RESEARCH ARTICLE

Computer-Aided Brain Tumor Diagnosis: **Performance Evaluation of Deep Learner CNN Using Augmented Brain MRI**

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INTRODUCTION

Brain tumors are a serious health issue, with **increasing mortality rates**. **Manual diagnosis** of MRIs is time-consuming and **prone to errors**. This **research proposes** a **CNN-based Computer-Aided Diagnosis (CAD) system** for **early** and **accurate detection**.

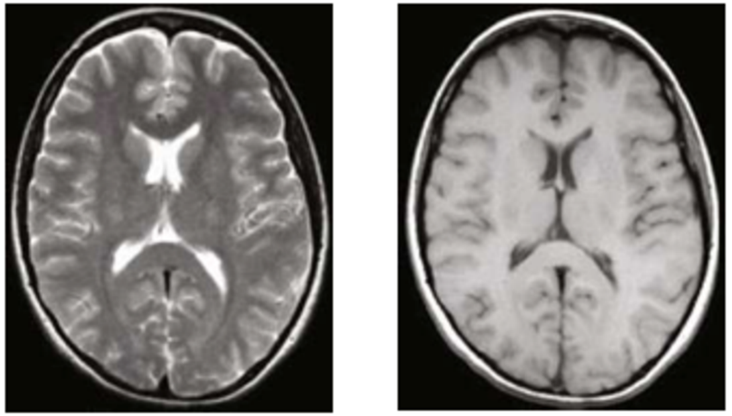
Motivation & Problem Statement

Accurate and timely diagnosis of **brain tumors** can significantly improve patient outcomes. **Manual diagnosis lacks precision**, and **existing automated methods** need **improvement** in **accuracy and generalization**.

Proposed Methodology

- The study focuses on **automated brain tumor diagnosis** using **Convolutional Neural Networks (CNN)** trained on **MRI images**.
- **CNN extracts features** from **labeled images** to **classify** them as **positive or negative** for brain tumors.
- The methodology includes dataset collection, **preprocessing**, **incremental training on BR35H dataset** , and **performance evaluation**.
- The **model** is **tested** on **six different unseen MRI datasets (BMI-I, BTI, BMI-II, BTS, BMI-III, BD-BT)** to **ensure robustness.**

Data Analysis



(a) T1-weighted MRI with darker CRF (b) T2-weighted MRI with brighter CRF

Table 2: Brain MRI datasets.

		Brain tumor images datasets	Positive	Negative	Total
Training	BR35H	BR35H::Brain Tumor Detection 2020	255	255	510
Testing	BMI-I	Brain MRI Images for Brain Tumor Detection	86	85	171
	BTI	Brain Tumor Image Dataset	10	10	20
	BMI-II	Brain MRI Images for Brain Tumor Detection	86	6	92
	BTS	Brain Tumor Segmentation	70	70	140
	BMI-III	Brain MRI Images for Brain Tumor Detection	86	85	171
	BD-BT	BD-BrainTumor	671	0	671
		Total	1264	511	1775

Data Augmentation & Preprocessing

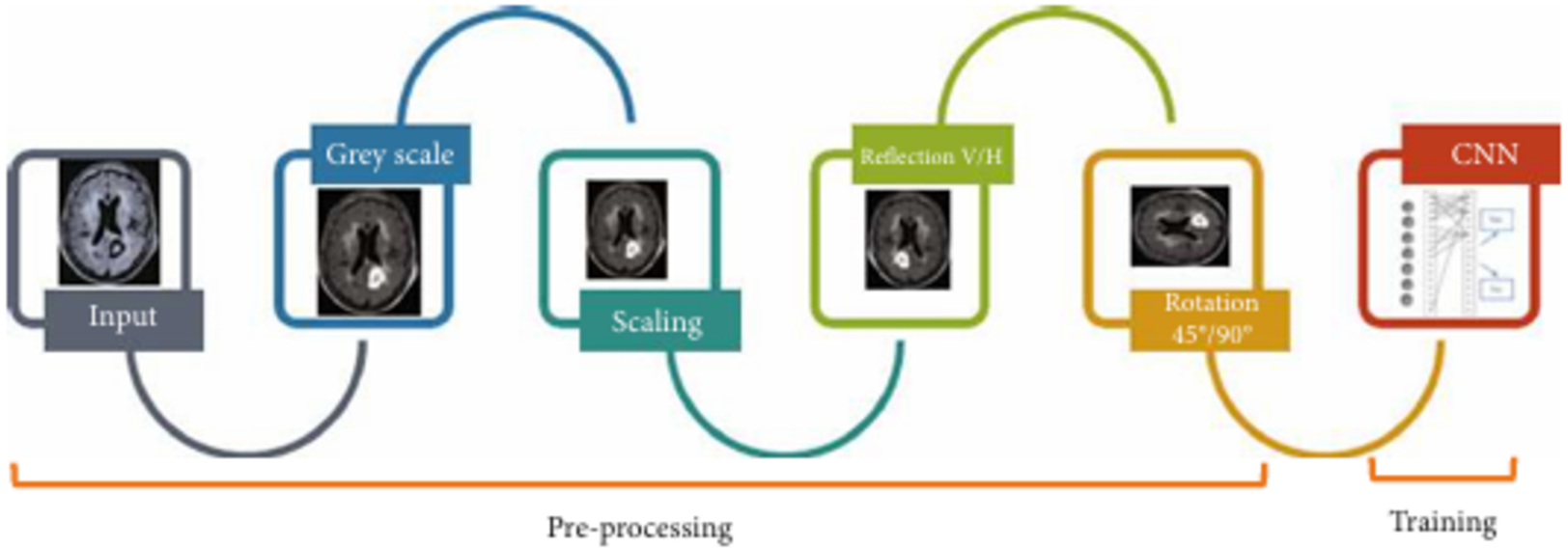


FIGURE 2: Preprocessing steps: greyscale conversion, scaling, rotation, and reflection.

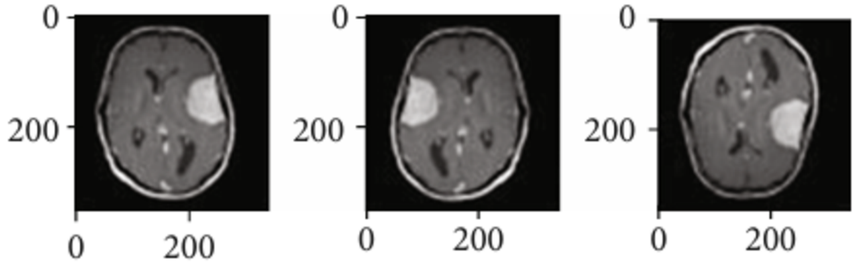


Figure 3 : Reflection on MRI images

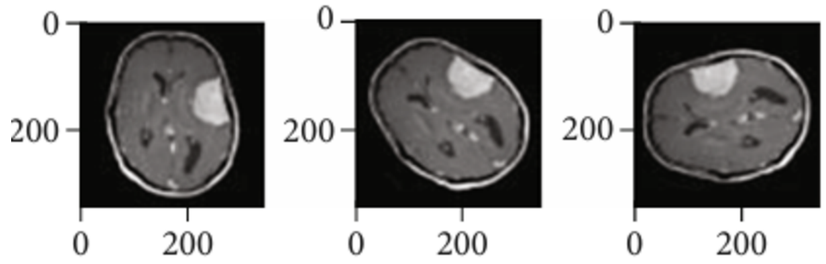


Figure 4 : Rotation on MRI images

CNN Architecture

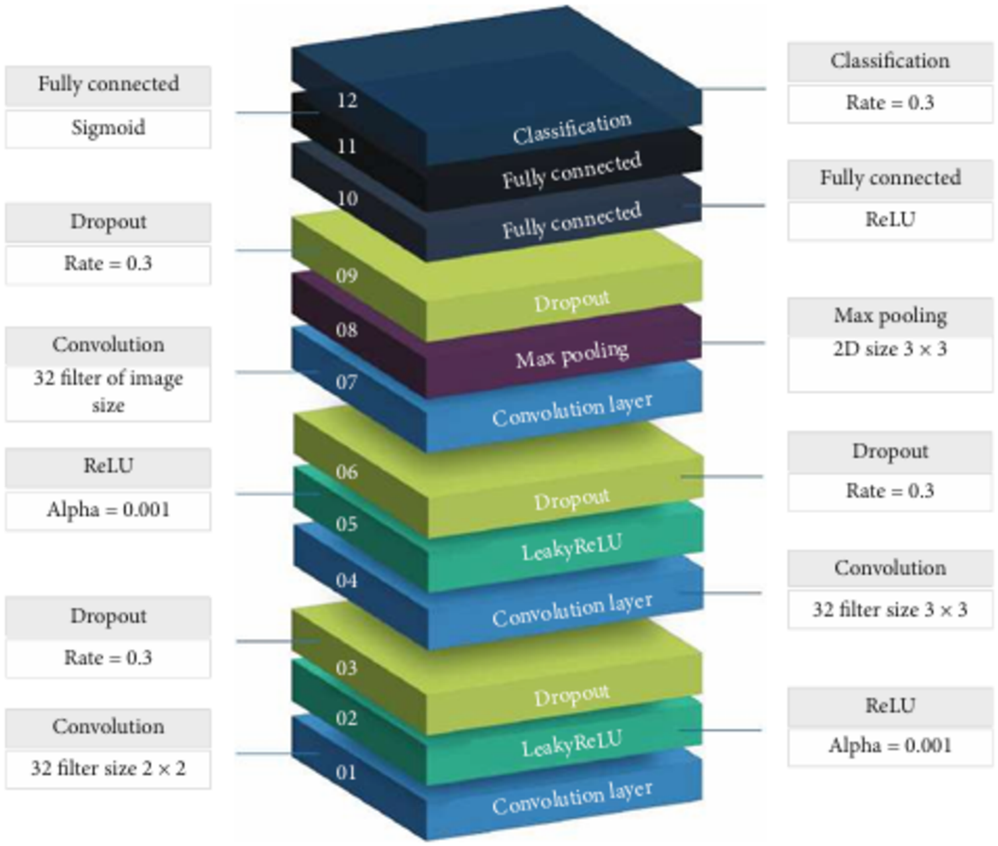


Figure 5: Layers of the proposed convolution neural network architecture.

Training Data

BR35H dataset, Sigmoid Activation Function, Learning Rate Of 0.001, Cross-Entropy Loss Function.

Table 3: Loss and accuracy trends during the gradual training of CNN model.

No. of epochs/phase	Total epochs	Loss	Accuracy
10	10	0.4711	79.36
5	15	0.3675	83.44
10	25	0.13	94.34
20	45	0.0098	98.91
20	49	0.0091	100
	65	0.0077	100

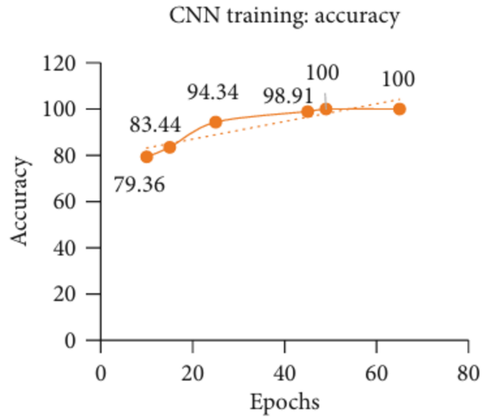


Figure 6 : Training Sccuracy Curve

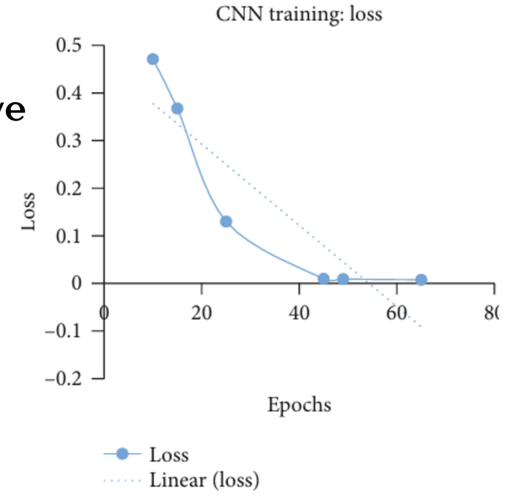


Figure 7 : Loss Curve

Testing Data

Table 4: Precision, recall, and $F_{measure}$ with $\alpha = 0.5$, for six testing datasets.

Datasets	Total	TP	TN	FP	FN	Precision	Recall	$F_{measure}$ $\alpha = 0.5$
BMI-I	171	86	80	0	5	1	0.946	0.973
BTI	20	9	**8**	1	2	0.9	0.819	0.86
BMI-II	92	86	**5**	0	1	1	0.989	0.995
BTS	140	70	**70**	0	0	1	1	1
BMI-III	171	86	**79**	0	6	1	0.935	0.968
BD-BT	671	671	**0**	0	0	1	1	1
Total	**1265**	**1008**		**1**	**14**	—	—	—

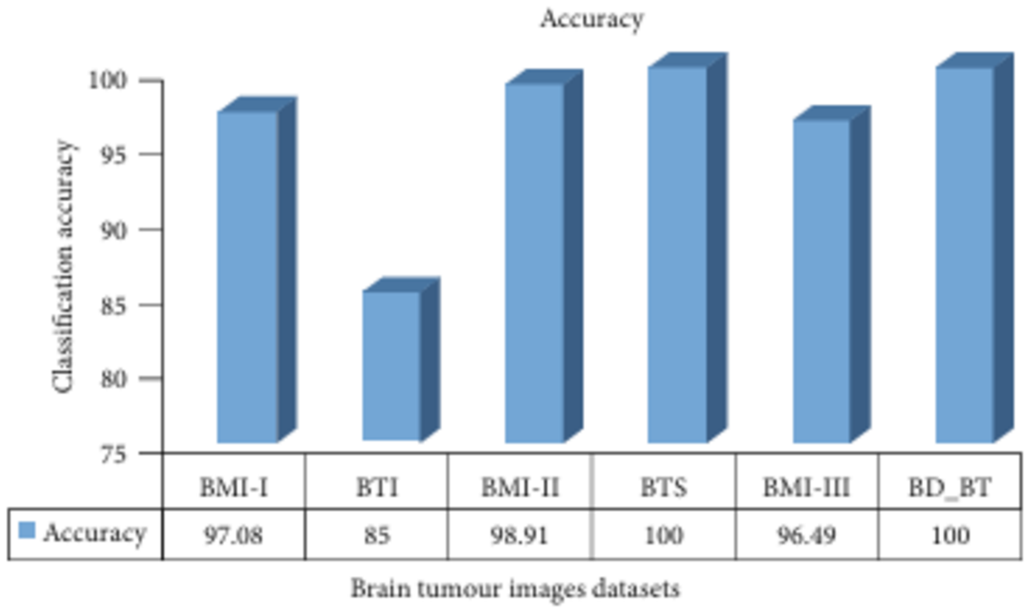


Figure 8: Accuracy of the proposed Convolution Neural Network for all the six test datasets.

Comparative Analysis with the Other Systems

Table 5: Comparative analysis of the proposed system with the other CAD systems.

Reference	Technique	Training images	Testing images	Accuracy
[38]	Random Forest Classifier	372	93	86%
[36]	CNN	2451	613	91.30%
[35]	R-CNN	2451	613	91.66%
[39]	ANN	160	40	92.14%
[34]	CNN	222	56	93.9%
[33]	CNN	400	100	96.08%
[37]	CNN	2451	613	96.13%
[41]	Support Vector Machine (SVM)	372	93	97.1%
[40]	Deep CNN (D-CNN)	372	93	98.07%
Proposed model	CNN	**510**	**1265**	**98.8%**

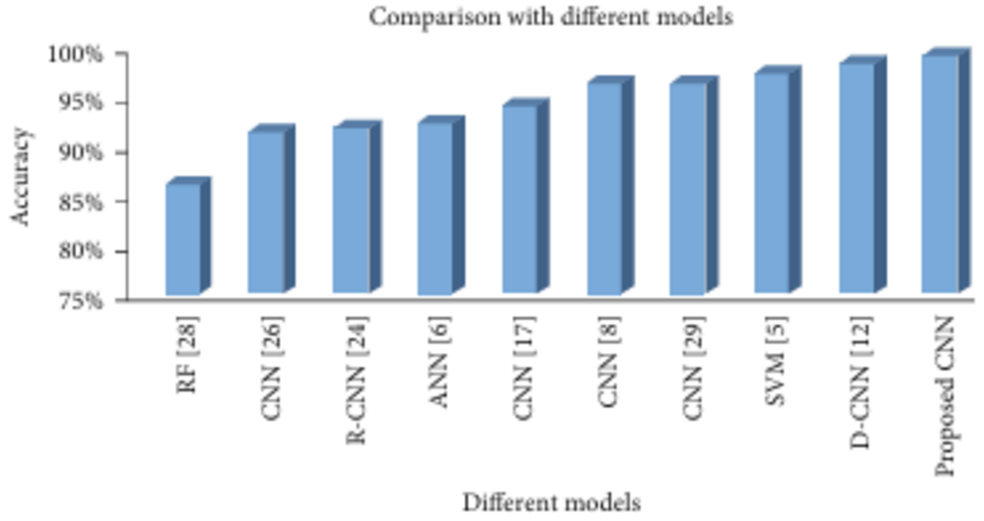


Figure 10: Comparison between the performance of the proposed CNN model and the other existing models.

CONCLUSION & Future Work

The study presents an advanced CNN model for brain tumor diagnosis, demonstrating superior accuracy. Future research may focus on refining the model with larger datasets and real-time applications.