealed that the hybrid model proposed offers improved and more efficient categorization procedures. Future research can demonstrate the overall improvement in decision-making using the quicker CNN with SVM and other optimization techniques (bio inspired algorithms) [03].

Vinayak Singh, et. al., (2022) Humans develop brain tumors when a normal cell in the brain develops into an abnormal cell. In general, benign tumors and malignant tumors are the two main categories of brain tumors in Homo sapiens. Magnetic resonance imaging (MRI) is crucial in the identification of brain tumors because it demands great precision and accuracy; otherwise, a small inaccuracy might have serious repercussions. In order to assess whether or not a person has a brain tumor, multiple configurable convolution neural network (CNN) paradigms were used for brain tumor MRI data in this study. This study focuses on objective function values (OFV) obtained by different CNN paradigms with the least validation cross-entropy loss (LVCEL), maximum validation accuracy (MVA), and training time (TT) in seconds. These values can be used as a workable tool by clinicians and the medical community to precisely identify tumor patients. A total of 2189 brain MRI images were used for the experimentation and assessment, and the best architecture had the greatest accuracy (0.8275), maximum objective function value (1.84), and area under the ROC (AUC-ROC) curve (0.737) for correctly identifying and categorizing whether or not a person was conscious [04].

Shko M. Qader, et. al., (2022) The primary goal of the DCNN-G-HHO described was to offer an automated brain tumor detection model. As a result, a CNN based on deep learning was taken into consideration and improved by using a hybrid optimization method that combines GWO and HHO approaches. Additionally, segmentation is crucial in the detection of tumors. As a result, an Otsu thresholding method is used. As a consequence, more accurate segmentation and classification were accomplished. On massive augmented MRI images, the performance of the new technique was evaluated by comparison with the old technique in terms of accuracy, precision, recall, f-measure, execution time, and memory consumption. The performance comparison initially showed that the proposed DCNN-G-HHO was significantly more effective than the existing methods. The suggested DCNN-G-HHO technique exceeded existing methods for brain tumor diagnosis, with 0.97 accuracy. This indicates the precision and efficacy of the method. The preceding approaches have lower recalls than the new strategy, which had a recall of 0.95. Finally, 0.96 is the Measure for the method described. Therefore, in terms of accuracy, precision, recall, and F-measure, the presented methodology is more effective than the current methods. On the enhanced MRI image dataset, the overall effectiveness of the authors' presented position was benchmarked in terms of execution time and memory use. On the MR images, the proposed DCNN-G-HHO was quicker at classifying and identifying brain tumor cancers. Similarly to this, the author's approach consumed less RAM than its rivals. Unexpectedly, KNN used more time than the other techniques, although SVM used the most memory. Compared to other classifiers, the DCNN-G-HHO technique was speedier and consumed less memory [05].

P Gokila Brindha, et. al., (2021) one of the greatest methods for analyzing picture collection is CNN. CNN performs the prediction by cropping the image to the desired size while preserving the necessary data. By giving more picture data, the testing accuracy of the ANN model created here, which is 65.21%, may be improved. Applying image augmentation techniques and examining ANN and CNN performance can achieve the same results. This model was created using the trial and error methodology. The number of layers and filters that may be employed in a model will eventually be decided using optimization approaches. The CNN currently shows to be the best option for the supplied dataset [06].

Manav Sharma, et. al., (2021) The aim of this paper is to create a model with high accuracy to determine brain tumors from the MRI images. The dataset used consists of 253 brain MRI images and was sufficient to check the performance of the model. The model is based on the machine learning algorithm CNN (Convolutional Neural Network). 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 an accuracy of 97.79% when applied to the training set and an accuracy of 82.86% when applied to the validation set. The loss gradually starts decreasing with the increase in the number of epochs. The model loss is very less when applied to the training set whereas it is high when applied to the validation set [07].

Marcin Woz´niak, et. al., (2021) the presented CLM model is fast learning from the data. Authors can see that all statistics show the ability of fast and efficient learning. The system gives a novel and easy idea of CNN composition. The palette can be composed from the variety of filters to modify the image and number of grids to extract the most important features. In presented research tests, Authors have used those which gave the best results in brain tumor detection, but the CLM can be also applied to other purposes. Due to parallel implementation, the CLM can evaluate many incoming palettes (configuration of the CNN architecture) in each iteration. The model can be run on various number of threads, so that as a result researchers receive flexible system composition with possibility to examine broad spectrum of CNN configurations whose performance actually depends only on the type of used cpu. Construction of the system does not limit it only to biomedical research domain but makes it useful model in most image processing and object detection tasks which is another advantage of author's idea. Presented training model was originally tested on brain images; however, it could be easily implemented in other medical fields like lung analysis, sarcoidos is detection and others [08].

Muhammad Yaqub, et. al, (2020) A comparative analysis of different optimization algorithms used by authors presented CNN architecture to measure the performance for brain tumor segmentation. The comparison is made on a publicly available MRI brain image data set, i.e., BraTS2015. Both quantitative and graphical results show that all optimizers perform consistently but that Adam performs much better. Among the 10 optimizers for authors' architecture, Adam has the smallest error rate and the highest accuracy rate when it reaches the minimum on a particular epoch. The NAG and RMS Prop optimizers failed badly. Due to limited resources to run several architectures, AdaDelta and Adam ax should be used to provide minimal risk. The performances of the momentum and SGD optimizers were inferior to that of Adam. The adapted pipeline of the CNN optimizer comparison concludes that the performance of Adam is comparable with the latest research [09].

Siraj Khan et.al. (2020) In computer vision, traditional machine learning (TML) and deep learning (DL) methods have significantly contributed to the advancements of medical image analysis (MIA) by enhancing prediction accuracy, leading to appropriate planning and diagnosis. These methods substantially improved the diagnoses of automatic brain tumor and leukemia/blood cancer detection and can assist the hematologist and doctors by providing a second opinion. This review provides an in-depth analysis of available TML and DL techniques for MIA with a significant focus on leukocytes classification in blood smear images and other medical imaging domains, i.e., magnetic resonance imaging (MRI), CT images, X-ray, and ultrasounds. The proposed review's main impact is to find the most suitable TML and DL techniques in MIA, especially for leukocyte classification in blood smear images. The advanced DL techniques, particularly the evolving convolutional neural networks-based models in the MIA domain, are deeply investigated in this review article [10].

III. PROBLEM FORMULATION

When compared to other industries, the healthcare sector is completely singular. People have high expectations for the quality of care and services they get, regardless of the cost, since this is a high priority industry. As a result of the success that deep learning has had in other real-world applications, it is also bringing intriguing solutions with excellent accuracy for medical imaging, and it is a critical approach for future applications in the health industry. It is the brain that is responsible for controlling the activity of every other portion of the body. Due to the intricacy of size and location variations, the process of recognizing an automated brain tumor using magnetic resonance imaging (MRI) is a challenging one. A statistical analysis, morphological analysis, and thresholding approach are presented in this study as a means of processing the pictures generated by magnetic resonance imaging (MRI) for the purpose of tumor detection from brain MRI images. For the purpose of classifying the performance of the tumors portion of the picture, a feed-forward back prop neural network will be used. The outcomes that are generated by this method will result in an improvement in accuracy while simultaneously reducing the number of repeats.

IV. MRI DATASET

We have used open-source (freely available) brain MRI images that include tumor and non-tumor images in various sizes and formats such as JPG, JPEG, and PNG. The MRI dataset used in this study has been manually labeled and collected by radiologists, researchers, medical experts, and doctors and several researches have also been published on this dataset. In this dataset, there are a total of 253 brain MRI images from two categories with and without tumor segments of varying sizes and shapes. The dataset is further classified into two parts, 155 images with tumor segments and 98 images without tumors. This dataset also includes both types of MR images T1 and T2 weighted with non-uniform picture resolution. We presented the images in such a way that tumor images are labeled as "yes" and normal images (without tumors) are labeled as "no", as shown in Fig. 4.

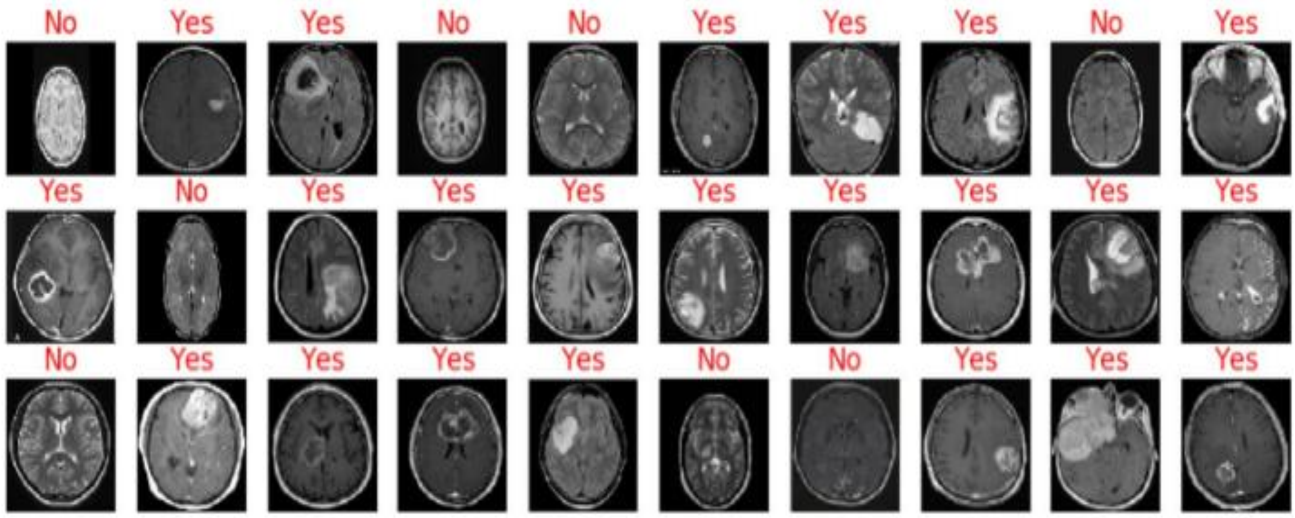

Fig. 4: images of the brain MR image dataset [31]

A. MRI DATA PRE-PROCESSING

Pre-processing is the process of enhancing or gathering pertinent data before the data is processed. This is a crucial aspect of signal or picture analysis, where valuable information is extracted or pre-processed data is cleaned. This step is crucial because, even with a very effective classifier, inaccurate information, noisy data, or uncategorized data might provide subpar analysis findings. Using the image ration distribution graph, we were able to get the MRI image dataset's dimensions, form, and pixel information at this point. Given the diverse nature of the dataset utilized for this project, each picture has a unique size, shape, pixel composition, and format. Thus, we can get the image ratio distribution data by dividing the width by the height of each picture. To see the image size in the dataset, this image ratio distribution data is plotted against the image count, as shown in Fig. 3.2. As can be seen, the width to height ratio of around 90 photographs is equivalent to one with the same dimensions; the width to height ratio of the other images varies. As a result, it is required to adjust these photographs to make them uniform before using them for training. Before feeding the raw MR images for classification, a number of preprocessing methods are used, including data augmentation (DA), data distribution, cropping, and scaling [32].

V. CONCLUSION FROM LITRATURE SURVEY

The identification of brain tumors has shown artificial intelligence to be a useful technique. Through the use of deep neural networks and sophisticated image processing techniques, scientists and physicians have created precise and effective ways for identifying and categorizing brain tumors from medical imaging data. The creation and implementation of these models have been greatly aided by deep learning tools like Tensor Flow, PyTorch, and Keras. The development and training of deep neural networks are made easier by the abundance of tools, resources, and methods offered by these libraries. There are several advantages of using deep learning for brain tumor identification. It makes it possible to analyse medical pictures objectively and automatically, which lowers human error and variability. Rapid data processing using deep learning models enables quicker and more effective diagnosis. Additionally, they are capable of handling intricate patterns and characteristics in the photos, which improves tumor detection accuracy.

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