Mind the Clot: Automated LVO Detection on CTA using Deep Learning

Shubham Kumar[1], Arjun Agarwal[1], Satish Golla[1], Swetha Tanamala[1], Ujjwal Upadhyay[1], Subhankar Chattoraj[1], Preetham Putha[1], Sasank Chilamkurthy[1]

[1]Qure.ai, Mumbai, India

Abstract

- Stroke is a major global health concern, emphasizing the critical need for timely diagnosis and intervention. Large vessel occlusions (LVOs) in stroke cases demand swift detection to improve patient outcomes. Traditional diagnostic methods face challenges, including inter-reader variability and time constraints. Leveraging deep learning, our study introduces a robust automated solution for LVO detection from computed tomography angiography (CTA) scans.
- Our model achieves high accuracy, rapid results, and eliminates the need for extensive manual annotation, addressing critical limitations in stroke diagnosis and management.

Problem Statement & Goal

- In stroke evaluation, CTA scans are commonly used to assess the head and neck region. Our primarily focus on to detect LVO in the head, including the cervical segment of ICA.
- To differentiate between ICA LVO and MCA LVO, we need distinct models.
- For MCA occlusions, we must address the noise contributed by the venous phase contamination caused by delayed acquisition. [3]
- To detect ICA occlusion, we have to avoid skull stripping methods, as it leads to incomplete visualisation of ICA vessels, due to their similar Hounsfield Unit (HU) intensity values with surrounding structures. [1]
- Our goal is to achieve rapid and accurate results, requiring less complex models.

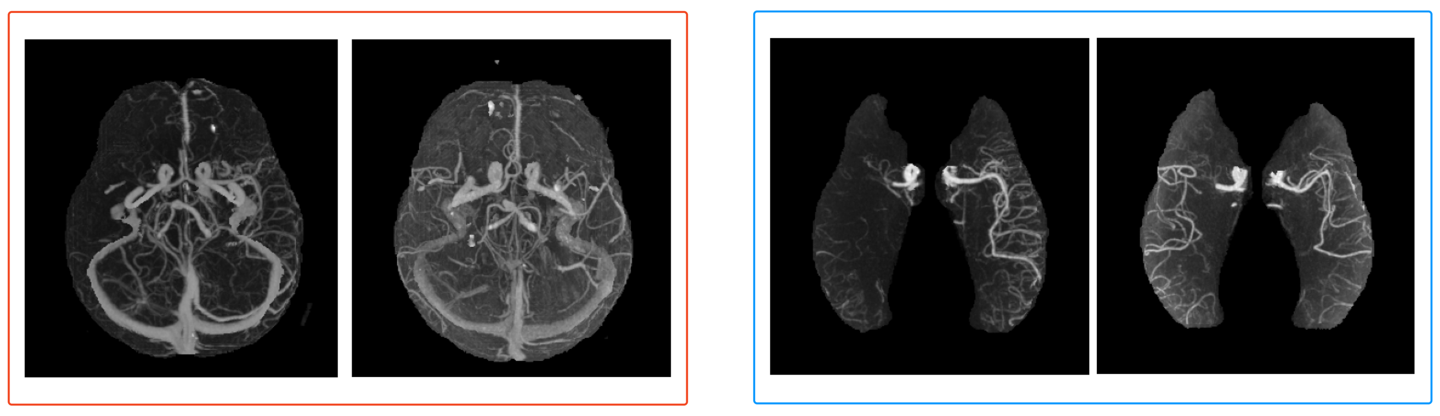

Fig. 1: MIP of ICV showing venous phase and vessel overlap vs MIP showing MCA vessels only

Methodology

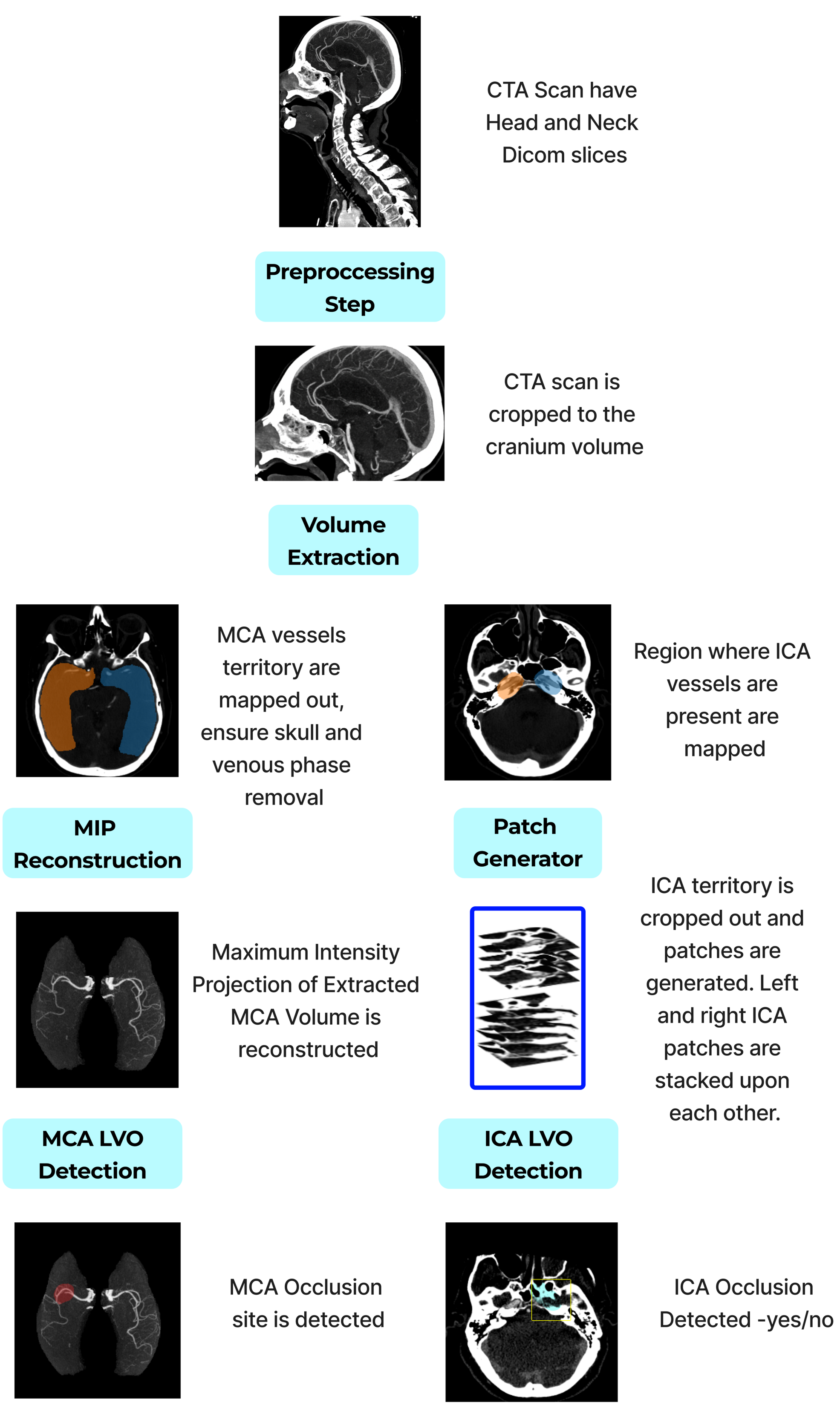

Fig. 2: CTA LVO Detection Algorithm

MCA LVO Detection

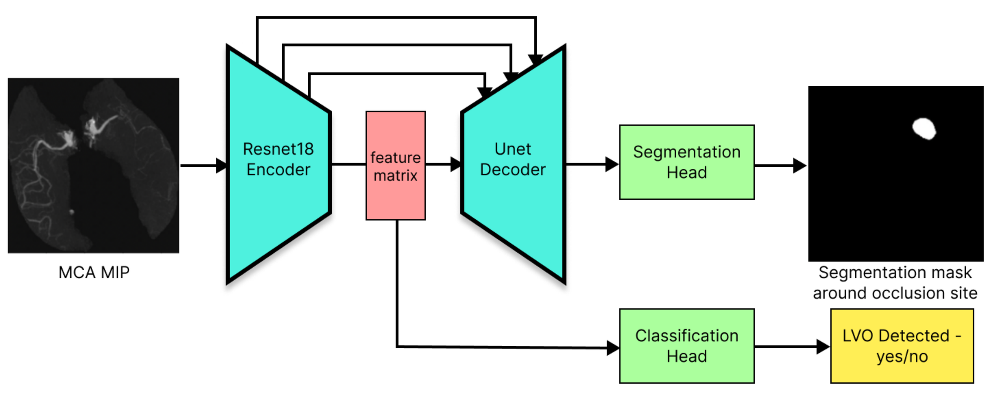

Fig. 3: Used architecture in MCA LVO Detection model [2] [4]

ICA LVO Detection

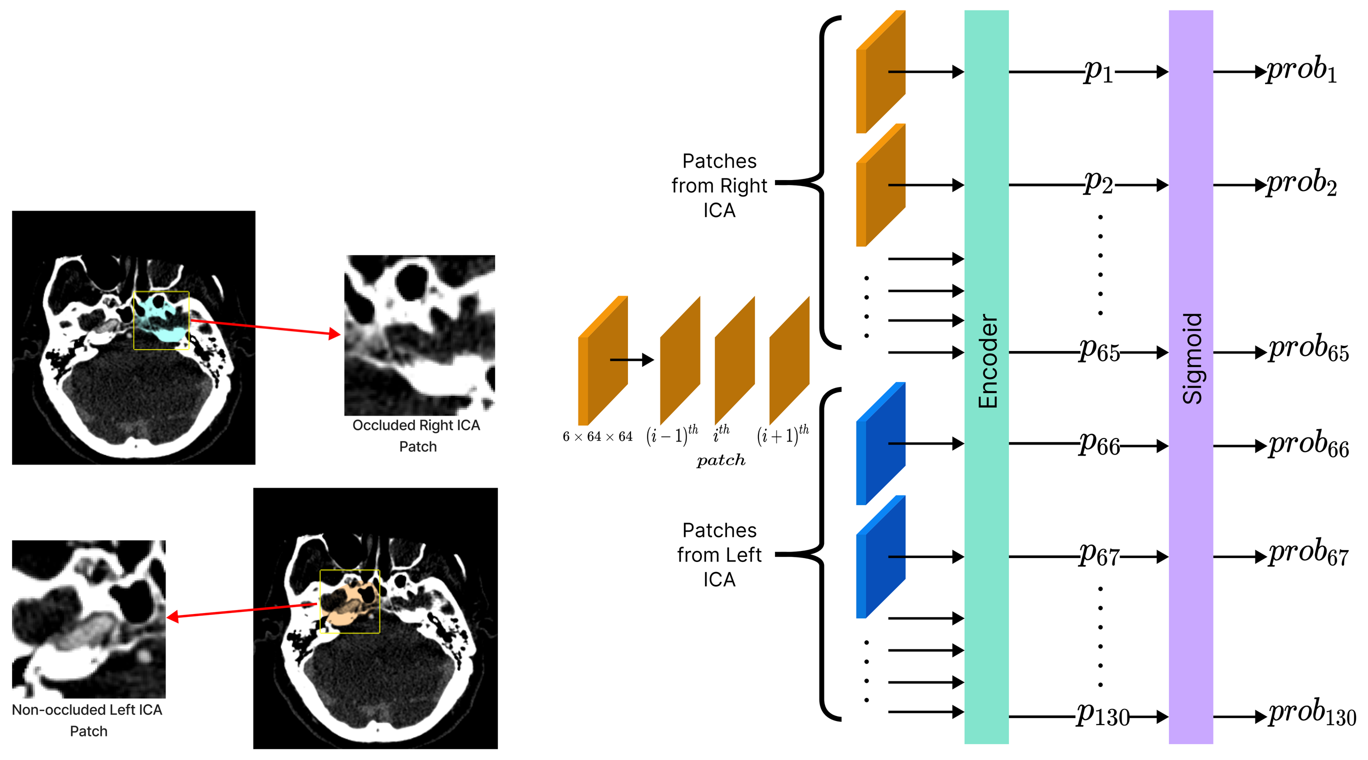

Fig. 4: ICA Patch Extraction (left side) and Architecture Used in ICA LVO Detection Model (right side)

Results and Discussion

Dataset	MCA		ICA	
	Positive	Negative	Positive	Negative
Train	831	3837	250	507
Val	170	1119	93	64
Test	372	538	256	538
Total	1373	5494	599	1209

Table 1: Dataset Distribution

MCA LVO Detection			
Task	**Sensitivity**	**Specificity**	**DSC**
ICV MIP Classification	0.65	0.67	-
MCA MIP Classification	0.76	0.77	-
MCA MIP Classification + Segmentation	0.85	0.86	0.86
MCA MIP Classification + Segmentation (Tilt corrected)	0.88	0.91	0.90
ICA LVO Detection			
ICA Per Scan Classification	0.93	0.94	-

Table 2: Performance Evaluation based on Test Set

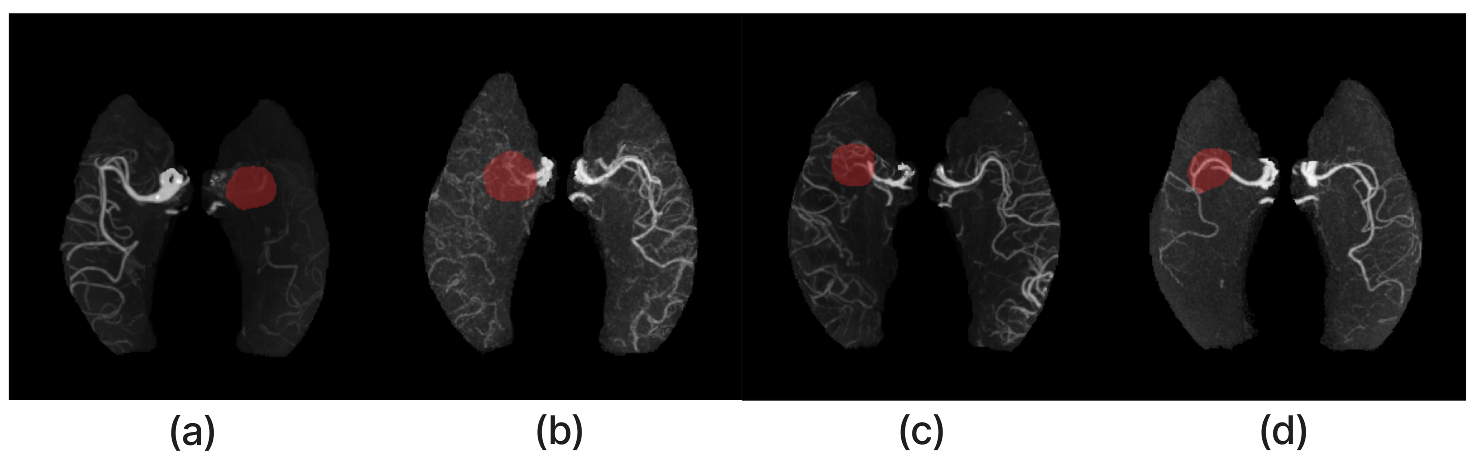

Fig. 5: Some examples of MCA LVO detection model output (a) complete occlusion on the left side of the brain, (b) occlusion at the ICA terminus, (c) occlusion in M1 segment of MCA branch, (d) proximal M2 occlusion

Conclusions

- In conclusion, our proposed solution utilizes deep-learning models to automate the identification of large vessel occlusions (LVOs) in acute ischemic stroke (AIS) patients from CTA scans. This approach reduces inter-observer variability and enhances stroke care efficiency.
- To strengthen our models, we aim to validate and improve their generalizability by testing them on larger and more diverse datasets. This will refine their performance and reliability. Additionally, we plan to extend their capabilities to detect distal occlusions further enhancing their usefulness in stroke diagnosis and treatment.

References

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