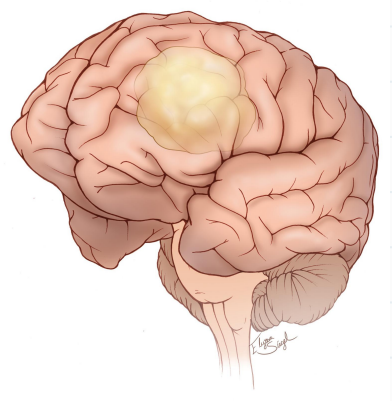
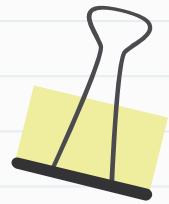
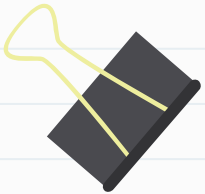
International Conference on Computer and Information Technology 2024
(ICCIT 2024)



A Hybrid Deep Learning Approach For Brain Tumor Detection Using XAI with GradCAM





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01 Introduction

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Background

- Brain tumors are among the most critical health concerns due to their rapid progression.
- Early detection of brain tumors significantly improves treatment success and survival rates.
- Automated techniques, particularly machine learning, are crucial for enhancing the efficiency and accuracy of brain tumor detection.
- MRI (Magnetic Resonance Imaging) is the standard for non-invasive brain imaging, offering high detail.
- Deep learning, especially convolutional neural networks (CNNs), has shown remarkable success in medical image processing.

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Motivation

- High prevalence and mortality rates of brain tumors demand early diagnosis.
- Limitations of manual MRI interpretation: time-consuming and prone to errors.
- Often AI models lack interpretability, hindering clinical trust.
- Need for a reliable and explainable hybrid approach in tumor detection.

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02 Methodology

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Contribution

- Developed a hybrid deep learning model (VGG19+LSTM) achieving state-of-the-art accuracy and VGG16 + INCEPTIONV3.
- Integrated GradCAM for explainable AI to enhance clinical trust.
- Demonstrated better performance compared to traditional single-model and with proposed work.

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Dataset

- **Source**: Kaggle brain tumor MRI dataset with more than 7000 images divided into four classes (glioma, meningioma, pituitary, no tumor).
- **Data Split**: 5617 images for training, 702 for validation, 704 for testing.
- **Data Preprocessing** :
  → Image Resize
  → Image Augmentation Translation
  → Image Translation (shifts)

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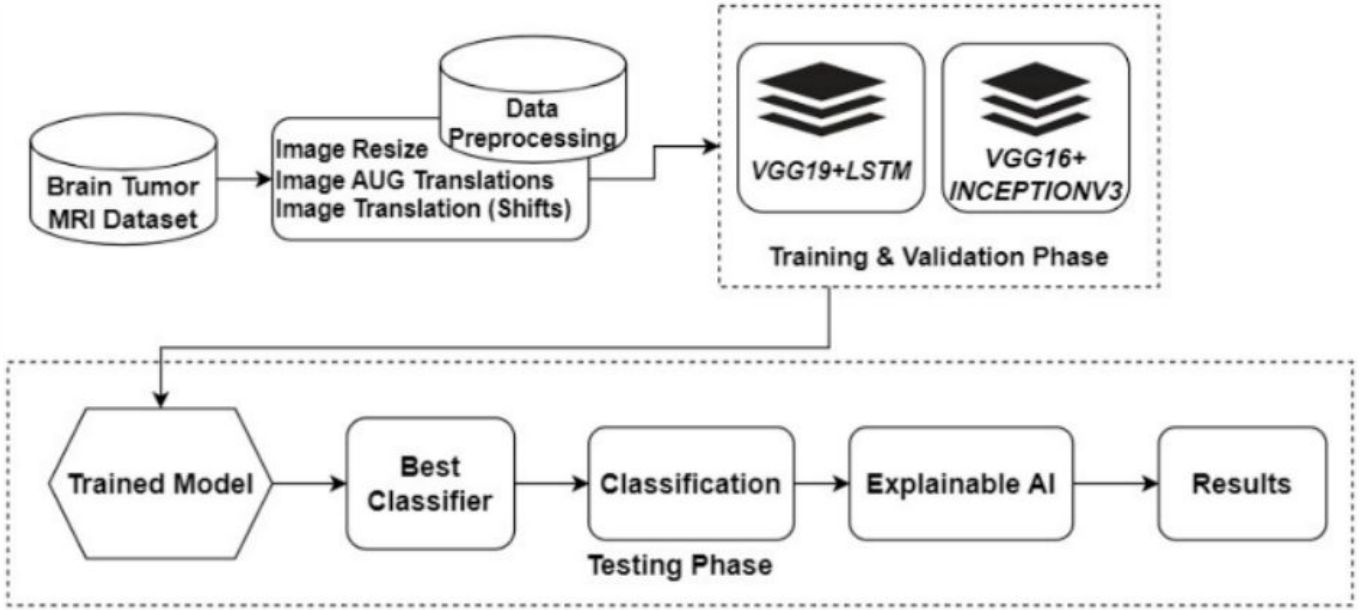
Proposed System Architecture



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VGG19+LSTM

- VGG19: A deep convolutional neural network designed for extracting spatial features from MRI images.
- LSTM: A type of recurrent neural network (RNN) that processes sequential data to capture temporal dependencies.
- Combines VGG19's spatial feature extraction with LSTM's sequential learning for better contextual understanding.

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VGG16+INCEPTIONV3

- VGG16: A simplified version of VGG19, focusing on spatial feature extraction with 16 layers
- InceptionV3: A sophisticated convolutional neural network designed for diverse feature extraction.
- Hybrid Integration: Combines VGG16's spatial detail extraction with InceptionV3's multi-scale analysis.

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03 Result Analysis

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Comparisons with Single Models

Models	Precision	Recall	F1-Score	Accuracy
VGG19+LSTM	**98%**	**98%**	**98%**	**98%**
VGG16+ INCEPTIONV3	96%	96%	96%	96%
VGG16	96.19%	96.16%	96%	96.19%
ResNet-101	94.05%	94.05%	94.05%	94%
MobileNet	92.98%	93%	92.97%	92.98%
Xception	90.69%	90.69%	90.7%	90.69%
InceptionV3	91%	91%	91%	91%

The Comparisons of Proposed Work with Related Work

Authors	Method	Accuracy	XAI
Narayana et al[9]	Metaheuristic optimization technique	91%	NO
A. Ercan and S. Kerem[10]	Faster-R-CNN	91.66%	NO
Hossain et al[11]	CNN	97.87%	NO
Pitchai et al. [12]	DL	94%	NO
A. Çinar and M. Yildirim[13]	Hybrid CNN	97.2%	NO
Indu singh et al. [14]	Ensemble Learning Algorithm	96.08%	NO
Gaur et al[15]	Dual Input CNN	94.34%	LIME & SHAP
Lamrani et al[16]	CNN	96%	NO
Ahmet et al [17]	VGG16	97.33%	LRP
Proposed Model	VGG19+ INCEPTIONV3	96%	NO
Proposed Model	VGG19+LSTM	98%	GradCAM

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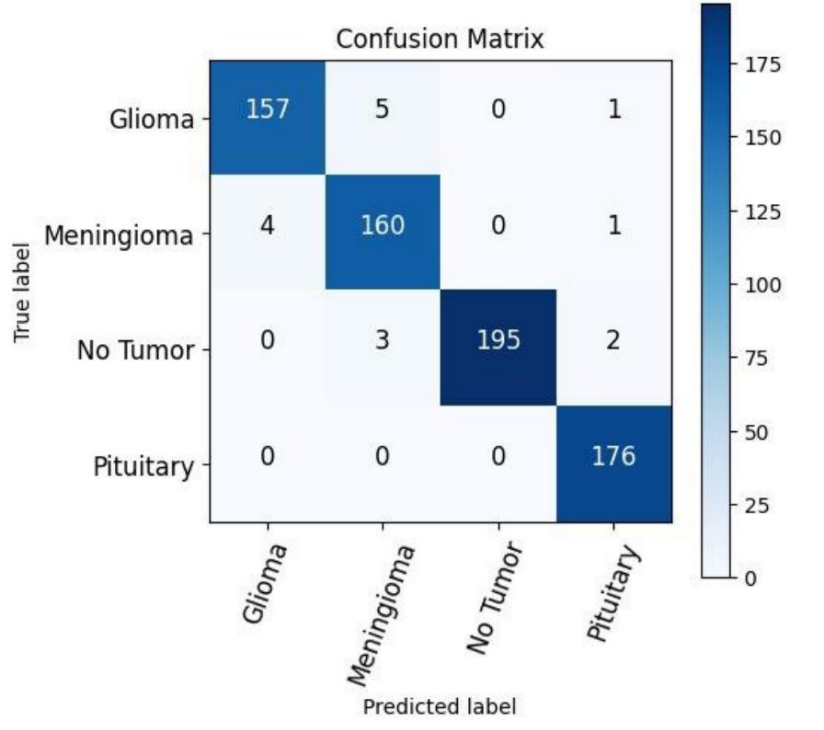
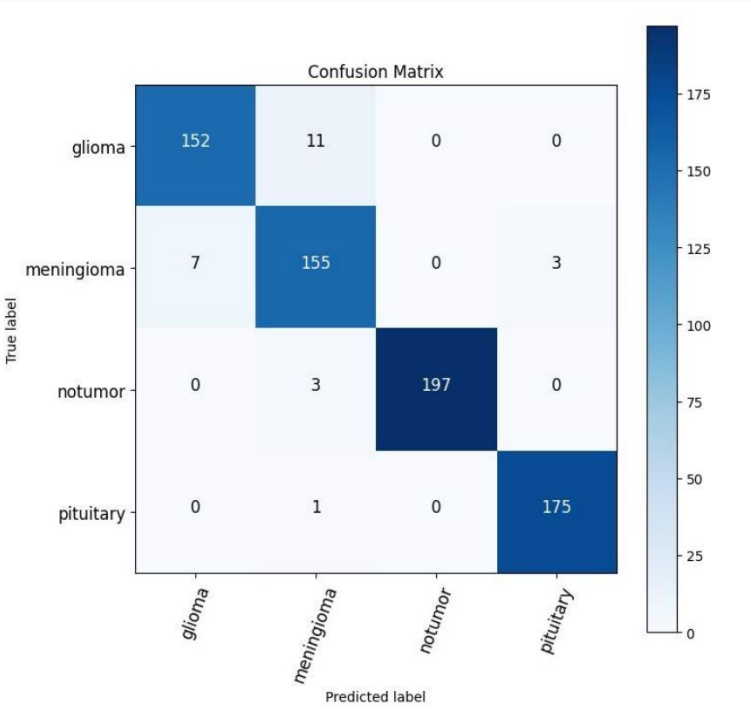
Confusion Matrix of VGG19+LSTM & VGG16+INCEPTIONV3





Output of GradCAM

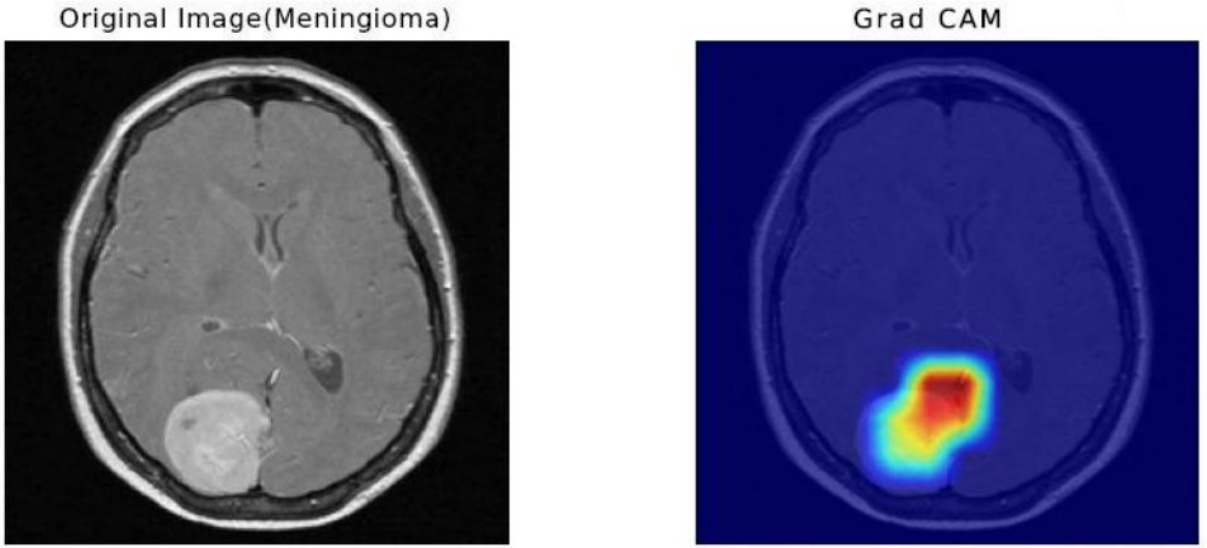


Fig. 10. GradCAM image for brain tumors class meningioma

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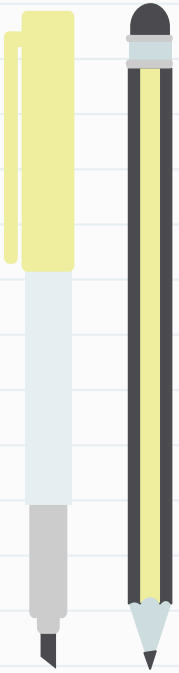
04 Conclusion



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Conclusion

- Presented a hybrid approach for brain tumor detection using deep learning and XAI.
- Achieved high accuracy with VGG19+LSTM (98%) and competitive performance with VGG16+InceptionV3 (96%).
- Introduced GradCAM for explainable AI, making the model's predictions more interpretable for clinicians.
- Need to be experimented on more complex and larger dataset, and the focus on GradCAM restricts evaluation to one XAI technique. Future work could explore larger datasets and diverse interpretability methods.

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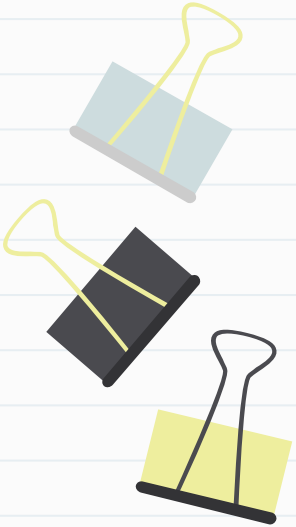

Thanks!