MRI-BASED BRAIN TUMOR DETECTION USING

CONVOLUTIONAL NEURAL NETWORK

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***Abstract*— An abnormal growth of cells in the brain is called a tumour and cancer refers to malignant tumour. The purpose of proposed work is to detect brain tumour and treat them more effectively. Computer vision plays a significant part, which diminishes the human judgement that gives precise result about. CT scans, X- Ray, and MRI looks are the common imaging strategies among attractive resonance imaging that are the foremost solid and secure. MRI identifies search miniature objects. In proposed work, the brain tumour detection is determined using deep learning algorithm. These algorithms are connected on the MRI image forecast of brain tumour is done exceptionally quick and a higher accuracy makes a difference in giving the treatment to the patients. Convolution neural network (CNN) is also used in detecting brain tumour detection and the performance is analyses.**

Index Terms: Image Processing, Brain tumour, MRI, Artificial neural network, CNN, Keras

I. INTRODUCTION

The brain is the most important organ within the human body which controls the whole human body that includes other organs and also make sades is ion making. It is the fundamental control center of the central apprehensive framework and is responsible for performing the everyday voluntary and involuntary exercises within the human body. The tumour is basically a fibrous work of undesirable issue development interior brain that is used in unconstrained way. On this year at the age of 15, approximately 3,540 children get analysed with brain tumour. The correct way of understanding of brain tumour and its stages is an vital errand to anticipate and to carry out the steps in curing the sickness. To do so, magnetic resonance imaging is broadly utilized by radiologists to analyse brain tumour. The result of the examination carried out in this will uncover if the brain tumour is present or not. In this CNN is used as an algorithm to detect the brain tumour. CNN are a specialized type of artificial neural network that uses a mathematical operation called convolution in place of general matrix multiplication in at least one of their layers. They are specifically designed to process pixel data and are used in image recognition and processing.

The brain is an essential organ in the human body which control and cord in a test the tasks carried out by the other parts of the body. It is primarily the control center of the central nervous system and is responsible for performing the daily voluntary and in voluntary activities in the human body. The tumour is a fibrous mesh of unwanted tissue growth inside the brain that proliferates in an unconstrained way. To prevent and cure the tumour, magnetic imaging (MRI) is widely used by radio logs to analyze stages of brain tumors. The result of this analysis reveals the presence of the brain tumour. Appear as a front-line brain tumor detection tool (without ionization radiation). In this manuscript, an unsupervised clustering approach for tumor segmentation is proposed. Moreover, used feature vector is used which is a mixture of Garbo wavelet features(GWF),histograms of oriented gradient (HOG), local binary pattern (LBP) and segmentation based fractal texture analysis(SFTA) features .Random forest(RF) classifier is applied for classification between three sub tumor regions such as complete, enhancing and non-enhancing tumor.

Brain Cancer Detection and Classification System have been developed with the use of ANN. The image processing techniques such as histogram equalization, image segmentation, image enhancement, and feature extraction have been used. The proposed approach using ANN as a classifier for classification of brain images provides a good classification efficiency as compared to other classifiers. The sensitivity, specificity and accuracy are also improved. The proposed approach is computationally effective and yields good result.

The method applied is based on Hugh voting, a strategy that allows for fully automatic localization and segmentation of the anatomies of interest. It also used a learning techniques-based segmentation method which is robust, multi-region, flexible, and can be easily adapted to different modalities. Different amounts of training data and different data dimensional (2D, 2.5D, and 3D) are applied in predicting the final results. Convolution neural networks, Hugh voting with CNN, Vowel-wise classification, and Efficient patch-wise evaluation through CNN are used in analysing the image.

In proposed work, the Convolution Neural Network (CNN) was implemented, which drives an overall accuracy of 91.3% and are call of 88%, 81% and 99% in the detection of meaning a pituitary tumour respectively. Deep learning architecture by leveraging 2D convolution neural networks for the classification of the different types of 3 brain tumour from MRI images lice. In this paper techniques like data acquisition, data per processing, per –model, model optimization and hyper parameter tuning are applied. More over the 10-fold cross validation was performed on the completed at a set to check for the generalize ability of the model.

II. PROPOSED METHODOLOGY

Raw data is given as data set which holds 3000 images of brain tumour and non-brain tumour MRI images. This data set is taken as an input and further proceed into data augmentation , it is a algorithm which utilize data information and form integrated model and it has the ability to improve the accuracy of data set then these model proceed into convolution layer which is image filtering used to process of modifying image such as shaping, contracts, brightness, pixel-ed its then the image is further proceed into max pooling layer used to reduce the dimensions of the feature maps, here flatten layer is used to convert the data of images into one dimensional array which is used as input for then ext-layer that is fully connected layer. In fully connected layer, the flatten layer output is used as input which will classifies the object and identifies the pattern in the input image data, which produces the output whether the image is Brain tumour or non-Brain tumour.

In the realm of medical imaging, particularly in the diagnosis of brain tumors, the utilization of advanced algorithms and convolutional neural networks (CNNs) has revolutionized the way we interpret MRI (Magnetic Resonance Imaging) scans. These scans, which provide detailed images of the brain's structure, hold crucial information that can aid in the early detection and treatment of tumors.

A pivotal step in this process begins with the acquisition of a substantial dataset comprising both brain tumor and non-tumor MRI images. These images serve as the raw material upon which the entire diagnostic framework is built. With advancements in technology, datasets of such magnitude have become more accessible, allowing for more robust training of machine learning models.

The output of the fully connected layers provides a probabilistic assessment of whether the input image contains a brain tumor or not. This output, often represented as a probability score, assists healthcare professionals in making informed decisions regarding patient diagnosis and treatment planning.

III. BRAIN TUMOUR

A brain tumor is a mass or growth of abnormal cells in the brain. Many different types of brain tumors exist. Some brain tumors are noncancerous, while others are malignant. Begin in brain or can begin in other parts of body and spread to brain as secondary (metastatic) brain tumour

A. *Health Risks and Impact*

Brain tumours pose significant health risks to affected individuals due to their potential to interfere with normal brain function and cause neurological symptoms. These symptoms may include headaches, seizures, cognitive deficits, motor impairments, and changes in mood or behaviour, depending on the location and size of the tumour. Malignant brain tumours, in particular, can rapidly grow and infiltrate surrounding brain tissue, leading to life-threatening complications such as cerebral edema, increased intracranial pressure, and herniation.

B. *Importance of Early Detection*

Early detection and accurate diagnosis of brain tumours are crucial for initiating appropriate treatment strategies and improving patient outcomes. Timely intervention allows for the implementation of targeted therapies, including surgery, radiation therapy, chemotherapy, and immunotherapy, aimed at reducing tumour burden, controlling disease progression, and preserving neurological function. Furthermore, early detection facilitates the monitoring of treatment response and the timely adjustment of therapeutic regimens based on individual patient needs. There are several types of brain tumour such as:

1. Benign brain tumour : It causes many serious issues. Noncancerous tumours grow slowly and do not spread to other tissues. They have more clearly defined borders, allowing for surgical removal, and they do not come back after removal.

2. Malignant brain tumour : It is cancerous, growing rapidly and capable of spreading to other parts of the brain or central nervous system, which can lead to life-threatening complications.

3. Primary brain tumour : it can develop from our brain cells the membranes that’s unrounded don brain.it can benign or cancerous.

IV. DETECTION OF BRAIN TUMOUR

Magnetic resonance imaging and computed tomography scans are used most often to look for brain diseases. These scans will almost always show a brain tumour, if one is present. Doctors can often also get an idea about what type of tumour it might be, based on how it looks on the scan and where it is in the brain. It is categorized into primary and secondary brain tumour.

1. A primary brain tumour originates in brain. Many primary brain tumour are benign

2. A secondary brain tumor, also known as a metastatic brain tumor, occurs when cancer cells spread to the brain from another organ, such as the lung or breast.

I. *Image Processing Techniques*

Various image processing techniques are employed to analyze MRI data and extract meaningful information for brain tumour detection. These techniques include:

1) Preprocessing: MRI images often undergo preprocessing steps to enhance image quality and reduce noise. Common preprocessing techniques include intensity normalization, spatial filtering, and motion correction.

2) Feature Extraction: Feature extraction plays a crucial role in identifying regions indicative of tumour presence. Features such as texture, shape, intensity, and spatial relationships are extracted from MRI images to characterize tumour morphology and distinguish tumourous from non-tumourous tissue.

3) Deep Learning Algorithm: Instead of traditional machine learning algorithms, deep learning algorithms, particularly CNNs, are utilized for automated feature extraction and classification in brain tumour detection tasks. CNNs learn hierarchical representations of image features through multiple layers of convolutional and pooling operations, followed by fully connected layers for classification. These algorithms leverage large datasets of annotated MRI images to learn discriminative patterns directly from raw pixel data, enabling accurate detection and segmentation of brain tumours. These algorithms leverage training data to optimize classification models and improve detection accuracy.

II. TRAINING MODEL

The training of the model is done using python code in the platform of visual studio code. The code sets up the model with a single layer of Dense, which has two neurons. The first neuron is set to have an activation function of soft max, and the second neuron is set to have no activation function. The code also specifies that it will use cross-entropy as its loss function, and a dam as its optimizer. Code starts by importing the necessary libraries. It then imports a function from tensor flow that will be used to load the data into memory. Define some of the variables for training set and test set as x_train, y_train, x_test, y_test respectively for training data. NumPy arrays containing all images in order. It then defines the variables needed for this code, such as cv2 which is used to import the OpenCV library an dos which is used to import the operating system functions and two lists are created, one for images with no tumour and one for images with a tumour. Image classification is done using data set of images and labels them as either containing a tumour or not, then the input size is set to 64, which h means that each image will be 64x64pixels. The code then loops through each image in the data set ,resizes it to 64x64,and appends it to the data set. It also labels each image as 0 (no tumour) or 1 (tumour). Then it loads the data set and then splits the data into a training set and a test set. Next, it normalizes each of the datasets so that they are on the same scale. Then it creates two categorical variables for each of the data sets: one with 2 classes (y_train) and one with 3classes (y_test) and it rates over batches of data from x_train and y_train then it creates a new model. The model has 10epochs and uses categorical cross entropy as the loss function with a dam as the optimizer. It also sets metrics to be accuracy for evaluation purposes. For each batch, it fits the model using fit(), evaluates its performance on validation data using evaluate(), saves out a file called Brain Tumour 10Epochs Categorical. In HDF5 format, the information about the completed training iterations is printed. Next, two loss functions are defined: `categorical_crossentropy()`, which computes our loss.

The training data process is comprised of three steps:

1. Feed -Feeding a model with data.

2. Define-The model transforms training data into text vectors (numbers that represent data features).

3. Test-Finally, test the model by feeding it test data (unseen data). The pixels from the image are fed into the convolutional layer, which performs the convolution operation, resulting in a convoluted map. This convoluted map is then applied to a ReLU function to generate a rectified feature map. The image undergoes multiple convolutions and ReLU layers to locate features. Different pooling layers with various filters are employed to identify specific parts of the image. The pooled feature map is flattened and fed into a fully connected layer to obtain the final output.

III. TESTING MODEL

Testing data is used to check the accuracy of the model. Once Deep learning model is built (with training data), you need unseen data to test model. This data is called testing data, and you can use it to evaluate the performance and progress of algorithms' training and adjust or optimize it for improved results. Testing data should have two main criteria:

1. Represent the actual data set.
2. Be large enough to generate meaningful predictions

V. CONVOLUTIONAL NEURAL NETWORKS

A convolution neural network is a network architecture for deep learning which learns directly from data, eliminating the need for manual feature extraction. CNN are particularly useful for finding patterns in images to recognize objects, faces, and scenes. They can also be quite effective for classifying non-image data such as audio, time series and signal data. CNN provide an optimal architecture for uncovering and learning key features in image and time-series data. CNN area key technology in applications such as:

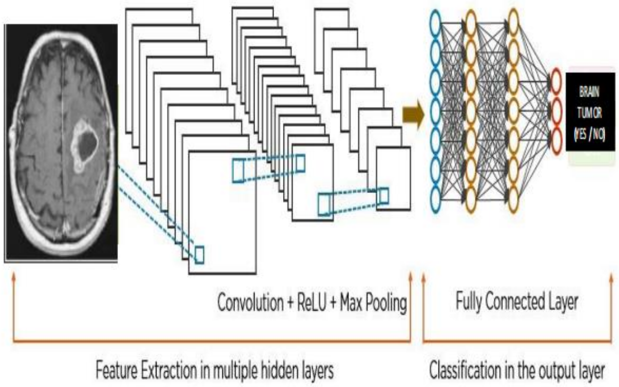
1. Medical Imaging: CNN can examine thousands of pathology reports to visually detect the presence or absence of cancer cells in images.

2. Audio Processing: Keyword detection can be used in any device with a microphone to detect when acer ta in word or phrase is spoken-('Hey Siri!').CNN scan accurately learn and

detect the keyword while ignoring all other phrases regard less of the environment.

3. Stop Sign Detection: Automated driving relies on CNN to accurately detect the presence of a signor other object and make decisions based on the output.

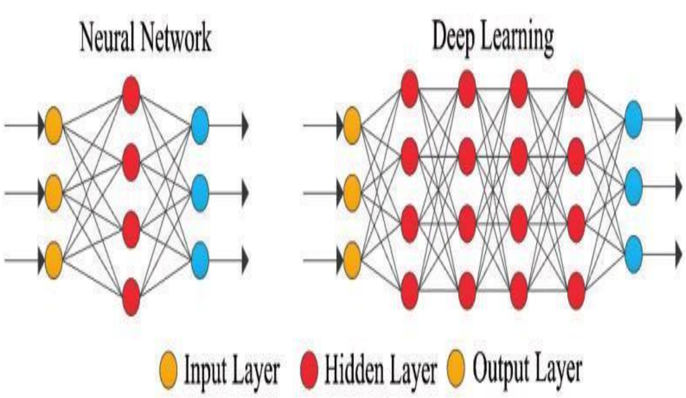
4. Synthetic Data Generation: Using Generative Adversarial Network new images can be produced for use in deep learning applications including face recognition and automated driving.



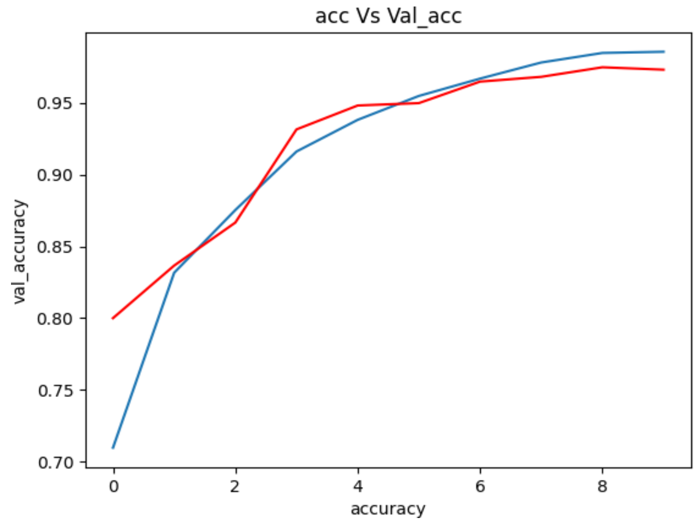
Convolution Neural Network or CNN is a type of artificial neural network, which is widely used for image/object recognition and classification. Deep Learning thus recognizes objects in an image by using a CNN.CNN are playing a major role in diver set asks/functions like image processing problems, computer vision tasks like localization and segmentation, video analysis, to recognize obstacles in self-driving cars, as well as speech recognition in natural language processing.

Figure 1 which implies the architecture of CNN in which images is given as input and further proceeded to feature extraction In multiple hidden layer with help of convolution layer, ReLU layer, pooling layer, flatten layer then these output is given as an input to the fully connected layer as shown in Figure 1 which goes under further classification of neural network layer such as input layer, hidden layer, output layer

VI. DEEP LEARNING



Deep learning is a type of machine learning and artificial intelligence (AI) that mimics the way humans acquire certain types of knowledge. It is a crucial component of data science, which includes statistics and predictive modelling. Deep learning differs fundamentally from conventional machine learning. In this example, a domain expert would need to invest a considerable amount of time in engineering a conventional machine learning system to detect the features.



1. Instruct computer.
2. Used in medical imaging –Does not require their liability of an expert.
3. Requires large amount of data–Produce good classification result.

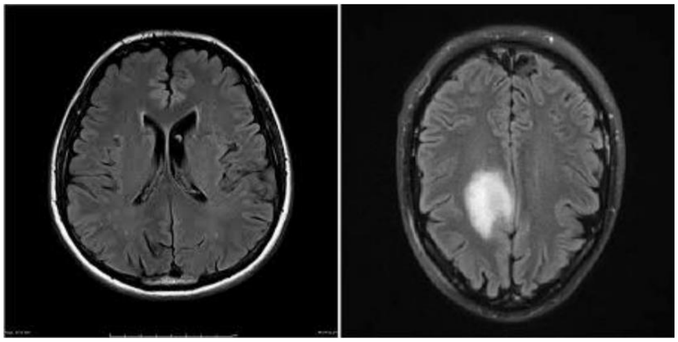
Convolution Neural Network is the deep learning technique to perform image classification. The aim of this project is to build a system that would help in cancer detection from MRI images through convolution neural network.

VII. DATA SET

Computer vision data set are used. Visual data provides multiple numbers of the great data set that are specific to computer visions such as Image Classification, Video classification, Image Segmentation, etc. Data set contains certain number of images which is grouped into tumorous group(YES)and non-tumorous group (NO).

1. The folder Yes contains 1800 brain tumour MRI images which are tumour us.

2. The folder NO contains 1800 brain tumour MRI images which are non tumour Data set is taken from Kaggle platform. Here, Kaggle is an online community platform for Data scientists and machine learning enthusiasts. Kaggle allows users to collaborate with other users, find and publish datasets, use GPU integrated notebooks, and compete with other data scientists to solve data science challenges.

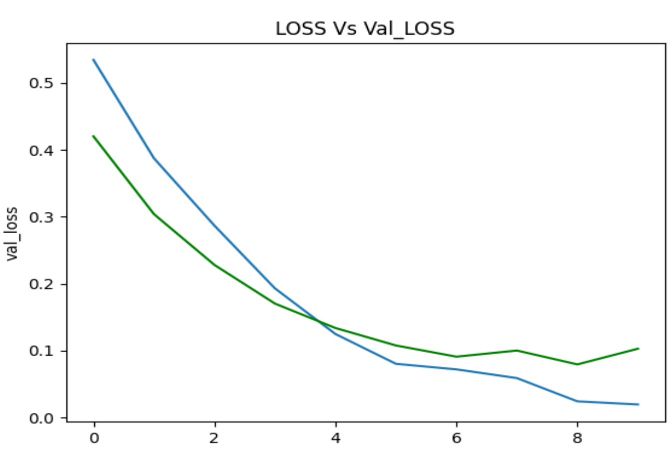


A. GRAPH LOT BETWEEN ACCURACY AND VAL_ ACCURACY

Figure 3 graph shows the accuracy and val accuracy of the brain tumour detection algorithm. The graph indicates that the accuracy of the brain tumour detection algorithm is high, with an accuracy of over 98%. However, the val accuracy is lower, at around 95%. This suggests that the brain tumour detection algorithm is more accurate when used on data that is not from the validation set as shown in Figure 4.

B. GRAPH LOT BETWEEN LOSS AND VAL_LOSS

Figure 4 graph below shows the loss vs val loss in brain tumour detection. As can be seen, the loss decreases as the number of epochs increases, while the val loss remains relatively constant. This suggests that the brain tumour detection model is not over fitting the data



VII. CONCLUSION

In recent years, demand for image-processing-based diagnostic computer systems has grown, enabling radiologists to speed up diagnosis while simultaneously assisting patients. The most deadly and lifethreatening cancer, which affects many individuals globally, is the brain tumour. A variety of brain tumour segmentation and classification methods have been suggested to enhance medical image analysis. These algorithms, however, suffer from a number of drawbacks, including low contrast images, incorrect tumour region segmentation caused by some artifacts,a computationally complex method that needs more treatment time to correctly identify the tumour region, and existing deep learning methods need a large amount of training data to overcome over fitting. The proposed brain tumour detection and classification scheme in this paper aims to address the a fore mentioned concerns.

In the study, as a processing step, used layered in CNN architecture is proposed for brain tumour segmentation and a modified architecture is used for feature extraction and trained using the transfer learning.An experimental study reveals that the proposed method obtained an enhanced performance in visual and comprehensive information extraction compared to current methods.

The proposed classification method for the detection of brain tumour achieves an accuracy of 97.47% and 98.92%. The proposed method outperforms existing methods in terms of the detection and classification of brain tumour using MRI, as well as being more aesthetically pleasing and yielding superior results.

REFERENCES

[1] Javeria Amin Muhammad Sharif MudassarRaza Mussarat Yasmin 2018 Detection of Brain Tumour based on Features Fusion and Machine Learning Journal of Ambient Intelligence and Humanized Computing Online Publication.

[2] RajeshwarNalbalwarUmakantMajhiRajPatilProf.Sudhans huGonge2014 DetectionofBrainTumourbyusingANNInternationalJourna lofResearchin Advent Technology 2.

[3] Fatih Özyurt Eser Sert Engin Avci Esin Dogantekin 2019 Brain tumour detection based on Convolution Neural Network with neutr osophic expert maximum fuzzy sure entropyElsevierLtd147.

[4] Fausto Milletari Seyed-Ahmad Ahmadi Christine Kroll Annika Plate Verena RozanskiJuliana Maiostre Johannes Levin Olaf Dietrich Birgit Ertl-Wagner Kai Bötzel, NassirNavab 2016 Hough-CNN: Deep learning for segmentation of deep brain regions in MRI and ultrasound ElsevierInc 164 92-102.

[5] Dena Nadir George Hashem B Jehlol Anwer Subhi Abdulhussein Oleiwi 2015 Brain Tumour Detection Using Shape features and Machine Learning Algorithms

International Journal of Scientific& Engineering Research6 12454-459.

[6] P. Gokila Brindha, M. Kavinraj, P. Manivasakam and P. Prasanth, “Brain tumor detection from MRI images using Deep Learning Techniques,” IOP Conference Series: Materials Science and Engineering, p. 012115, 2021.

[7] N. Abiwinanda, M. Hanif, S. T. Hesaputra, A. Handayani and T. R. Mengko, “Brain tumour classification using Convolutional Neural Network,” IFMBE Proceedings, pp.183-189, 2018.

[8] M. Aarthilakshmi, S. Meenakshi, A. P. Pushkala, N. B. Prakash and V. R.Ramalakshmi, “Brain Tumor Detection Using Machine,”INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH, pp. 1976-1979, 2020

[9] H. Mohsen, E.-S. A. El-Dahshan, E.-S. M. El-Horbaty and A.-B. M. Salem, “Classification using deep learning neural networks for brain tumors,” Future Computing and Informatics Journal, pp. 68-71, 2018.

[10] Deepa , Singh Akansha. (2016). - Review of Brain Tumor Detection from tomography. International Conference on Computing for Sustainable Global Development (INDIACom)

[11] SHUBHANGI SOLANKI, UDAY PRATAP SINGH, SIDDHARTH SINGH CHOUHAN, SANJEEV JAIN4 "Brain Tumor Detection and Classification Using Intelligence Techniques: An Overview" Digital Object Identifier 10.1109/ACCESS.2023.3242666

[12] SOHAIB ASIF, WENHUI YI, QURRAT UL AIN, JIN HOU, TAO YI, AND JINHAI SI "Improving Effectiveness of Different Deep Transfer Learning-Based Models for Detecting Brain Tumors From MR Images" Digital Object Identifier 10.1109/ACCESS.2022.3153306

[13] MUHAMMAD RIZWAN, AYSHA SHABBIR, ABDUL REHMAN JAVED 2, MARYAM SHABBIR,THAR BAKER, AND DHIYA AL-JUMEILY OBE,"Brain Tumor and Glioma Grade Classification Using Gaussian Convolutional Neural Network" Digital Object Identifier 10.1109/ACCESS.2022.3153108

[14] HASNAIN ALI SHAH, FAISAL SAEED, SANGSEOK YUN, JUN-HYUN PARK, ANAND PAUL, JAE-MO KANG,"A Robust Approach for Brain Tumor Detection in Magnetic Resonance Images Using Finetuned EfficientNet" Digital Object Identifier 10.1109/ACCESS.2022.3184113

[15] RUQSAR ZAITOON AND HUSSAIN SYED "RU-Net2+: A Deep Learning Algorithm for Accurate Brain Tumor Segmentation and Survival Rate Prediction" Digital Object Identifier 10.1109/ACCESS.2023.3325294

[16] Arabahmadi M., Farahbakhsh R., Rezazadeh J. “Deep Learning for Smart healthcare—A Survey on Brain Tumor Detection from Medical Imaging”. Sensors. 2022;22:1960. doi: 10.3390/s22051960. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[17] Gore D.V., Deshpande V. “Comparative study of various techniques using deep Learning for brain tumor detection” Proceedings of the 2020 IEEE International Conference for Emerging Technology (INCET); Belgaum, India. 5–7 June 2020; pp. 1–4. [Google Scholar]

[18] Soomro T.A., Zheng L., Afifi A.J., Ali A., Soomro S., Yin M., Gao J. Image Segmentation for MR Brain Tumor Detection Using Machine Learning: A Review. IEEE Rev. Biomed. Eng. 2022;16:70–90. doi: 10.1109/RBME.2022.3185292. [PubMed] [CrossRef] [Google Scholar]

[19] Pereira S., Meier R., Alves V., Reyes M., Silva C.A. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) Volume 11038. Springer; Cham, Switzerland: 2018. Automatic Brain Tumor Grading from MRI Data Using Convolutional Neural Networks and Quality Assessment; pp. 106–114. [Google Scholar]