A Survey on Different Techniques Used For Brain Tumor Detection With MRI Images

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Abstract- *Humans are the most abundant and widespread species in this environment and have thinking power with a large complex brain. The brain is made up of billions of nerves, if any of these nerves get damaged, it caused the "Brain Tumor". The human body is made up of several molecules that handle the full functionality of the body. But when human lives are affected by drastic diseases then it affects the survival rates of humans. These diseases must be predicted at an early stage by professionals so human lives will be free from these diseases. Nowadays, advanced technology plays an important role in the medical field and detects diseases properly. Machine Learning and Deep Learning technologies are very efficient and can solve complex data in lesser time. Conventional Neural Networks in deep learning has many algorithms and make an effective model for the prediction of brain tumor easily. Many Researchers are conducting experiments to diagnose the disease using ML and DL techniques used for brain tumor prediction. This paper presents a detailed review and comparative study of existing ML and DL techniques used in the early prediction of brain tumors. This paper will help future researchers to make better decisions and to know which datasets and techniques are used in previous research work.*

Keywords- Brain Tumor, Deep Learning, Image Processing, Image Segmentation, MRI images, Machine Learning.

I. INTRODUCTION

Is the Human brain a biological computer? If yes then it would be the greenest computer in this universe. The human brain and computer can be compared by many features such as learning properties, problem-solving, decision-making, storage, etc

The most challenging between the human brain and computer property between the human brain and computer is the "thinking" property that's why human is known as intelligent creature in the universe as compared to other creature in the universe. With the help of the brain, the human can make a decision very fast or can solve problems within a lesser time. By combining both features of humans and computers an expert machine is constructed which can work the same as a human behaves. The human brain and the computer play a key role in the advanced world with advanced Artificial Intelligence (AI) technology. AIis at the top with its advanced features and its applications. AI plays a key role in all fields like medical fields, education, Gaming, industrial area, etc. In medical fields, it is used for the diagnosis of diseases like lung cancer, breast cancer, tumor diagnosis, etc. Brain tumor diseases made human lives more drastic for the survivors and can lead to death.. For this, an awareness of brain tumors "World Brain Tumor Day" is celebrated on 8 June throughout the world. So that everyone gets aware of brain tumors or they can be easily detected at their early stages.In the detection of tumors, Machine Learning (ML) techniques are mostly used for the prediction of brain tumors in Magnetic Resonance Images (MRI). So an automated model can be introduced for the professional in the hospital for detection purposes of tumors and made the decision quickly and easily within lesser time. For the detection of tumors, firstly anatomy of the brain must be understood properly with its parts and functionalities. So tumors must be managed or controlled properly at their early stages.

1.1 Anatomy of the Brain

The brain of a newborn human baby weighs between 350 and 400 grams or around 3/4 pounds.The typical brain measure about 15 cm in length. The human brain is a vital and highly specialized three-pound organ with 1300 to 1400 grams, which controls the overall functionalities of the body[1]. The brain can analyze or interprets information from the outside world through the human five senses - sight, smell, touch, taste, and hearing. It puts the signals together so that the human brain can sense the information immediately and store it in the brain's memory. By sending data from the human body to the brain, the functioning of the human body is greatly influenced by the central nervous system. The cranial nerves that come from the brain and the spinal nerves that originate from the spinal cord make up the peripheral nervous system. The brain mainly has three parts: The cerebrum, cerebellum, and brainstem. The brain's two primary tissues are grey matter and white matter. Meninges is another tissue that covers the

brain and spinal cord from damage by providing a protected layer.The harder part that covered the brain is known as the skull. It can protect the brain from damage. The anterior fossa, middle fossa, and posterior fossa are three separate regions located inside the skull. These phrases are sometimes used by doctors to describe the location of a tumor, such as middle fossa meningioma. The brain is the very sensitive part of the human body that handles billions of nerves. If any nerve stop working or gets damaged then it generated a tumor at that location[2].

1.2 Brain Tumor

In the brain, thereare billions of nerves and if any of these nerves get damaged then they form a tumor at that location. Damage to the brain nerves and healthy tissues can be caused by a tumor, depending upon the type of cell affected by the brain tumor, the size of the tumor, and tumors that can be cancerous and noncancerous, etc. are the basic classification of brain tumor. A tumor is assigned from grade I to grade IV[3].

Grade I: Pilocytic or benign, slow-growing, and having clearly defined borders.

Grade II: Slow-growing, infrequently spreading astrocytoma with a distinct boundary

Grade III: Anaplastic Astrocytoma, grows more quickly.

Grade IV: Glioblastoma, a malignant tumor that is most invasive, multiform, and spread quickly to surrounding tissues. The statistics of brain tumor cases also play a vital role inproviding knowledge about the cases of brain tumors all over the world.According to the International Association of Cancer Registries (IARC), India reports about 28000 cases of brain tumors each year, and sadly, 24000 individuals pass away from a brain tumor in 2022.The United States (US) of America, also suffered drastically for many years. In 2022, all age groups of people in the US suffer from brain tumor disease, which also leads to death.An estimated 700,000 Americans living with a primary brain tumor, 88,970 individuals in the US got diagnosed in 2022 with a primary brain tumor, estimated cases 63,040, individuals having a benign tumor in the US, estimated cases the US, 25,930 individuals with a malignant tumor, and sadly 18,200 individuals lose their lives through the malignant tumor in US 2022. A tumor is a very serious disease that can occur anywhere in the human body.The origin of the tumor can have several ways - damage to nerves, highly used high levels of radiation, due to family genes, due to cancer, etc[2]. A brain tumor classification is based on a cancerous and non-cancerous forms known as primary classification and secondary classification[4].Benign and malignant tumors come under the primary classification which can be easily curable. Metastatic brain tumors are secondary brain tumor which is not curable. The symptoms carried out by brain tumors are memory loss, fewer eye vision, vomiting, headache, weakness, irritation, hearing problem, muscles ache, etc[5].Diagnosis of the tumor is always taken by professional doctors using medical imaging.There are different types of imaging used for diagnoses such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Single-Photon Emission Computed Tomography (SPECT), and Positron Emission Tomography (PET).Out of these CT and MRI are widely used because of their widespread techniques[5]. Surgeries can be done by doctors using stereotactic radiosurgery, radiation therapy, medication therapy, chemotherapy, targeted therapy, etc[6].With the advancement of computer and image technologies, medical imaging had a big impact on the medical sector.

Paper Organization

This paper is organized into different sections as follows:Section II describes the techniques used for the detection of brain tumors in MRI images. Section III describes the literature review. Section IV describes the comparative analysis of the techniques with their accuracies. Section V describes the conclusion of the paper and what work have been done in the paper in short. Section VI describes the future scope.

II. DIFFERENT TECHNIQUES USED FOR THE DETECTION OF BRAIN TUMORS IN MRI IMAGES

Different techniques are used for the detection of the object from the images. In medical fields, it is mostly used for tumor and cancer detection in particular regions. Techniques such as image processing, image segmentation, wavelet transforms, filters, etc. are widely used for detection purposes. Image processing and image segmentation techniques work on the appropriate algorithms and provide better results. Transform is used for image encoding, decryption, restoration, and enhancement for preserving the good quality of images. To highlight the contour for the detection of edges, and sharpen the edges, image filters are used. A noise removal filter is used to remove the noise which is present in the images but it is a challenging task in medical imaging. Some techniques used for the detection of a brain tumor in MRI images are as follows.

(A). Image processing (IP)

IP is a technique used for converting a physical image into a digital format by applying various operations to it[7]. It also improves the visualization of the images by applying sharpening contrast to the images so that objects can be identified easily from these images. Simply IP is a process used for adding new features to the old ones for the improvement of the images[8]. IP within the world of medical sciences plays a crucial role in the diagnosis of the disease. It helps in diagnosing or visualizing the disease within the interior parts without much complexity[8]. The image is made up of collections of pixels. Pixels can be of the same type or different, each pixel is connected to another pixel and form an image[9]. If these images have bluish pixels or visually are removed then, IP is used for renewing the images.

(B).Image segmentation Techniques

Image segmentation is part of DIG. It plays an important role in the phases of digital image processing[10]. Selecting a particular part from the image by the region of interest and then dividing the particular part into sub-parts with common pixels, color, or intensity regions is known as **image segmentation**[11]. It is mostly used in the recognition part of the image so that it can detect the object easily. It is mostly usedfor detection purposes at a particular part within the image.Table 1 showImage segmentation is done by using various method and some of which is listed below.

(C). Wavelets Transforms

Wavelets transform is the mathematical function that is used for calculating the frequency of the signal concerning time. Wavelet transforms play an important role in IP techniques such as image encoding, decryption, restoration, and the enhancement of an image. It enhanced images by applying contrast to the image, so the image visually becomes clear. Nowadays wavelet transforms techniques are mostly used in medical fields in imaging like ECG, EEG, EMG signals, etc.

Table 2 show Image transforms is done by using various method and some of which is listed below.

(D). Image Filtering

Image filtering is an advanced technology that is mostly used in IP.It is the part of image processing that providesthe filtering properties in the images[12]. Filtering is mostly used in cinema industries for clear visualization in the video, films, etc. Nowadays, in advanced technology filters are used in many areas but in the medical sector filter applications provide usefulness to doctors for clear visualization of diseases in

Table 1: Different Segmentation Methods.

Sr. No.	Ref No	METHODS	DESCRIPTION
1.	[10]	**Region growing segmentation.**	Region growing is a simple region-based image segmentation method. It involves the selection of initial seed points.
2.	[11]	**Clustering-based segmentation.**	Clustering is a set of data with similar characteristics. In dividing the data into groups similar objects are used in a similar group and dissimilar data in another group.
3.	[13]	**Thresholding segmentation**	Thresholding is one of the frequently used methods for image segmentation. This method is effective for images with different intensities.
4.	[11]	**Edge detection-based segmentation**	Edge segmentation is mostly used for enhancing the image's object from its edges.
5.	[5]	**Watershed segmentation**	Water segmentation is used in images to segment the overall regions with the same pixels in the images.
6.	[11]	**Region splitting and merging**	In this method, the image is split into various regions depending on some criteria, and then it is merged.
7.	[6]	**Deep learning-based segmentation**	It is a simple approach, which always extracts the information from the hidden layer for the segmentations.

imaging. This technique makes the biomedical fields more advanced for identifying the diseases like tumors.Quality is an important concern in imaging by which diseases can be visualized properly.Medical images are affected by noise and its degradation to a greater extent.Different types of noise are present in an image **e.g.salt and pepper noise**, **impulse noise**, **Gaussian noise,** etc.De-noising is done by using appropriate filters.Table 3 shows the various types of filters used in images.

Table 2: Various Transforms in IP

Sr. No.	Ref No.	FILTERS NAME	DESCRIPTION
1.	[17]	Mean filter	It is used to find the mean value and used for the removal of noise from the MRI images.
2.	[18]	Gaussian filter	It is used to remove the Gaussian noise from the images.
3.	[19]	Linear filter	It is also used for the removal of noise but linear filters are not sufficient for enhancement when noise levels are too high.
4.	[17]	Weiner Filter (WF)	Weiner Filter is optimal for Mean Square Errors (MSR) and DE blurring. The limitation of the Weiner Filter is that it gives poor performance for the large noise which is overcome by the Wavelet Filter.
5.	[20]	Wavelet Filter	Wavelet filters are used for noise removal but have the advantage of the removal of large noise from images.
6.	[18]	Median filter	Median filters are used for noise removal which provides an accurate result as compared to the mean filters. The median filter is much better at preserving sharp edges than the mean filter.
7.	[20]	Anisotropic filter	An anisotropic filter is applied for noise reduction and to make the image suitable for extracting features.
8.	[8]	Hybrid filter	It is used for noise removal within the images. It is the combined feature with the median filter and Weiner Filter.
9.	[4]	Morphological filter.	It is also used for the removal of noises in images which provides accurate results as compared to the above filters. It also provides dilation and erosion operations.

III. LITERATURE REVIEW

In this section, we will discuss the related works which have already been done by different authors for the

Table *3*: Various Filters Used in Image Processing for Removal of Noises.

Sr. No.	Ref No.	TRANSFORM METHODS	DESCRIPTION
1.	[14]	**Gabor Wavelet Transform**	Gabor wavelets transform (GWT) is used in image processing which is used for edge detection, corner detection, and blob detection.
2.	[15]	**Fourier Transform**	A Fourier transform (FT) is a mathematical transform that is used to decompose functions concerning space and time.
3.	[16]	**Haar Transform**	It is the oldest and most simple wavelet transform which is used in image processing to analyze the image resolution.
4.	[16]	**Daubechies Transform**	Daubechies transform (DT) is the most popular transform it is the foundation of wavelet-based multidimensional signal processing.
5.	[15]	**Morlet and Symlet Transform**	Both have symmetric in shape and have no scaling functions.
6	[14]	**Gray-level Transform (GLRM)**	It is also used in image processing which has a level from 0 to 255.
7.	[15]	**Discrete Cosine Transform**	The Discrete Cosine Transform (DCT) helps separate the image into parts of spectral sub-bands of differing importance for the image's visual quality.

Identification and detection of brain tumors. We look at different imaging used in medical fields for the diagnosis of diseases, IP techniques are used in digital imaging for the improvement of visualization, image segmentation techniques are used for the detection of tumors or diseases at a particular location, and MLalgorithms and deep learning techniques are used with their accuracy, also different classifiers are used for the classification of brain tumors i.e. ***benign and malignant***.

PriyankaModiya et al.[21] Conventional Neural Network (CNN) model is developed for brain tumor detection using transfer learning (TL) with dimensionality reduction method (DRM) with or without Principal Component Analysis (PCA) is used to classify MRI brain images as normal, Benign, and Malignant. The KAGGLE brain tumor detection dataset, which contains 3000 MRI normal and abnormal images was used to test the model with the help of python language, and kernel filters are used for enhancing or smoothening the MRI images. A comparative analysis of CNN models such as EfficientNet-B7 and VGG-16 is done. EfficientNet-B7 provides better accuracy with a PCA of 80.00%.

Yurong Guan et al.[22] presented a brain tumor classification model which is based on high accuracy and low complexity. The IP techniques are used in MRI images for the classification of tumors such as meningioma, Glioma, and Pituitary. The MRI images 3064 are collected from 223 patients during 2005–2010 from two different state-owned hospitals in Guangzhou and Tianjin, China datasets are used for testing purposes in Mat Lab. The result shows that Glioma tumors achieved the highest accuracy 99.66% with a similar dataset.

Sunita M. Kulkarni et al. [23]presented a comparative analysis of the DL techniques which is based on CNN such as Alex Net, VGG-16, ResNet18, Res Net 50, and Google Net for the classification of brain tumors such as**Benignand Malignant tumors.** The datasets are collected from the Hospital with 200 total images for testing in MatLab2019a. After analyzing the result, the author found that the Alex Net technique provides the best result as comparedto the others with an accuracy of 0.937, recall of 1, and F- the measure of 0.96774.

ParthaSutradhar et al.[24] proposed a hybrid model based on ML and DL techniques such as SVM, KNN, RF, EfficientNet-B3, ResNet-150v2, Inception ResNetv2, and VGG-16 in MRI images for the classification of tumors such as Pituitary, Glioma, Meningioma, and no tumor. The datasets are collected from Kaggle datasets with 3264 MRI brain tumor images At last, the experimental result showed that the DL CNN model i.e. EfficientNet-B3 performed better result with 98.16% accuracy as compared to the others.

ChetanaSrinivas et al [25] presented the comparative performance analysis of TL approaches such as VGG-16, Inception-v3, and ResNet-50 for the detection of brain tumors

as benign and malignant tumors. The datasets are collected from Kaggle with 233 MRI images of which 158 images are benign and 98 images are malignantly used for testing the model in python language. The experimental result showed that VGG-16 provides the best result with 0.94 accuracies.

Anil Kumar Mandle et al.[26] proposed a model for brain tumor detection in MRI images using ML techniques such as K-means clustering used for segmentation and Kernel-based support vector machine (K-SVM) used for classification purposes. The datasets are collected from brat's datasets using 160 MRI images, consisting of 20 normal and 140 abnormal images used for testing the model in Mat Lab. After analysis, the experimental result showed that K-SVM has 98.75% of accuracy, 95.43% precision, and 97.65% recall.

Abhishek Anil et al.[27] proposed a model for the detection of brain tumors using TL techniques such as Alex Net, VGG-16, and VGG-19 using the Mat Lab 2018. The MRI images are collected from OASIS and Brats 2018 datasets more than 20000 images are selected where 80% of images are for training and the remaining 20% for testing purposes and features are extracted by using the CNN algorithm. After analyzing the performance, the author found that VGG-19 has the best detection accuracy with 95.78%.

SamiaMushtaq et al.[28] presented a comparative analysis of ANN and CNN with MRI images for brain tumor detection using Python with TensorFlow. The datasets are collected from Brats 2020 images with 1060 tumorous images and 960 non-tumorous images. Features are extracted from SVM, RF, and K-means. After analyzing the model, the author found that CNN has 88.70% accuracy as compared to ANN with 68.7%.

Deepa P L et al.[29] presented a comparative analysis of TL techniques such as ResNet-50, Res Net- 101, and Res Net-152 for brain tumor detection using Mat lab 2020b. The MRI images are collected from the Brats 2017 and OASIS data sets with 11722 total images collected from where 3250 are normal images and 8472 are tumor images. After analyzing the performance, the author found that Res Net- 152 gives the highest accuracy with 93.8%.

Priya K. Chiwande et al.[30] proposed a model for the classification of brain tumors i.e. Benign and Malignant tumors. Different classifiers are used for classification such as KNN and SVM. In their study, the author collected two different types of datasets one from the clinical database 251.Second from Brats 2012 with 80 images for testing used in python language. After evaluating the algorithms, the author found that the SVM classifier achieved the highest accuracy of 96% as compared to KNN with 86%.

Leonie Lampe et al. [31] presented a comparative analysis of the ML algorithms such as SVM, RF, Gradient boosting, and Deep feed-forward neural network (D-FFNN) for MRI images using the Project repository dataset. LIME methods are used for feature extraction in MRI images. After analysis, the author found that a D-FFNN is the best method for MRI images for tumor detection.

IV. COMPARATIVE STUDY

The comparative study describes the analysis of thedifferent techniques for the detection of brain tumors.

Table 4: Comparative Analysis of different ML and DL Techniques for brain tumor detection

Ref No.	Year	Dataset	Filters	Feature Extraction	Techniques	Accuracy
[17]	2022	KAGGLE	Convolution Kernel	PCA	DL with CNN with EfficientNet-B7 and VGG-16	EfficientNet-B7 with 80.00%.
[18]	2021	Hospital	Optimal contrast	Efficient Net	BT Classification such as meningioma, GLIOMA, and Pituitary	GLIOMA with 99.66%.
[19]	2021	Hospital	Median, Anisotropic	CNN	TL techniques such as Alex Net, VGG-16, ResNet18, Res Net 50, and Google Net.	Alex Net provides an accuracy of 0.937.
[24]	2021	KAGGLE	Sharpen, SOBEL, Emboss, and Outline	CNN	ML and DL techniques such as SVM, KNN, RF, EfficientNet-B3, ResNet-150v2, Inception ResNetv2, and VGG-16	EfficientNet-B3 performed better results with 98.16% accuracy
[25]	2022	KAGGLE	Convolution Kernel	CNN	TL approaches such as VGG-16, Inception-v3, and ResNet-50	VGG-16 provides an accuracy of 0.94.
[26]	2022	Brats	Median filters	DWT and PCA	K-means clustering and Kernel-based Support Vector Machine	K-SVM has 98.75% of accuracy.
[27]	2019	Brats	Convolution Kernel	DL networks	TL techniques such as Alex Net, VGG-16, and VGG-19	VGG-19 has the best accuracy with 95.78%
[28]	2021	Brats		ML	ML techniques such as ANN and CNN.	CNN has the best accuracy with 88.70%.
[29]	2021	Brats 2017		Stochastic gradient descent momentum optimization	ResNet-50, ResNet-101, and ResNet-152 for brain tumor detection.	Rest Net-152 is more efficient with 93.8%.
[30]	2021	Brats	Median filters	GLCM	SVM and KNN Classifiers are used for the classification of BT.	SVM has the best accuracy of 96%.
[31]	2022	Hospital		LIME	SVM, RF, GB, and Deep Forward NN are used for BT.	DNN is the best method.
[32]	2021	KAGGLE	Gaussian Blurring, contour, CNN kernel	Gaussian Blurring, THRESHOLDING, contour.	ML and DL techniques Naive Bayer, SVM, Random Forest, and CNN.	CNN has the highest accuracy at 98.11%.
[33]	2021	KAGGLE and Brats	Convolution Kernel	CNN	TL techniques such as Alex Net, VGG-6, and ResNet-50.	ResNet-50 performs better.
[34]	2021	Brats		VGG-19	KNN classifier, Logistic regression, and Neural Network classifier	Logistic regression and neural networks give the best accuracy
[35]	2022	Different data sets		CNN	CNN approaches Alex Net, vgg16, Google Net, Zf Net, and Capsule Net with SVM.	The Hybrid model performed better with 98% accuracy.
[36]	2021	KAGGLE	Data augmentation	CNN	BMI, BTI, BMI-II, BMI-III, and BD-BT datasets are used with CNN.	BTI and BD-BT datasets provide 100%
[37]	2022	Hospital	Kernel plus SOBEL plus Low-pass filters	COM, RLM, and Gradient Feature.	Multilayer perception, J48, Meta bagging, and Random Forest	MLP has the highest accuracy with 98.30%.
[38]	2017	DICOM	Adaptive Contrast	GLCM and Statistics feature	ANFIS, BP, KNN, and SVM classifier.	The SVM classifier is better with 96.51% accuracy.
[38]	2017	DICOM	Adaptive Contrast	GLCM and Statistics feature	ANFIS, BP, KNN, and SVM classifier.	The SVM classifier is better with 96.51% accuracy.
[39]	2021	Brats	Median filters	Statistical features	NB, SVM, KNN, NN, J48, and Ensemble algorithms.	Ensemble provides the best accuracy.
[40]	2021	BD15 BD17, and BD19	Gaussian intensity	DWT	Performance is measured by different datasets such as Brats2015, Brats2017, and Brats2019 datasets.	Brats 2017 and Brats 2019 perform better.
[41]	2021	BD18, BD19, and BD20	Homomorphism wavelet filer	Inceptionv3 model with NSGA.	Wavelet filer, inceptionv3 model, YOLOv2-inceptionv3 model and segmented based on KAPUR entropy.	YOLO2 and inceptionv3 achieved greater prediction with an accuracy of 0.98.
[42]	2020	Hospital	Hybrid-median filter	GLRM	SVM, KNN, NB and ensemble KNN-SVM.	Ensemble KNN-SVM gives better performance with 97.3%.

different techniques for the detection of brain tumors.A literature review is conducted so that we can enhance the knowledge about existing research work. Table 4 shows that Many Researchers use DL and ML techniques for the detection of brain tumors from MRI images. These images are collected from different datasetssuch as KAGGLE, BRATS, clinics, Hospitals, etc. used to predict the tumor and also analyze the performance of these datasets. Feature extraction is also enhanced from these literature reviews so that we can find the best feature extraction algorithms for brain tumor detection from a computer-aided model (CAM).Researchers mainly used DL and ML techniques for comparison, from these comparisons we can find the best algorithms which work with efficient time and also provide an accurate result. Different classifiers are also used which are based on a neural networks such as ANN and CNN. The CNN classifier provides an accurate result. Establishing an automated CAM, can help doctors for making decisions faster and provide the best diagnosis for early tumor detection, and it can also save the lives of people with early detection of brain tumors.

V. CONCLUSION

Brain tumors are very invasive diseases that require many methods and time for curing from this dangerous disease. It also leads the patients to death. This research aims to present a detailed review and comparative study of existing ML and DL techniques used in the existing papers for the detection of brain tumors. A Survey on different techniques used for brain tumor detectionanda comparative analysis is conducted on these techniques which help in selecting the best approach for prediction purposes in the future. In the literature review, it has been observed that the selection of appropriate techniques improves the performance of the model and the accuracy of any model which is dependent on the good dataset and algorithms. Data preprocessing play an important role in the detection of disease. The existing papers show that the MATLAB tool is mostly used for experimental purposes. Many scholars used the BRAT dataset. After reviewing the literature, we found that CNN algorithms show the highest accuracy.

VI. FUTURE SCOPE

In the future, we can use the best feature selection and classification techniques for brain tumor detection with the proper algorithms and appropriate datasets and can establish an appropriate model for the early detection of brain tumor diseases with efficient functionalities. So in the medical field, it can be useful for doctors to predict the tumor easily and efficiently and make the patient's life more prominent by controlling and managing the tumor at an easy stage with lesser time.

REFERENCES

[1] A. Salami *et al.*, “Brain weights in adult Africans,” *J. Morphol. Sci.*, vol. 34, no. 4, pp. 223–225, 2017, doi: 10.4322/jms.106316.

[2] C.Sushma, “NOVEL SEGMENTATION METHOD FOR DETECTION OF TUMORS IN HUMAN BRAIN,” vol. 5, no. 7, 2018.

[3] P. John, “Brain tumor classification using wavelet and texture based neural network,” *Int. J. Sci. Eng. Res.*, vol. 3, no. 10, pp. 1–7, 2012, [Online]. Available: https://pdfs.semanticscholar.org/787a/fbd3e6363dbb88384096a20327926db5f374.pdf

[4] S. Sivasundari, R. Siva Kumar, and M. Karnan, “Review of MRI Image Classification Techniques,” *Page 1 Int. J. Res. Stud. Comput. Sci. Eng.*, vol. 1, no. 1, pp. 21–28, 2014, [Online]. Available: http://scholar.googleusercontent.com/scholar?q=cache:6OfPk5C-A38J:scholar.google.com/&hl=en&as_sdt=0,5

[5] B. Alther, V. Mylius, M. Weller, and A. R. Gantenbein, “From first symptoms to diagnosis : Initial clinical presentation of primary brain tumors,” no. December, pp. 1–7, 2020, doi: 10.1177/2514183X20968368.

[6] B. G. Elshaikh, H. Omer, M. E. M. Garelnabi, and A. Sulieman, “Incidence , Diagnosis and Treatment of Brain Tumours,” no. July, 2021.

[7] H. Tiwari, “A review paper on medical image processing,” vol. 5, pp. 21–29, 2017.

[8] N. S. Sikarwar, V. Y. Borole, S. S. Nimbhore, and S. S. Kawthekar, “Image Processing Techniques for Brain Tumor Detection : A Review”.

[9] S. Naseera, G. K. Rajini, B. Venkateswarlu, and J. P. P. M, “A Review on Image Processing Applications in Medical Field,” no. May 2018, 2017, doi: 10.5958/0974-360X.2017.00644.8.

[10] K. Jeevitha, A. Iyswariya, V. Ramkumar, S. M. Basha, V. P. Kumar, and T. Nadu, “A REVIEW ON VARIOUS SEGMENTATION TECHNIQUES IN IMAGE PROCESSSING,” vol. 7, no. 4, pp. 1342–1348, 2020.

[11] A. K. Jha, M. A. Kupinski, M. J. Trimpl, S. Primakov, L. Liu, and J. M. Wolterink, “A comparative study of new and existing segmentation techniques,” 2021, doi: 10.1088/1757-899X/1022/1/012027.

[12] S. R. Mahakale, “International Journal of Image Processing and Vision Science A COMPARATIVE STUDY OF IMAGE FILTERING ON VARIOUS NOISY PIXELS,” vol. 1, no. 3, 2013, doi: 10.47893/IJIPVS.2013.1029.

[13] M. Angulakshmi and G. G. Lakshmi Priya, "Automated brain tumour segmentation techniques— A review," *Int. J. Imaging Syst. Technol.*, vol. 27, no. 1, pp. 66–77, 2017, doi: 10.1002/ima.22211.

[14] Y. Y. Musa and J. Wang, "Wavelet Tranformations & Its Major Applications In Digital Image Processing," *Int. J. Eng. Res. Technol.*, vol. 2, no. 2, pp. 1–8, 2013.

[15] A. Graps, "An Introduction to Wavelets," vol. 2, pp. 1–18, 1995.

[16] S. Thakral and P. Manhas, "Image processing by using different types of discrete wavelet transform," *Commun. Comput. Inf. Sci.*, vol. 955, no. July, pp. 499–507, 2019, doi: 10.1007/978-981-13-3140-4_45.

[17] H. Kuhad, A. Joshi, A. Gurpude, N. Chimankar, and R. Maskey, "Image Denoising By Hybrid Average Gaussian Filter For Different Noises," vol. 2013, no. Ratmig, 2013.

[18] S. Satpathy, M. C. Pradhan, and S. Sharma, "Comparative Study of Noise Removal Algorithms for Denoising Medical Image Using LabVIEW 2015 International Conference on Computational Intelligence and Communication Networks," no. December, 2015, doi: 10.1109/CICN.2015.67.

[19] K. Ahmad, "A comparative study of Different Denoising Techniques in Digital Image Processing," *2019 8th Int. Conf. Model. Simul. Appl. Optim.*, pp. 1–6, 2019.

[20] V. Ranga, R. Kommineni, and H. K. Kalluri, "Image Denoising Techniques," no. 5, pp. 417–419, 2019.

[21] P. Modiya and S. Vahora, "INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING Brain Tumor Detection Using Transfer Learning with Dimensionality Reduction Method," vol. 10, no. 2, pp. 201–206, 2022, doi: 10.18201/ijisae.

[22] Y. Guan, M. Aamir, Z. Rahman, A. Ali, and W. A. Abro, "A framework for efficient brain tumor classification using MRI images," vol. 18, no. May, pp. 5790–5815, 2021, doi: 10.3934/mbe.2021292.

[23] S. M. Kulkarni and G. Sundari, "COMPARATIVE ANALYSIS OF PERFORMANCE OF DEEP CNN BASED FRAMEWORK FOR BRAIN MRI CLASSIFICATION USING TRANSFER LEARNING," vol. 16, no. 4, pp. 2901–2917, 2021.

[24] D. Tree and K. Neighbor, "Multi-Modal Case Study on MRI Brain Tumor Detection Using Support Vector Machine, Random Forest,Decision Tree, K-Nearest Neighbor, Temporal Convolution & Transfer Learning," vol. 20, no. 3, pp. 107–117, 2021.

[25] C. Srinivas *et al.*, "Deep Transfer Learning Approaches in Performance Analysis ofBrain Tumor Classification Using MRI Images," vol. 2022, 2022.

[26] A. K. Mandle, S. P. Sahu, and G. Gupta, "Brain Tumor Segmentation and Classification in MRI using Clustering and Kernel-Based SVM," vol. 15, no. June, pp. 699–716, 2022.

[27] A. Anil, A. Raj, H. A. Sarma, N. C. R, and P. L. Deepa, "Brain Tumor detection from brain MRI using Deep Learning Brain," no. August, 2019, doi: 10.29027/IJIRASE.v3.i2.2019.

[28] S. Mushtaq, A. Roy, and T. A. Teli, "A Comparative Study on Various Machine Learning Techniques for Brain Tumor Detection," no. December, 2021.

[29] P. L. Deepa, N. Ponraj, and V. G. Sreena, "A Comparative Analysis of Deep Neural Networks for Brain Tumor Detection," no. May, pp. 36–40, 2021.

[30] P. K. Chiwande, P. J. Adhikari, and N. Chaudhari, "Classification of Brain MR Images into Malignant and Benign using Texture Features and Machine Learning Algorithm," no. May, pp. 2566–2571, 2021.

[31] L. Lampe *et al.*, "Comparative analysis of machine learning algorithms for multi - syndrome classification of neurodegenerative syndromes," *Alzheimers. Res. Ther.*, pp. 1–13, 2022, doi: 10.1186/s13195-022-00983-z.

[32] C. Chethan, R. Pankaja, and S. N. Raghavendra, "A Comparative Analysis of Convolution Neural Network and Machine Learning Algorithms in Brain Tumor Prediction," vol. 10, no. 2, 2021, doi: 10.15680/IJIRSET.2021.1002013.

[33] S. Kuraparthi, M. K. Reddy, C. N. Sujatha, H. Valiveti, and C. Duggineni, "Brain Tumor Classification of MRI Images Using Deep Convolutional Neural Network," vol. 38, no. 4, pp. 1171–1179, 2021.

[34] V. Kamble and R. Daruwala, "Classification Comparative Analysis for Detection of Brain Tumor Using Neural Network , Logistic Regression & KNN Classifier with VGG19 Convolution Neural Network Feature Extraction," no. Wrec, 2021, doi: 10.21467/proceedings.114.

[35] G. Matter, "A Review on Comparative analysis and methods of Early detection of Brain tumor using Deep Learning," vol. VIII, no. I, pp. 114–118.

[36] A. Naseer, T. Yasir, A. Azhar, T. Shakeel, and K. Zafar, "Computer-Aided Brain Tumor Diagnosis : Performance Evaluation of Deep Learner CNN Using Augmented Brain MRI," vol. 2021, 2021.

[37] S. A. Nawaz, D. M. Khan, and S. Qadri, "Brain Tumor Classification Based on Hybrid Optimized Multi-features Analysis Using Magnetic Resonance Imaging Dataset Brain Tumor Classification Based on Hybrid Optimized Multi-features Analysis Using Magnetic Resonance Imaging," *Appl. Artif. Intell.*, vol. 36, no. 1, 2022, doi: 10.1080/08839514.2022.2031824.

[38] N. B. Bahadure, A. K. Ray, and H. P. Thethi, "Image Analysis for MRI Based Brain Tumor Detection and

Feature Extraction Using Biologically Inspired BWT and SVM," vol. 2017, 2017.

[39] H. Peni *et al.*, "Analysis of machine learning algorithms in brain tumour prediction," 2021, doi: 10.1088/1742-6596/2070/1/012090.

[40] Z. Barzegar and M. Jamzad, "Fully automated glioma tumour segmentation using anatomical symmetry plane detection in multimodal brain MRI," no. December 2020, pp. 463–473, 2021, doi: 10.1049/cvi2.12035.

[41] M. Irfan, S. Jian, P. Li, J. Amin, and A. Sharif, "An improved framework for brain tumor analysis using MRI based on YOLOv2 and convolutional neural network," *Complex Intell. Syst.*, no. 0123456789, 2021, doi: 10.1007/s40747-021-00310-3.

[42] T. Nadu, "Performance Analysis and Comparison of Machine Learning Algorithms for Classification of Brain Tumor in MRI Images," vol. 13, no. 13, 2020.