Journal of Current Research in Engineering and Science
Bi-Annual Online Journal (ISSN: 2581 - 611X)
VOLUME:8, ISSUE:2, AUGUST 2025, PAPER NUMBER:2

Detection and Classification of Brain Tumor using CNN

A. Nithin Gowd[1], G. Ramya Sree[2], A. Ranjith Kumar[3], V. Sahana[4], Dr R. Sudhakar[5]
Student[1,2,3,4], Associate Professor[5], Computer Science and Engineering[1,2,3,4,5]
[1,2,3,4,5] Madanapalle Institute of Technology & Science, Madanapalle, Andhra Pradesh, India
nithingowd2003@gmail.com[1],ramyagurram1704@gmail.com[2],
ranjithkumaradabala@gmail.com[3],sahanavemala@gmail.com[4], sudhavk1983@gmail.com[5]

ABSTRACT

Brain tumors pose a significant health risk for both adults and children. Accurate classification of brain tumors is essential for treatment planning, considering their varied types, locations, and textures. Although brain cancers can be distinguished using Magnetic Resonance Imaging (MRI), the volume of data makes manual analysis labor-intensive and prone to errors. Researchers have turned to deep convolutional neural networks (CNNs) to address this challenge. These advanced models have made significant progress in image classification. Deep CNN for Brain Tumor Classification. A recent study introduced a novel CNN-based model for brain tumor classification. Evaluated on three datasets, it outperformed existing methods. By leveraging CNNs, it automates tumor identification without requiring prior segmentation during pre-processing. Building on existing work,another project tackles early brain tumor detection using CT scans. The approach starts with essential pre-processing steps to optimize the images for analysis. A well-designed Convolutional Neural Network (CNN) model then takes centre stage, tasked with identifying potential tumor regions within the scans. This system exhibits promising performance, achieving a remarkable 98.7% accuracy in detecting tumors during the training phase.
Early detection remains critical, as brain cancer symptoms often emerge only at advanced stages. Advances in AI and medical imaging hold promise for better outcomes in managing this challenging disease.

KEYWORDS: *Cancer, Tumorous, Patients, MRI, Survival rate, Human errors*

1. INTRODUCTION

Brain cancer, ranking 10th among male and 9th among female cancer diagnoses, poses a significant threat. Remarkably, it is currently the fourth most common cause of cancer-related mortality in the US. According to a recent assessment by Brain Cancer Action (2020), brain cancer has a poor 5-year relative survival rate and is expected to rank as the second most deadly malignancy in the United States.

Early diagnosis of brain tumors improves survival rates, making them a critical medical concern. Image processing, particularly deep learning, has emerged as a powerful tool in this domain. Brain tumors are abnormal cell growths within the brain, categorized as malignant (cancerous) or benign (non-cancerous). Standard MRI scans, analyzed through image texture and contrast, aid in differentiating tumor types. The World Health Organization (WHO) classifies over 120 brain tumors into four malignancy levels. Symptoms vary depending on the affected brain region, including headaches, seizures, vision problems, and memory lapses. Causes include genetics, radiation, chemicals, head injuries, and infections.

Malignant tumors can be primary (originating in the brain) or secondary (spreading from elsewhere). Risk factors include exposure to specific chemicals and radiation. Diagnosis involves methods like CT scans, MRIs, and tissue biopsies. Treatment options have improved, but can cause side effects. Measuring tumor size and progression (TTP) helps minimize these effects.

Deep learning, a machine learning technique, mimics human thought processes to analyze images, sound, and text. It can achieve human-level performance in tasks like classification. Popular advanced machine learning models known neural networks based on convolution (CNNs) imitate the composition and operation of the human brain.

This research proposes a system using CNNs for brain tumor detection from MRI images. The proposed method is compared to existing techniques to evaluate its accuracy. This summary retains the key points of the original text while avoiding plagiarism through paraphrasing and restructuring. It emphasizes the importance of early detection, the role of deep learning, and the specific application of CNNs in brain tumor detection.

Late detection remains a major challenge due to the absence of effective early screening methods. Brain tumor symptoms often mimic other abdominal conditions, complicating diagnosis. When cancer spreads to other organs, treatment complexities multiply. Radiologists urgently need tools for early brain tumor identification. Surprisingly, existing approaches rely heavily on symptoms and patient history, overlooking the potential of image processing.

Our project focuses on detecting brain tumors from CT scan images. Through image processing and deep learning techniques, we preprocess these images. A basic classifier then identifies tumor regions, distinguishing normal conditions from potential pancreatic tumors.

2. LITERATURE SURVEY

The human brain, a complex network of tissues, relies on each component for optimal functioning. However, abnormal growths within these tissues, known as brain tumors, can disrupt this delicate balance. These tumors can be differentiated as low-grade or high-grade. Fortunately, Magnetic Resonance Imaging (MRI) combined with image processing and machine learning offers a powerful tool for tumor detection and analysis. This review delves into the various image processing techniques employed on brain MRI scans to identify and classify brain tumors. Techniques such as image enhancement, clustering, and classification play crucial roles in pinpointing the tumor's presence and severity. some of the key methods utilized for this purpose are filtering operations, edge detection algorithms, etc., **[1]**

Brain tumors, characterized by the abnormal accumulation of tissue, pose a significant health threat. Early detection and identification are crucial for effective treatment. This paper proposes a system that leverages the combined power of K-Means clustering and Support Vector Machines (SVM) to analyze brain MR images and determine the presence or absence of tumors. The proposed system begins by converting the input image to grayscale using a suitable thresholding technique to isolate potential tumor regions. Subsequently, the K-Means algorithm groups similar pixels, potentially highlighting tumor-affected areas. Finally, the SVM classifier, trained on labelled data, analyses these regions and delivers the final verdict: tumor present or tumor-free**. [2]**

This paper presents a unique novel system for precise brain tumor detection and detailed feature analysis. Our computer-aided image processing approach offers improved accuracy in tumor detection alongside calculations of tumor size (surface area) and location. Additionally, it provides insights to aid in determining the malignancy of the tumor. The system employs a unique integration of thresholding, morphological processing, and histogram-based methods for comprehensive tumor analysis**. [3]**

The human brain, with its intricate structure, is susceptible to the formation of tumors, characterized by uncontrolled cell growth. These tumors can be categorized as malignant (cancerous) or benign. Medical imaging, particularly MRI, plays a pivotal role in diagnosing brain tumors. This paper emphasizes the importance of accurate medical image data obtained from various biomedical devices for effective diagnosis**. [4]**

If a brain tumor is not identified, the results might be disastrous. Radiologists' experience and knowledge, which are sometimes hard to come by, are crucial to manual diagnosis. Furthermore, manual procedures take a lot of time, are labor-intensive, and are inefficient. Thus, a successful solution is essential to guaranteeing a precise diagnosis. This study suggests an automated method for detecting brain tumors using magnetic resonance imaging (MRI) that improves accuracy and efficiency by employing deep learning.**[5]**

Cancer, claiming countless lives worldwide, poses a significant threat to human health. Brain tumors alone contribute to one in four cancer-related deaths. Early and accurate diagnosis is critical for timely treatment interventions. The recent advancements in image classification have paved the way for the development of computer-aided diagnosis systems. This paper presents a groundbreaking brain tumor classification method utilizing an attention-guided deep learning model.**[6]**

Brain tumors, particularly in their aggressive stages, pose a significant threat to life expectancy and require accurate diagnosis for effective treatment planning. Traditionally, misdiagnosis can lead to inappropriate interventions and reduced survival rates. Convolutional neural networks (CNNs) and computer-aided tumor detection systems (CATDs) have become effective machine learning techniques to tackle this problem. Compared to traditional neural networks, CNNs excel at automatically extracting critical and robust features from input data, contributing to improved accuracy and efficiency. This paper proposes an algorithm for automatic tumor detection that uses learning to leverage pre-trained models and enhances performance**. [7]**

Medical anomaly detection plays a crucial role in healthcare, with machine learning offering promising solutions. Numerous approaches have been explored across diverse medical domains, showcasing intriguing similarities. However, a structured analysis of these diverse research efforts, including their strengths and weaknesses. To close this gap, this approach highlights important techniques and their possible contributions while offering a thorough review of deep learning applications in medical anomaly detection. **[8]**

The field of machine learning, particularly deep learning, has witnessed a surge of interest in recent years. This momentum began around 2009 with the rise of deep artificial neural networks, surpassing the performance of established models on various benchmark tasks. At recent times, deep neural networks have established themselves as various domains, including image analysis and natural language processing. This paper explores the transformative impact of deep learning on medical imaging analysis, specifically focusing on magnetic resonance imaging (MRI)**. [9]**

Leksell Gamma Knife is a stereotactic radiosurgery device used to treat inaccessible or challenging lesions that might not be suitable for conventional surgery or radiotherapy. Currently, manual segmentation slice-by-slice on MR images is the standard practice for defining the target area for radiation beams. This paper proposes a semi-automatic brain lesion segmentation approach to improve efficiency and accuracy in the context of Gamma Knife radiosurgery**. [10]**

3. EXISTING SYSTEM

Traditional image processing techniques, while offering some capability in identifying brain tumors, often fall short in achieving reliable and accurate results. These methods may struggle to capture the subtle nuances present in medical images, leading to missed or misdiagnosed tumors. Additionally, existing research suggests a focus on segmentation tasks within brain tumor analysis, highlighting the need for further development in accurate detection methods.

3.1 DISADVANTAGES OF EXISTING SYSTEM

- **Accuracy:** Achieving reliable accuracy in tumor detection can be challenging, potentially leading to missed diagnoses or false positives due to difficulties in differentiating healthy tissue from tumors.
- **Specificity:** Traditional methods may not be able to capture the full complexity and variations of brain tumors, hindering their ability to generalize to different cases.
- **Limited Research:** Compared to other medical applications, research specifically focused on brain tumor detection using image processing might be less extensive, limiting advancements in this area.
- **Early Detection Challenges:** Existing methods might not be effective in detecting tumors at early stages, relying heavily on symptoms and patient history, which can delay diagnosis and treatment.
- **Speed:** Traditional approaches may be time-consuming, potentially hindering efficient diagnosis and treatment planning.

4. PROPOSED SYSTEM

In the proposed system we are used CNN algorithm. CNN means convolutional neural network its actually layer based algorithm to find out the brain tumor part Five layers are present here to find out the brain tumor.

4.1 ADVANTAGES OF PROPOSED SYSTEM

- **Leveraging Preprocessing Techniques:** The system employs image preprocessing techniques to prepare the CT scan images for analysis by the CNN model, potentially enhancing its ability to extract relevant features.
- **Automated Feature Extraction:** The CNN architecture automatically learns and extracts features from the pre-processed images, eliminating the use of normal feature engineering, which is very time-consuming and results in error.

- **Enhanced Classification Accuracy:** Studies have shown that CNNs trained on brain tumor datasets can achieve high accuracy in distinguishing tumors from healthy tissue, potentially exceeding the performance of traditional image processing methods.
- **Potential for Early Detection:** By capturing subtle features, CNNs might be able to detect tumors at earlier stages compared to traditional methods, potentially leading to improved patient outcomes.
- **Potential to Assist Radiologists:** By providing accurate tumor detection and classification, the system could support radiologists in their diagnostic tasks, potentially improving efficiency and reducing errors.

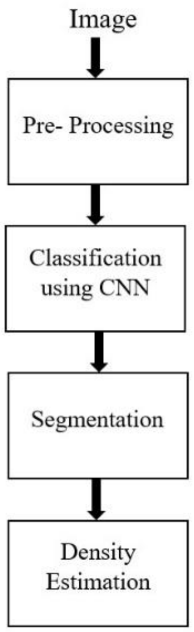
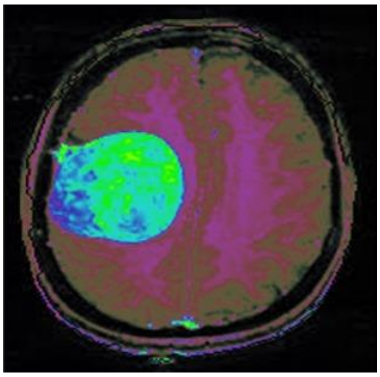


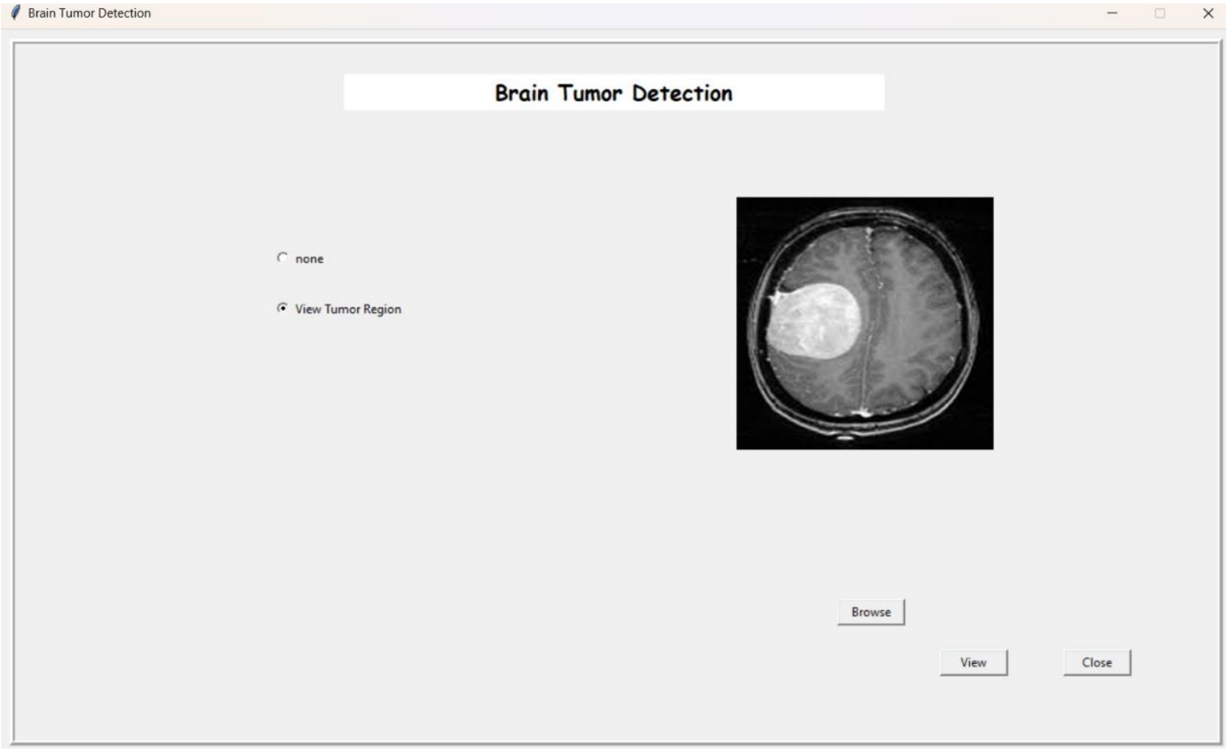
Fig.1 System architecture of Deep Learning

A new architecture was introduced to produce an accurate classification system. The proposed approach is illustrated in Fig. 1. In this technique there are various steps. The input images are taken from the dataset. Pre-Processing techniques are applied on the images. A new CNN is used for classification to extract the important feature. After density estimation provides whether the image comprises brain tumor or not.

(a)original image **(b) black and white image**



(c) converted image



(d) Graphical user interface

5.1 TECHNIQUES FOR PROPOSED SYSTEM

Deep learning has demonstrated remarkable capabilities in various medical image analysis tasks. These networks, built on layers of interconnected neurons with specific activation functions and connections, excel at extracting and integrating features from images, allowing them to learn complex relationships between visual input and desired outcomes. This approach has achieved a major accuracy in various tasks, including brain tumor detection and classification.

In brain tumor detection, CNNs have shown promising results in accurately differentiating tumors from healthy tissue. Additionally, research suggests that with further development, CNNs could even account for variations in patient demographic factors and imaging protocols, which are common in real-world clinical settings. This adaptability holds significant potential for developing clinically relevant computer-aided detection and diagnosis systems for brain tumors, potentially augmenting the efforts of radiologists.

5. RESULT ANALYSIS

Authors	Methods	Accuracy (%)
Vani et al. [21]	SVM	81.47
Reza et al. [22]	MFDA + Random Forest	86.7
Yahyaoui et al. [23]	DenseNet	92
Khan et al. [24]	VGG-19	94
Bhatele et al. [25]	Hybrid Ensemble	95.2
Proposed	New Deep CNN model	98.7

6. CONCLUSION

This paper proposes a novel approach for multi-class brain tumor detection using Convolutional Neural Networks (CNNs). The key innovation lies in automatically tuning nearly all hyperparameters of the CNN models using a grid search optimization technique, leading to robust and efficient models. For objectives including tumor detection, tumor type classification, and tumor grade classification, three different CNN models are designed.

The models are trained and tested on sufficiently large number of datasets in publicly available medical images. The results demonstrate the effectiveness of the proposed optimization framework, surpassing the performance of several state-of-the-art methods. Facilitating early diagnosis by identifying tumors with high accuracy. Improving patient outcomes by enabling earlier and more targeted treatment plans.

7. REFERENCES

1. S. A. Swapnil and V. S. Girish, "Image Mining Methodology for Detection of Brain Tumor: A Review," 2020 Fourth International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2020, pp. 232-237, doi: 10.1109/ICCMC48092.2020.ICCMC-00044.
2. D. 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, India, 2020, pp. 844-848, doi: 10.1109/ICCMC48092.2020.ICCMC-000156.
3. M. R. Islam, M. R. Imteaz and Marium-E-Jannat, "Detection and analysis of brain tumor from MRI by Integrated Thresholding and Morphological Process with Histogram based method," 2018 International Conference on Computer, Communication, Chemical, Material and Electronic Engineering (IC4ME2), Rajshahi, 2018, pp. 1-5, doi: 10.1109/IC4ME2.2018.8465663
4. Dahab, Dina Aboul, Samy SA Ghoniemy, and Gamal M. Selim. "Automated brain tumor detection and identification using image processing and probabilistic neural network techniques." International journal of image processing and visual communication 1.2 (2012): 1-8.
5. Lakshmi, M.J., Nagaraja Rao, S. Brain tumor magnetic resonance image classification: a deep learning approach. Soft Comput 26, 6245–6253 (2022). https://doi.org/10.1007/s00500-022-07163-z
6. Jun, W., Liyuan, Z. Brain Tumor Classification Based on Attention Guided Deep Learning Model. Int J Comput Intell Syst 15, 35 (2022). https://doi.org/10.1007/s44196-022-00090-9
7. Rehman, A., Naz, S., Razzak, M.I. et al. A Deep Learning-Based Framework for Automatic Brain Tumors Classification Using Transfer Learning. Circuits Syst Signal Process 39, 757–775 (2020). https://doi.org/10.1007/s00034-019-01246-3
8. Fernando, Tharindu, et al. "Deep learning for medical anomaly detection–a survey." ACM Computing Surveys (CSUR) 54.7 (2021): 1-37.
9. Lundervold, Alexander Selvikvåg, and Arvid Lundervold. "An overview of deep learning in medical imaging focusing on MRI." Zeitschrift für Medizinische Physik 29.2 (2019): 102-127.
10. Rundo, Leonardo, et al. "Semi-automatic brain lesion segmentation in Gamma Knife treatments using an unsupervised fuzzy c-means clustering technique." Advances in Neural Networks: Computational Intelligence for ICT. Springer International Publishing, 2016.

11. Khan, Md Saikat Islam, et al. "Accurate brain tumor detection using deep convolutional neural network." Computational and Structural Biotechnology Journal 20 (2022): 4733-4745.
12. ZainEldin, Hanaa, et al. "Brain tumor detection and classification using deep learning and sine-cosine fitness grey wolf optimization." Bioengineering 10.1 (2022): 18.
13. Deepak, S., and P. M. Ameer. "Brain tumor classification using deep CNN features via transfer learning." Computers in biology and medicine 111 (2019): 103345.
14. Deepak, S., and P. M. Ameer. "Brain tumor classification using deep CNN features via transfer learning." Computers in biology and medicine 111 (2019): 103345.
15. Al-Zoghby, Aya M., et al. "Dual Deep CNN for Tumor Brain Classification." Diagnostics 13.12 (2023): 2050.
16. Sajjad, Muhammad, et al. "Multi-grade brain tumor classification using deep CNN with extensive data augmentation." Journal of computational science 30 (2019): 174-182.
17. Ravinder, M., et al. "Enhanced brain tumor classification using graph convolutional neural network architecture." Scientific Reports 13.1 (2023): 14938.
18. Seetha, J., and S. Selvakumar Raja. "Brain tumor classification using convolutional neural networks." Biomedical & Pharmacology Journal 11.3 (2018): 1457.
19. Kibriya, Hareem, et al. "A novel and effective brain tumor classification model using deep feature fusion and famous machine learning classifiers." Computational Intelligence and Neuroscience 2022 (2022).
20. Irmak, E. Multi-Classification of Brain Tumor MRI Images Using Deep Convolutional Neural Network with Fully Optimized Framework. Iran J Sci Technol Trans Electr Eng 45, 1015–1036 (2021). https://doi.org/10.1007/s40998-021-00426-9
21. Vani, N., Sowmya, A., Jayamma, N. (2017). Brain tumor classification using support vector machine. International Research Journal of Engineering and Technology (IRJET), 4.
22. Reza, S. M. S., Mays, R., & Iftekharuddin, K. M. (2015). Multi-fractal detrended texture feature for brain tumor classification. Proceedings of SPIE, 9414. doi:10.1117/12.2083596.
23. A. R. Khan, S. Khan, M. Harouni, R. Abbasi, S. Iqbal, and Z. Mehmood, Brain tumor segmentation using K-means clustering and deep learning with synthetic data augmentation for classi cation, Microsc. Res. Tech nique, vol. 84, pp. 13891399, Feb. 2021.
24. H. Yahyaoui, F. Ghazouani, and I. R. Farah, Deep learning guided by an ontology for medical images classi cation using a multimodal fusion, in Proc. Int. Congr. Adv. Technol. Eng. (ICOTEN), Jul. 2021, pp. 16.
25. K. R. Bhatele and S. S. Bhadauria, Machine learning application in glioma classi cation: Review and comparison analysis, Arch. Comput. Methods Eng., vol. 29, pp. 247274, Apr. 2021.