Brain Stroke Analysis from Non-Contrast Brain CT and Path-planning for Robot-assisted Thrombectomy

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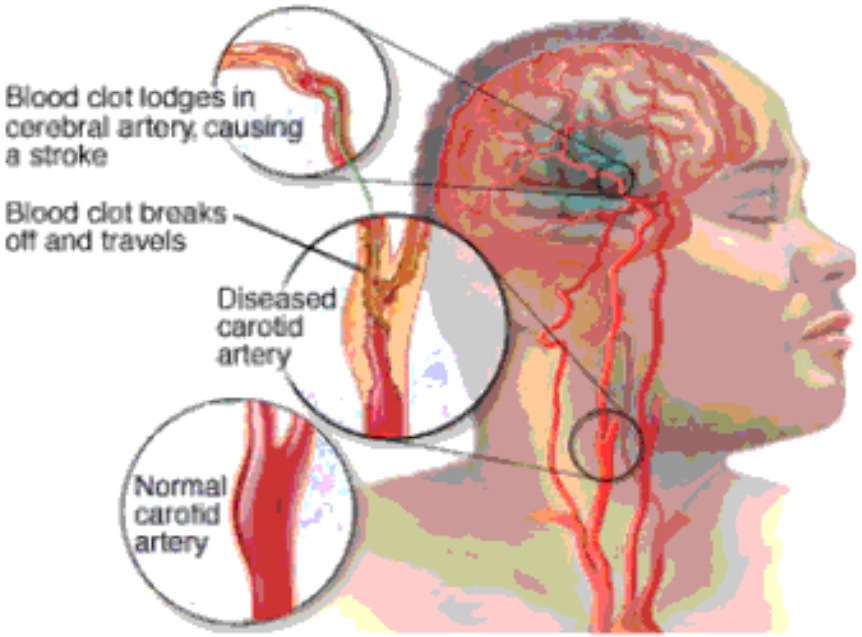
Background

- A stroke is a medical emergency. Prompt treatment is crucial to reduce brain damage and other complications.
- There are *two prominent causes of stroke*: a blocked artery (**ischemic stroke**), or leaking or bursting of a blood vessel (**hemorrhagic stroke**).



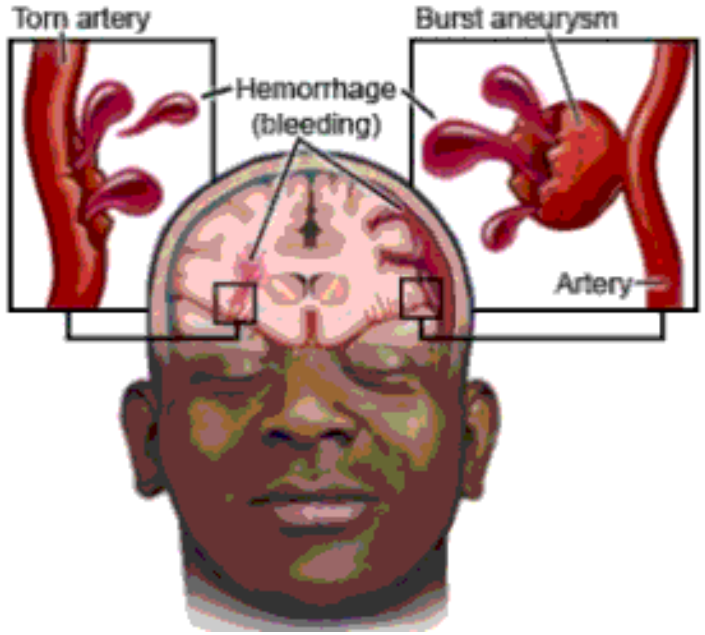


Figure: Depiction of brain strokes.

Problem Statement

Module A: Detect and localize stroke regions on NCCT volumes

- Context-aware segmentation of stroke regions.
- 2D and 3D feature fusion for multi-dimensional processing.
- Rendition of stroke and brain as 3D visualization.
- Potentially, make quantitative measurements to aid *module B*, if relevant metadata is available.

Module B: Perform path-planning for robot-assisted surgical intervention

- Assistive intervention using a 6-DOF robotic arm.
- Path-planning using Reinforcement Learning (RL).
- Specific focus on smooth operation in a precision setting.

Solution Architecture

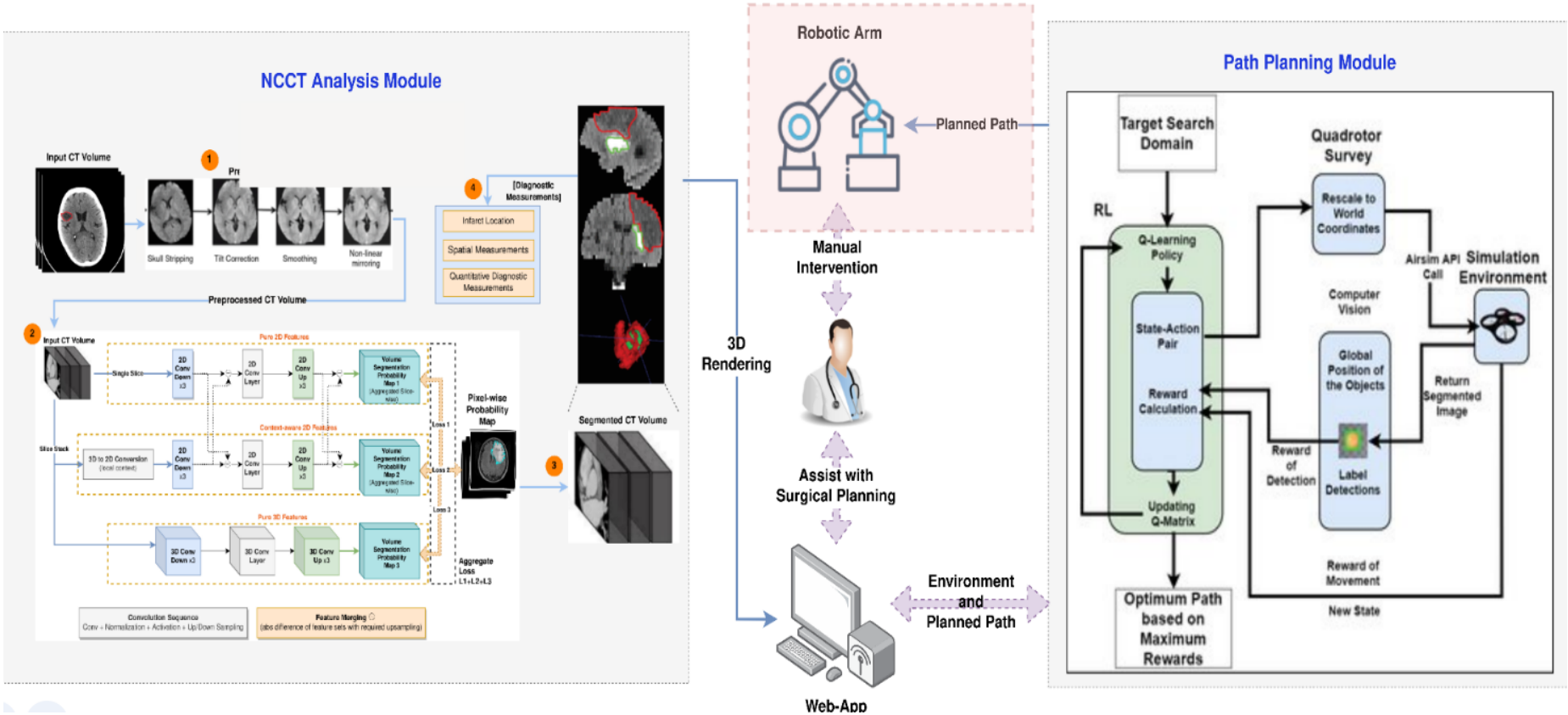
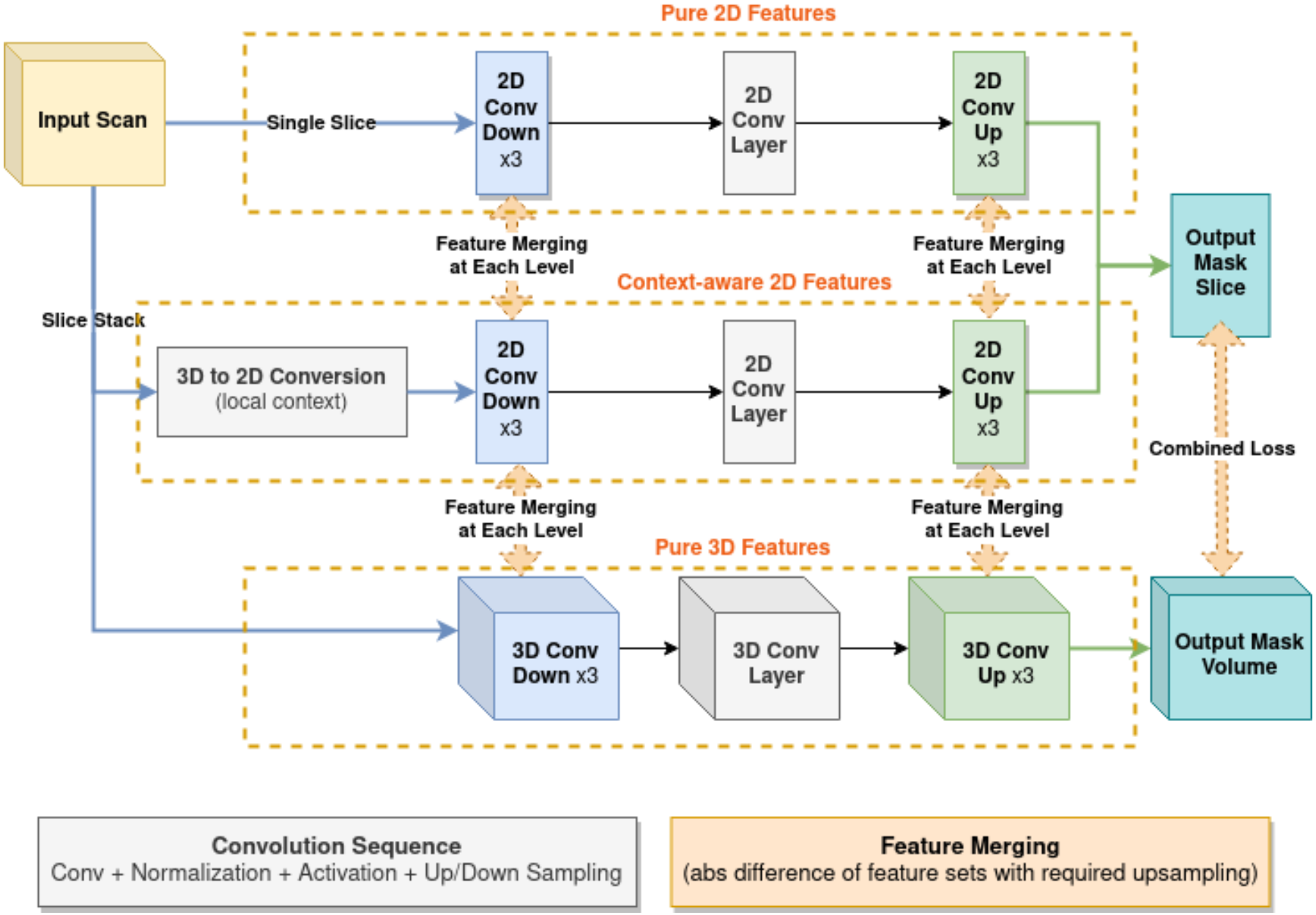


Figure: Architecture of the proposed solution.

Proposed Segmentation Network



Stroke Infarct Segmentation Approaches

Table: Comparison of segmentation approaches on open-access datasets.

Approach	**Backbone**	**Dataset**	**DSC**	**Mean IoU**	**AuROC**
FPN	EffNet-B0	Peer-Reviewed Open-Access Intracranial Hemorrhage Dataset [1]	41.18%	28.20%	-
UNet	EffNet-B0		46.73%	30.42%	-
PSPNet			40.21%	27.51%	-
DeepLabV3+			33.82%	17.43%	-
Best UNet *			44%	27.5%	-
ChanVese [2]*			70%	-	-
M-Net			70.41%	59.95%	86.13%
Proposed			**76.11%**	**64.52%**	**89.15%**

*reported results from literature

Demo (cont.)

NCCT Analysis Module

- Qualitative analysis of results [Link].
- Prediction workflow [Link].
- Web-app for 3D segmentation demo [Link].

Path-planning Module

- Comparison of Deep-RL and Q-Learning [Link].
- Result representation of Q-Learning [Link].
- Web-app to assist robotic surgery for neurosurgeons [Link].