Brian Tumor Detection in MRI Using Faster R-CNN

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Agenda

Background

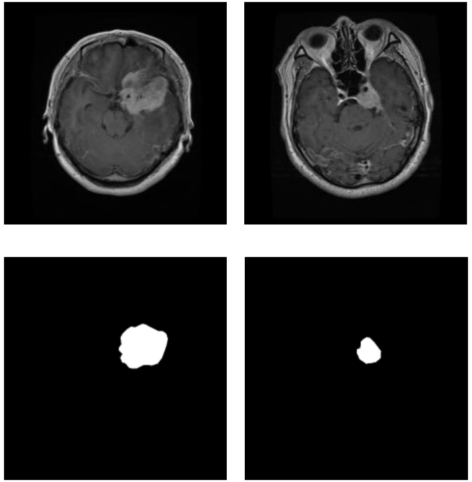
- Brain Tumor
- Object Detection in Medical Imaging
  - YOLO
  - Faster R-CNN

🎯 Objective

Accurately Detect Brain Tumors in MRI Using Faster R-CNN

Data Acquisition

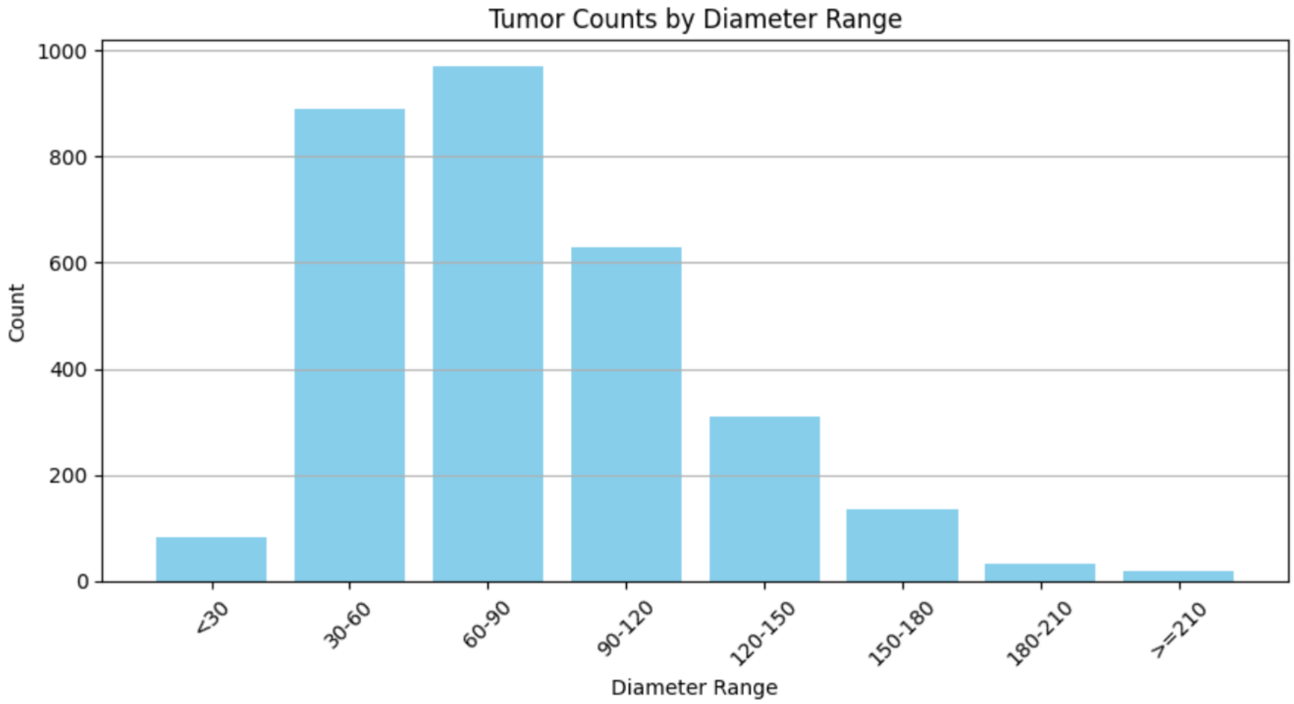
Name	Source	Samples	Data Format
Brain Tumor Segmentation	Kaggle [1] / Figshare [2]	3067	.jpg Images + Binary Mask



3D NumPy arrays (NIfTI format)

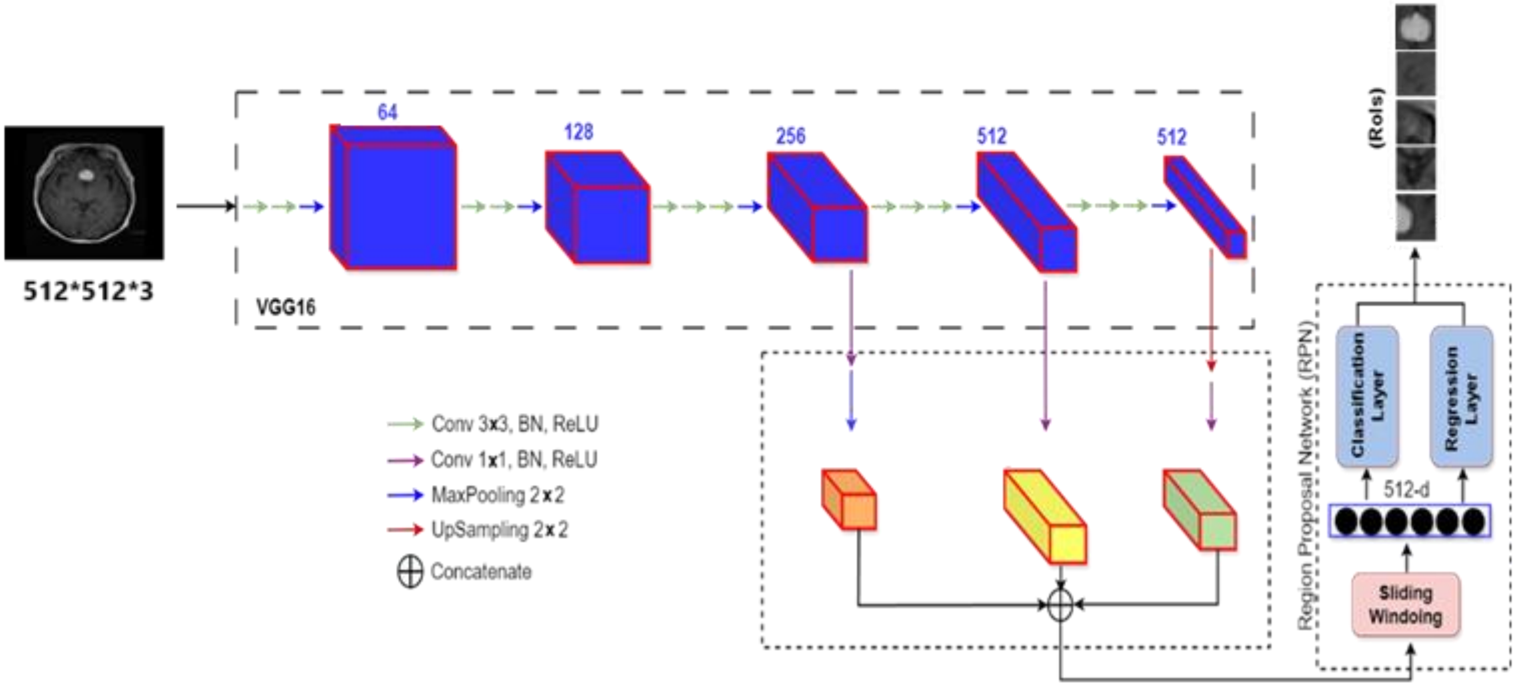
	filename	x-pos	y-pos	dia
0	1.png	323	214	113
1	10.png	268	288	74
2	100.png	198	221	90
3	1000.png	250	222	50

Data Analysis



Method: Brain Tumor Detection

Overview



Method: Brain Tumor Detection

Methodology

- **Create the anchor box list :** [(8,8),(25,25),(38,38),(58,58),(85,85),(120,120)]
- **Create RPN model using a pretrained VGG16 network**
- **Loss Functions**

$$Smooth_{L1}(x) = \begin{cases} 0.5x^2 & if\ |x| < 1, \\ |x| - 0.5 & Otherwise. \end{cases}$$

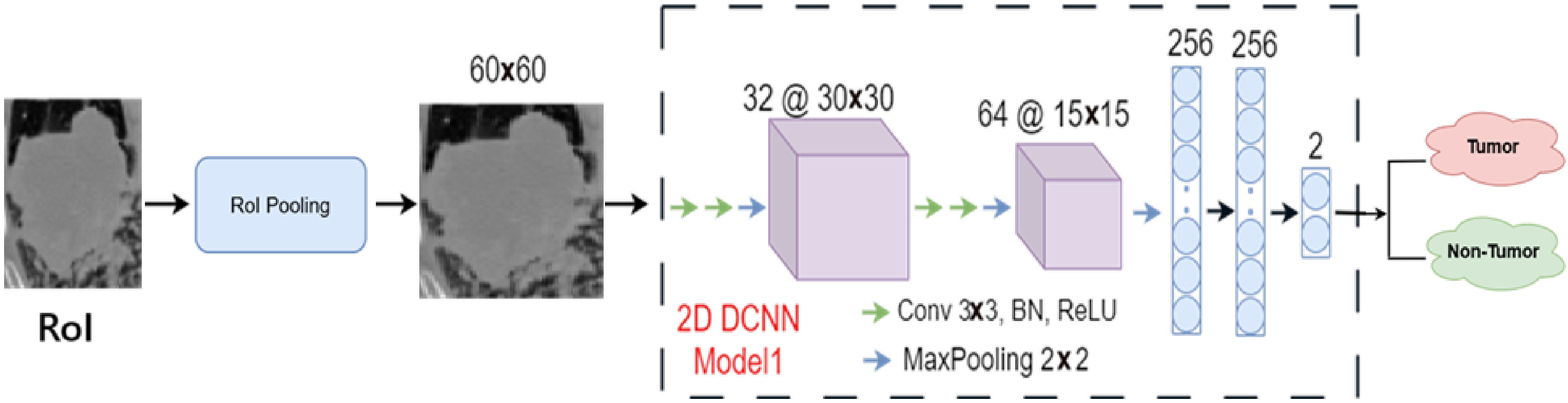
$$L_{reg}(t_i, t_i^*) = \frac{1}{N_{reg}} \sum_i P_i^* . Smooth_{L1}(t_i - t_i^*)$$

$$L_{clc}(P_i, P_i^*) = -\frac{1}{N} \sum_i [P_i^* \log(P_i) + (1 - P_i^*) \log(1 - P_i^*)]$$

$$L = \frac{1}{N_{clc}} \sum_i L_{clc}(P_i, P_i^*) + \lambda \frac{1}{N_{reg}} \log(P_i) \sum_i L_{reg}(t_i, t_i^*)$$

Parameters for training RPN	
Data	Train(85%) Validation (10%) Test (5%)
Optimizer	Adam
Batch size	8
Learning Rate	0.0001
Weight Decay	0.000001
Tools	Pytorch, Nibabel Matplotlib, GPU, …

Method: False Positive Reduction



Results : Metrics

$$\text{IoU} = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$

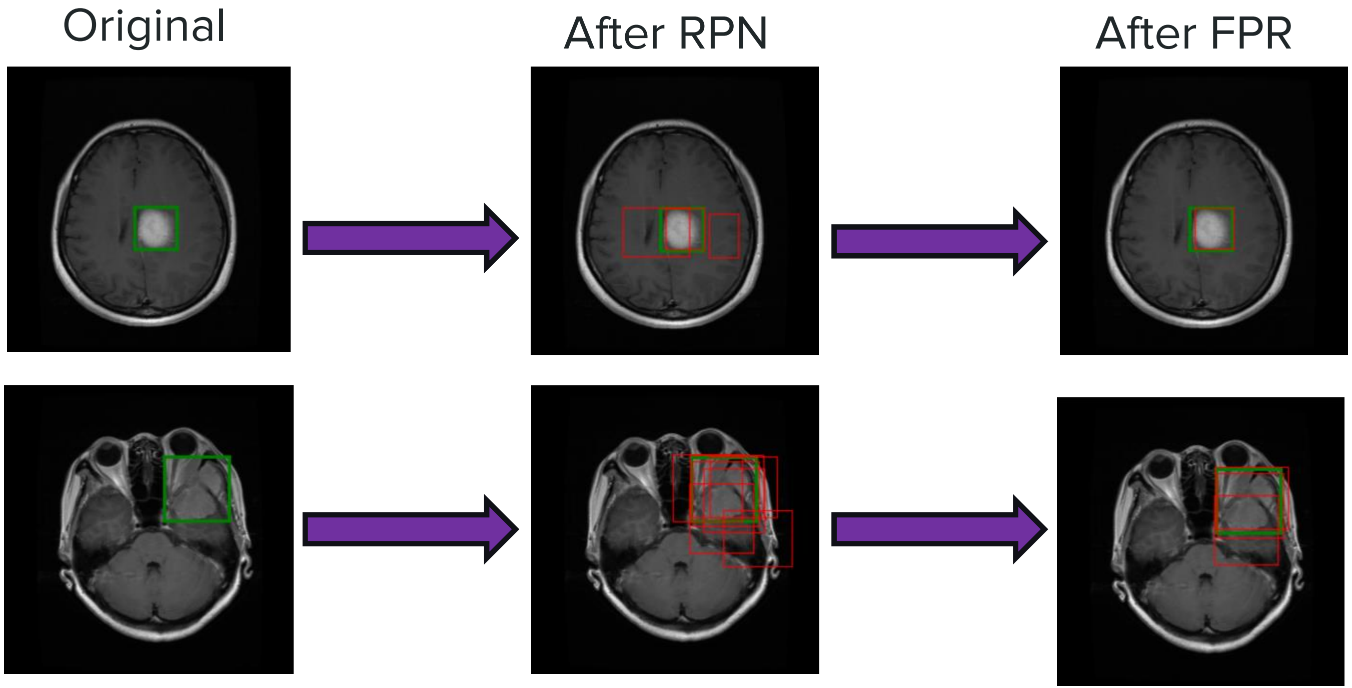
$$\text{Sensitivity} = \frac{TP}{TP+FN}$$

$$\text{Precision} = \frac{TP}{TP+FP}$$

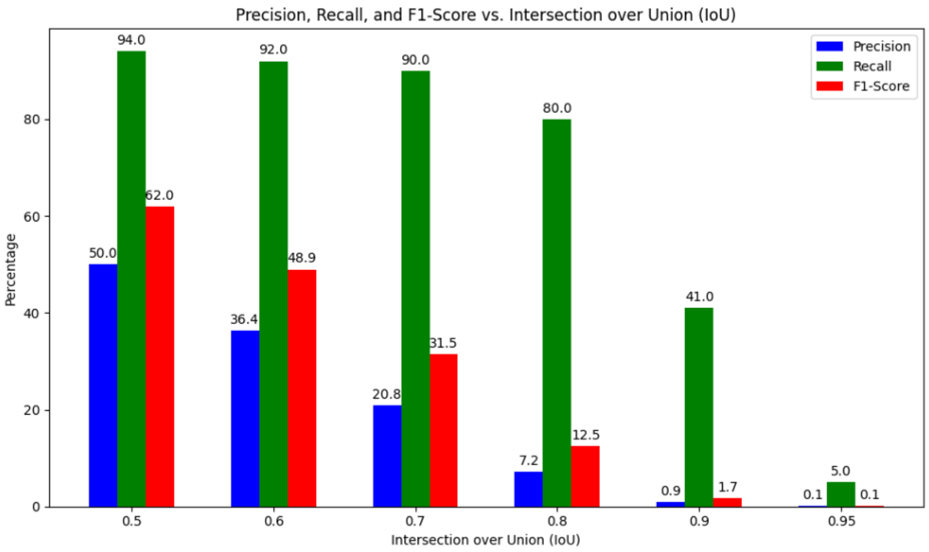
$$\text{F1 Score} = 2 * \frac{\text{Precision * Sensitivity}}{\text{Precision + Sensitivity}}$$

FROC Curve = sensitivity vs. false positives per image

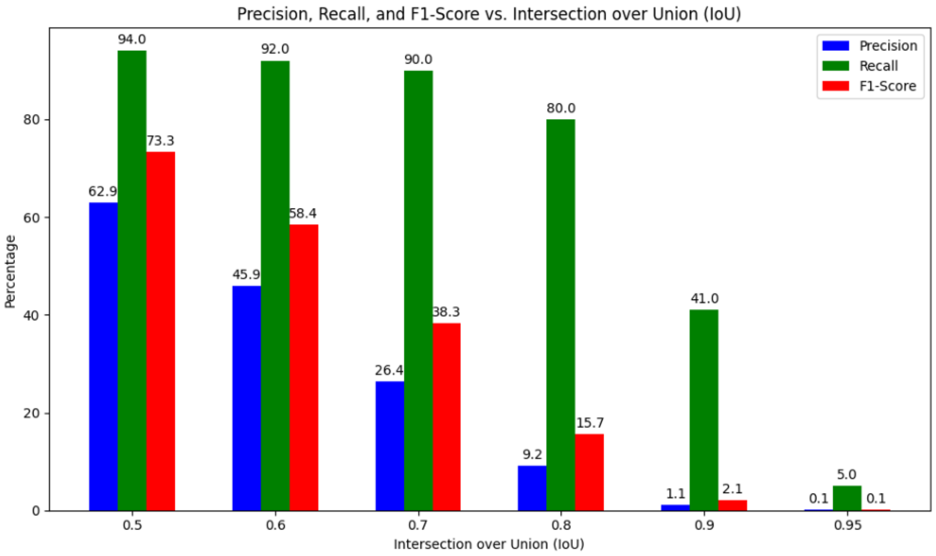
Results



Results

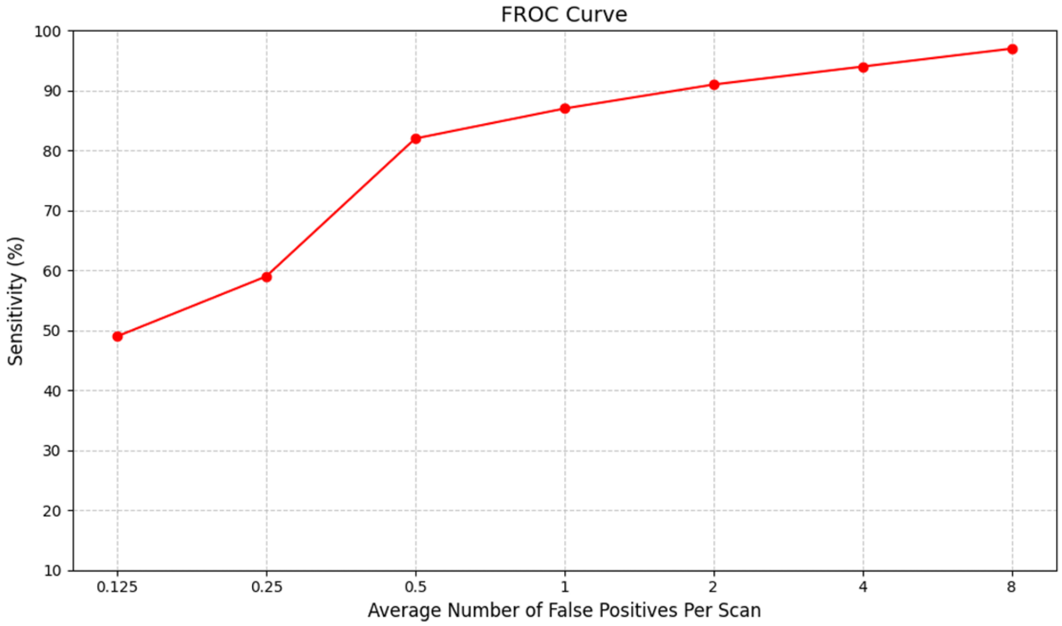


Precision, Recall, and F1-Score with 100 Predicted Bounding Boxes



Precision, Recall, and F1-Score with 100 Predicted Bounding Boxes after FPR Stage.

Results



FROC Curve for Proposed Model .

Deliverables

📁 GitHub Repository

– Source code (model, training, evaluation)
– ReadMe with setup instructions

🧠 Jupyter Notebooks

– Preprocessing, training, and evaluation steps
– Visualizations of predictions vs. ground truth

📄 Project Documentation

– Methodology and tool descriptions
– How to retrain or adapt the model

Conclusion

- This study presents an effective method for brain tumor detection using MRI images.
- It integrates a Region Proposal Network (RPN) with feature maps derived from the pretrained VGG16 model.
- By combining the last three layers of VGG16, we enhance feature map resolution, improving tumor detection accuracy.
- The RPN generates region proposals, which are refined using a 2D Deep Convolutional Neural Network (DCNN) for false positive reduction.
- This method is a valuable tool for brain tumor detection, providing more reliable and precise tumor identification.

Future work

- **Optimizing the anchor shape using metaheuristic algorithms**

References

[1] Brain Tumor Segmentation Dataset (Kaggle version). https://www.kaggle.com/datasets/navoneel/brain-mri-images-for-brain-tumor-detection

[2] Cheng, J. (2017). *Brain Tumor Dataset*. Figshare. https://figshare.com/articles/dataset/brain_tumor_dataset/1512427

[3] Bhanothu Y, Kamalakannan A, Rajamanickam G. Detection and classification of brain tumor in MRI images using deep convolutional network. In2020 6th international conference on advanced computing and communication systems (ICACCS) 2020 Mar 6 (pp. 248-252). IEEE.

[4] Ezhilarasi R, Varalakshmi P. Tumor detection in the brain using faster R-CNN. In2018 2nd International Conference on, 2018 2nd International Conference on 2018 Aug 30 (pp. 388-392). IEEE.

[5] Zamanidoost Y, Alami-Chentoufi N, Ould-Bachir T, Martel S. Efficient Region Proposal Extraction of Small Lung Nodules Using Enhanced VGG16 Network Model. In2023 IEEE 36th International Symposium on Computer-Based Medical Systems (CBMS) 2023 Jun 22 (pp. 483-488). IEEE.

Thank you for your attention!

Questions?