BRAIN TUMOR DETECTION AND CLASSIFICATION

R Yashodara[1], Divyashree K[2],
Hemapriya J[3], Kavya[4],Harshitha R[5]

[1] Assistant Professor,Information Science and Engineering, Don Bosco Institute of Techonology,Karnataka,India
[2] Assistant Professor,Information Science and Engineering, Don Bosco Institute of Techonology,Karnataka,India
[3] Student,Information Science and Engineering, Don Bosco Institute of Techonology,Karnataka,India
[4] Student,Information Science and Engineering, Don Bosco Institute of Techonology,Karnataka,India
[5] Student,Information Science and Engineering, Don Bosco Institute of Techonology,Karnataka,India

ABSTRACT

This report presents the findings and outcomes of the mini project titled "Brain Tumo Detection And Classification," conducted as part of the Mini Project under the Department of Information Science & Engineering, Visvesvaraya Technological Technology.

Early detection is crucial for effective brain tumor treatment, given the significant risks to patients' lives. The study proposes a distinctive method for automatically identifying and categorizing brain cancers using medical imaging data, specifically magnetic resonance imaging (MRI) scans. The technology facilitates precise, efficient, and real-time diagnostics by employing advanced image processing and machine learning algorithms to analyse brain images. A primary research objective is the development of an automated method for detecting brain cancers in MRI scans. Subsequently, a machine learning model is trained on a large and diverse dataset to classify tumors into various groups, including pituitary, glioma, and meningioma. The system's performance is rigorously tested using a substantial and varied dataset to ensure its therapeutic relevance. The overarching research goal is to achieve high sensitivity, specificity, and accuracy in tumor detection while minimizing false positives and negatives. The proposed system has the potential to assist medical practitioners in diagnosing patients more rapidly and accurately, thereby enhancing patient outcomes. This research and development project underscores the potential of combining medical imaging and artificial intelligence for early detection and classification of brain tumors, offering the prospect of reduced diagnostic time and increased effectiveness in healthcare systems.

Keyword: *MRI; brain tumor; classification; convolutional neural network; detection; fine-tuning; hyperparameter.*

---

1. INTRODUCTION

- Brain tumor detection and classification represent pivotal challenges in the real life of medical diagnostics and neuro-oncology.
- The ability to identify and differentiate between various types of brain tumors is fundamental for treatment planning.
- In recent years, the advent of deep learning, particularly Convolutional Neural Networks (CNNs), has revolutionized the landscape of medical image analysis.
- Traditionally, this task has heavily relied on the expertise of radiologists and clinicians, which, while invaluable, is inherently subject to human limitations.

- Brain tumor detection projects use artificial intelligence (AI) and machine learning to analyze brain imaging techniques, like Magnetic Resonance Imaging (MRI), to identify tumors.

1.1 Aim and Objectives of the Proposed

- **Enhance Diagnostic Accuracy:** The primary objective is to develop an automated system for brain tumor detection and classification that significantly improves diagnostic accuracy.

- **Speed Up Diagnosis:** Expedite the diagnostic process by automating the analysis of brain imaging data. The system should provide rapid and accurate results, particularly in cases where early detection and timely treatment are critical to patient outcomes.

- **User-Friendly Interface:** Design an intuitive and user-friendly interface that allows healthcare professionals, including radiologists and clinicians, to easily interact with the system and understand its output, fostering its adoption in clinical practice.

- **Cost-Efficiency:** It ensure that the system is affordable and accessible to healthcare facilities of varying scales,particularly in low-resource settings.

- **Improved Patient Outcomes**: Ultimately, the overarching objective is to improve patient outcomes by enabling early and accurate brain tumor diagnosis and classification. The system should contribute to better treatment planning and ultimately enhance the quality of patient care in the context of neuro-oncology.

1.2 Proposed System

The proposed system for the “Brain tumor detection and classification” project is designed by using several libraries which includes:

1. **TensorFlow and Keras:** TensorFlow, an open-source machine learning framework developed by Google, provided the backbone for implementing deep learning techniques. Keras, an API integrated into TensorFlow, streamlined the process of building and training neural networks, enabling the creation of complex CNN architectures.

2. **OpenCV (Open-Source Computer Vision Library):** OpenCV, a versatile computer vision library, served as the foundation for real-time video processing and image manipulation. Its vast array of functions facilitated tasks such as frame capture, image resizing, gray scale conversion,and data augmentation.

3. **NumPy:** NumPy, a fundamental package for scientific computing in Python, played a crucial role in handling multidimensional arrays and matrices. It facilitated efficient data manipulation, preprocessing, and manipulation of image pixel values, essential for data augmentation and normalization tasks.

4. **Matplotlib:** Matplotlib, a comprehensive library for creating static, interactive, and animated visualizations in Python, was utilized for generating detailed plots and graphs. It aided in visualizing the system's performance metrics, training/validation accuracy, and loss curves providing valuable insights during the development and evaluation phases.

5. **Streamlit**: Streamlit, a Python library for creating web applications with minimal effort, was employed for developing the user-friendly interface. Its simplicity and flexibility enabled the creation of an intuitive web-based platform where users could interact with the system,upload images, and witness real-time traffic sign recognition.

2. LITRATURE SURVEY

[1] T Hossain et al. (2019) established the work focusing on Brain tumor detection using CNN, FCM, Medical Image, Segmentation, SVM. In this paper, they proposed a method to extract brain tumor from 2D MRI by Fuzzy C-Means clustering algorithm which was followed by traditional classifiers and convolutional neural network. The experimental study was carried on a real-time dataset with diverse tumor sizes, locations, shapes, and different image intensities. CNN gained an accuracy of 97.87% from their model.

[2] G Hemanth et al. (2019) research proposes an automatic segmentation method that relies upon CNN, determining small 3 x 3 kernels. By incorporating this single technique, segmentation and classification is accomplished. CNN from Neural Networks where it has layer based for results classification. Various levels involved in the mechanisms are Data collection, Pre-processing, Average filtering, segmentation, feature extraction, CNN via classification and identification.

[3] Suresha D et al. (2020) proposed a system to decide whether the brain has tumor or is it tumor- free from the MR image using combined technique of K-Means and support vector machine. In the first stage the input image is converted to grey scale using binary thresholding and the spots are detected. The set of feature extracted are later characterized by using K-Means algorithm, then the tumor recognition is done using support vector machine.

[4] A. Sinha et al. (2021) proposed the work focusing on Medical Image Processing using MRI, Artificial neural network, CNN, Keras. Used components are image acquisition, pre-processing, segmentation, feature extraction and classification. Different segmentation algorithms were experimented. From this multilevel thresholding and OTSU thresholding are the best methods for the dataset. Density estimation method is also proposed using Gaussian kernel distribution.

[5] S. Solanki et al. (2023) explains Pre-processing, segmentation, extraction of features, and categorization techniques used to diagnose brain tumors. The measures utilized to assess the model’s performance were the highly sensitive, selectivity, accuracy, recall, and F1- score. The models have an overall accuracy of 95.4 percent, an average precision of 94.81 percent, an average recall of 95.07 percent, and an F1-score of 94.94 percent.

2.1 Methadology

The Methodology consists of steps like EDA (exploratory data analysis), Feature Extraction, PCA (Principal Component Analysis), Model Training, One Hot Encoding, Model Evaluation.

[1] Exploratory Data Analysis: Understanding a dataset's properties is the main goal of exploratory data analysis. EDA seeks to extract useful information that directs further analysis and modeling by summarizing important statistics, providing visualizations, and offering insights from analyzing the distribution, relationships, and patterns of the data. Making informed decisions about handling missing values, data preprocessing, and even feature engineering.

[2] Feature Extraction: A crucial step in machine learning is feature extraction, which turns raw data into a more condensed and representative set of features by extracting relevant data from it. The objective is to keep important patterns and features while reducing the dimensionality of the data. Feature extraction helps to highlight important information, increase computational efficiency, and improve machine learning model performance through methods like principal component analysis (PCA), wavelet transforms, or deep learning techniques. The extracted features serve as significant input variables, encapsulating the most relevant features of the data and enabling the models to learn and make decisions more efficiently.

[3] Principal Component Analysis: One of the popular dimensionality reduction method in machine learning is principal component analysis, or PCA. By recognizing and highlighting the principal components, which are linear combinations of the original features, it converts high- dimensional data into a lower-dimensional space. These elements capture the highest variation in the data, enabling a more condensed representation without sacrificing important information. PCA is especially helpful in lowering computational complexity, improving model performance, and displaying patterns in data.

[4] Model Training: A crucial phase in machine learning is model training, during which a model gains the ability to predict outcomes from input data. During the process, a labeled training dataset with known input feature values and associated target outputs are given to the model. In order to reduce the difference between the model's predictions and the actual target values, iterative adjustments are made to its internal parameters. The loss function is defined by the categorical crossentropy and adam optimizer is used. In order to generate precise predictions on new and unseen data, the model must be able to generalize patterns from the training set.

[5] One-hot Encoding: This step, which converts categorical labels into a format compatible with training algorithms, is a standard procedure in machine learning, particularly for neural network models. It ensures that class information is effectively represented and utilized during model training and evaluation.

2.2 System Desgin

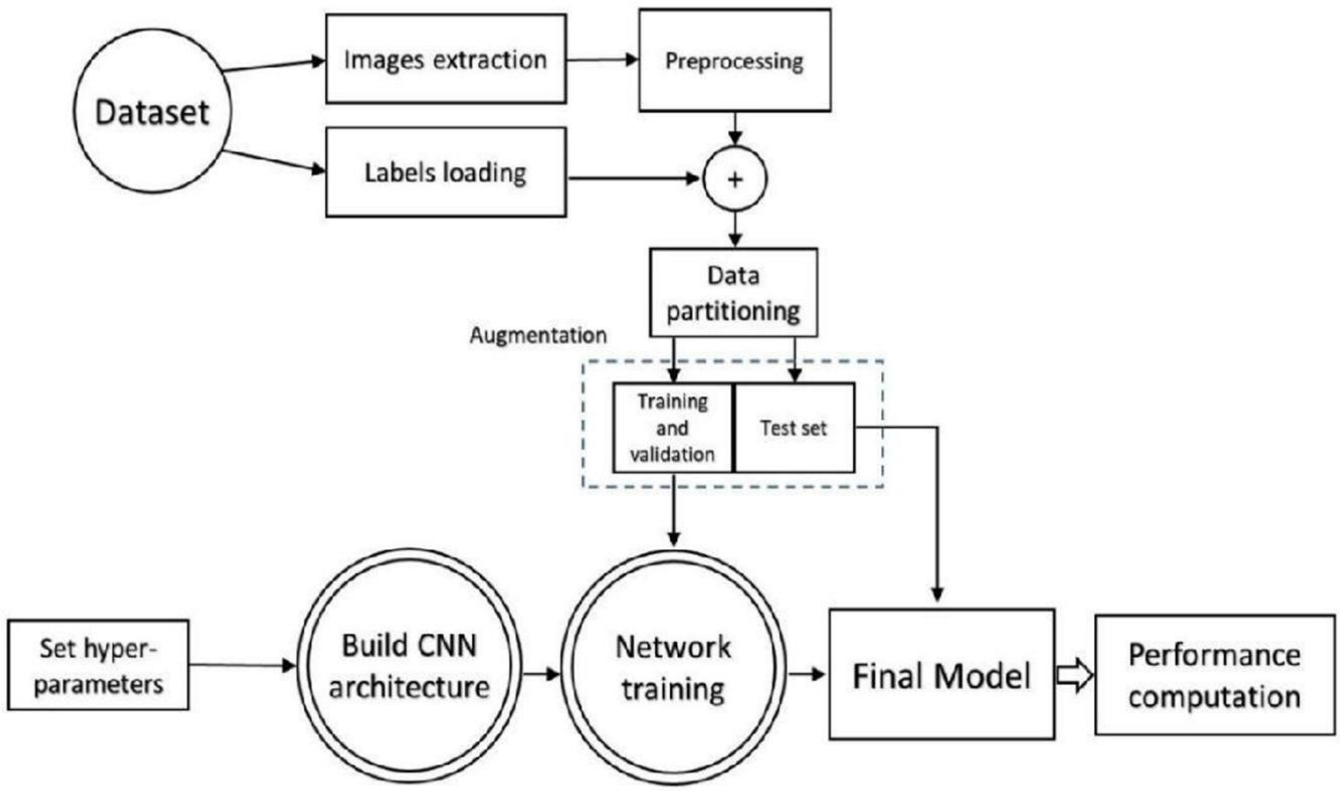

Fig -1:System Design

The Figure 1 explains the system design processes.

Data Set: Acquire a labeled MRI dataset of brain images (e.g., BraTS).
Image Extraction: Load MRI images from the dataset. Label Loading: Load corresponding labels for the MRI images.
Pre-processing: Normalize pixel values of the images.
Data Partition: Split the dataset into training, validation, and test sets.
Hyperparameters: Set learning rate, batch size, and number of epochs.
Build CNN Architecture: Add convolutional, pooling, and fully connected layers.
Network Training: Perform forward and backward passes.
Final Model: Serialize the model using HDF5 or TensorFlow SavedModel.

3. RESULT

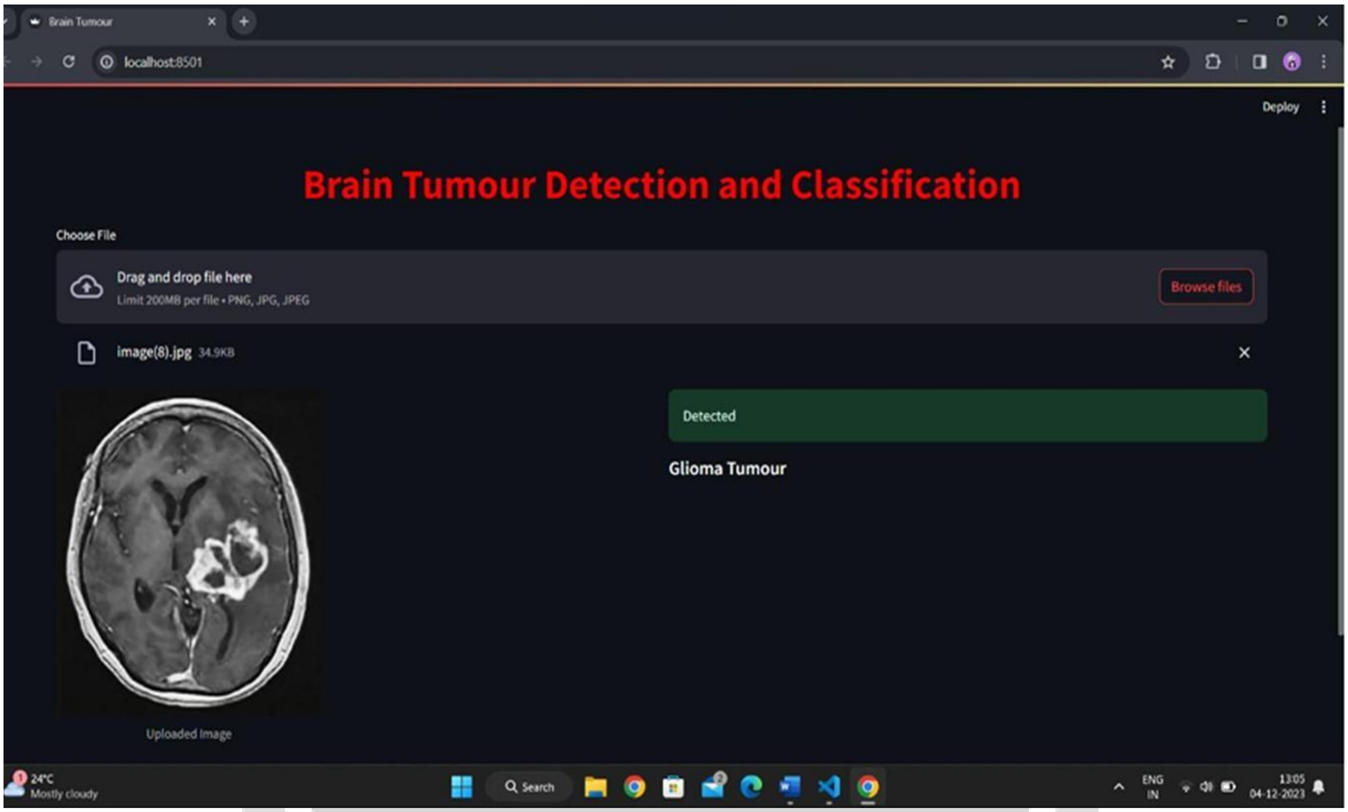

Fig -2:Detected Glioma Tumor

The Figure 2 Represents detection of Glioma Tumor. A glioma is a type of tumor that originates in the glial cells, which provide support and protection for the neurons in the brain and spinal cord. Gliomas are among the most common types of primary brain tumors. A glioma tumor is detected via imaging methods like MRI and analyzed using advanced techniques such as Convolutional Neural Networks (CNNs), several critical aspects of the tumor are assessed. Here's a detailed overview of the information typically gathered once a glioma tumor is detected. When a glioma tumor is detected, understanding its grade, size, location, and genetic profile is crucial for determining an effective treatment plan. Early detection using CNN-based AI models and advanced imaging techniques improves diagnostic accuracy and helps in personalizing patient care. A glioma is a primary tumor of the brain or spinal cord that originates from glial cells. These cells support and protect neurons and are essential for maintaining brain function. Gliomas account for about 33% of all brain tumors and can range from slow-growing to highly aggressive.

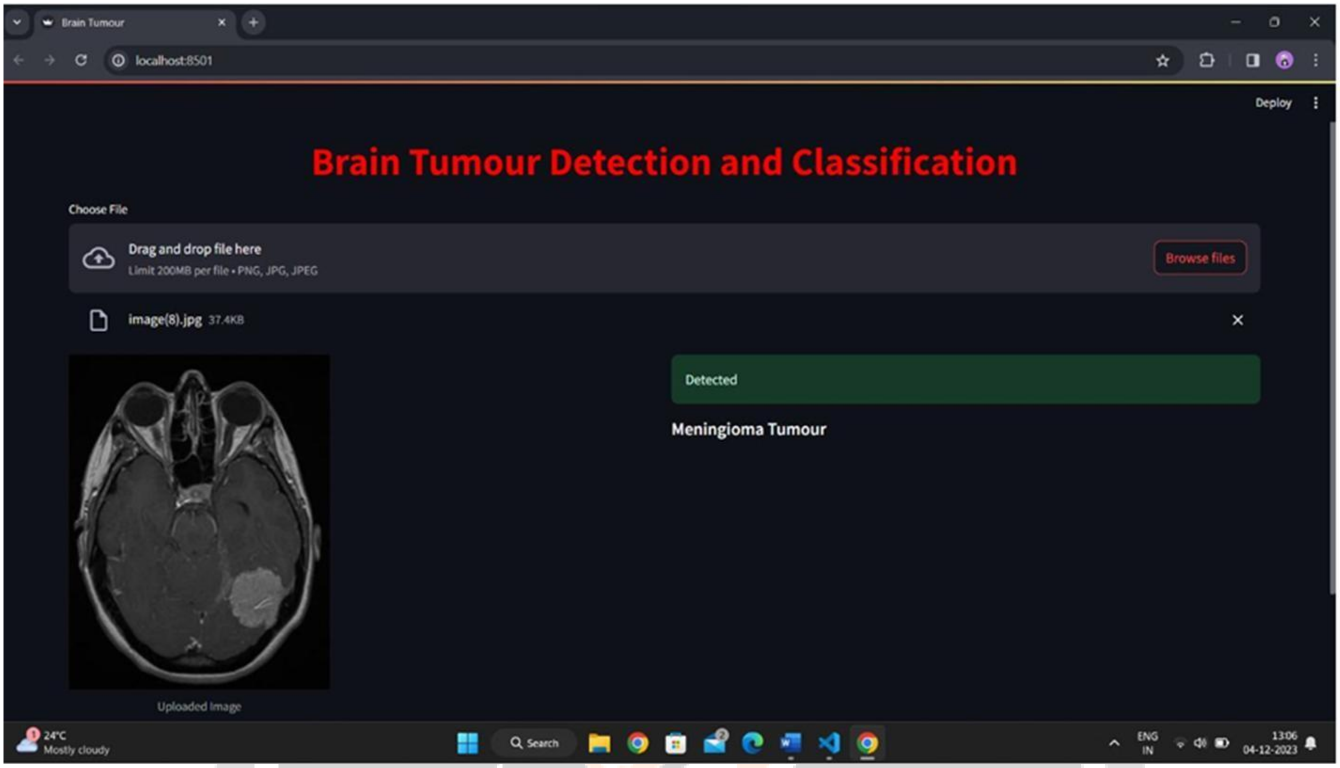

Fig -3: Detected Meningioma Tumor

The Figure 3 Represents detection of meningioma tumo. rA meningioma is a type of brain tumor that originates from the meninges, the protective layers of tissue that surround the brain and spinal cord. Meningiomas are typically slow-growing and are often benign (non-cancerous), although in some cases, they can be atypical or malignant.The detection of a meningioma tumor using Convolutional Neural Networks (CNNs) involves applying deep learning techniques to analyze medical imaging data such as MRI or CT scans. Here's a breakdown of how CNNs are used for brain tumor detection.

4. CONCLUSIONS

The In conclusion, the project focused on brain tumor detection and classification, leveraging the power of Convolutional Neural Networks (CNNs), represents a substantial advancement in the realm of medical imaging and healthcare technology. The integration of CNNs in this project has demonstrated an impressive capability to automatically discern and categorize brain tumors from MRI scans, a task traditionally reliant on manual interpretation by radiologists. Through the amalgamation of deep learning techniques, rigorous data preprocessing, and extensive model training, this project has brought forth a robust and highly efficient solution for early detection and precise classification of brain tumors. The implications of this project are profound, as it holds the potential to reshape clinical practices in the field of neurology and radiology. By providing a reliable and automated means of brain tumor diagnosis, the project can significantly expedite the decision-making process for healthcare professionals. Moreover, it greatly reduces the possibility of human error, enhancing diagnostic accuracy, and thus, offering substantial benefits in terms of patient care and outcomes. Although further refinement and extensive testing are essential to validate the system's clinical utility, the project serves as a powerful testament to the transformative capacity of artificial intelligence in the healthcare industry. It not only promises to improve the efficiency and accuracy of brain tumor diagnosis but also paves the way for innovative applications of AI in various medical domains, ultimately leading to enhanced patient care and superior outcomes.

5. ACKNOWLEDGEMENT

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of the people who made it possible, whose constant guidance and encouragement crowned the efforts with success. We would like to profoundly thank Management of Don Bosco Institute of Technology for providing such a healthy environment for the successful completion of Project work. We would like to express our thanks to Dr. Naghabhushana B S, Principal, Don Bosco Institute of Technology, Bengaluru for his encouragement that motivated us for the successful completion of Project work. It gives us immense pleasure to thank Dr. B K Raghavendra, Professor and Head of Department, Information Science and Engineering for his constant support and encouragement. We would like to express deepest sense of gratitude to our Mini Project coordinator Dr. Wahida Banu, Associate Professor, Department of Information Science and Engineering for her constant support throughout the work. We would like to express our deepest sense of gratitude to our guide Mrs. R Yashodara,Assistant Professor Department of Information Science & Engineering for her constant support and guidance throughout the Project work. Also, we would like to thank all teaching and non-teaching staff of Department of Information Science & Engineering who have helped directly and indirectly throughout the project work.

6. REFERENCES

[1] Solanki, U. P. Singh, S. S. Chouhan, S. Jain, "Brain Tumor Detection Using Intelligence Techniques: An Overview," in IEEE Access, vol. 11, pp. 12870-12886, 2023, doi: 10.1109/ACCESS.2023.

[2] Shetty, R. Fernandes, A. P. Rodrigues and P. Vijaya, "Brain Tumor Detection using Machine Learning and Convolutional Neural Network," 2022 International Conference on Artificial Intelligence and Data Engineering doi:10.1109/AIDE57180.20 22.10060254 (AIDE), Karkala, India, 2022, pp.86-91,

[3] Sinha et al. (2021), M. Ashraf, M. A. Al Nasim and F. Muhammad Shah, "Brain Tumor Detection Using Convolutional Neural Network," 2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT), Dhaka, Bangladesh, 2019, pp. 1-6, doi: 10.1109/ICASERT.2019.8934561.

[4] Suresha, N. Jagadisha, H. S. Shrisha and K. S. Kaushik, "Detection of Brain Tumor Using Image Processing," 2020 Fourth International Conference on Computing Methodologies and Communication (ICCMC), Erode, doi:10.1109/ICCMC48092.2020.ICCMC000156. India, 2020, pp. 844-848,

[5] Sinha, A. R P, M. Suresh, N. Mohan R, A. D and A. G. Singerji, "Brain Tumor Detection Using Deep Learning," 2021 Seventh International conference on Bio Signals, Images, (ICBSII), Chennai, India, 2021, pp.1-5, doi:10.1109/ ICBSII51839.20 21.9445185.

[6] T Hossain et al. (2019). P. Polly, M. A. Hossain, M. S. Ifthekhar, M. N. Uddin and Y. M. Jang, "An improved brain tumor detection and classification mechanism," 2017 International Conference on Information and Communication Technology Convergence (ICTC), Jeju, Korea (South), 2017, pp.54-57, doi:10.1109/ICTC.2017.81 doi90941.

[7] G Hemanth et al. (2019) "A survey on brain tumor detection using image processing techniques," 2017 7th International Conference on Cloud Computing, Data Science & Engineering - Confluence, Noida, India, 2017, pp. 582- 585, doi:10.1109/CONFLUENCE.2017.79 43218.