

ART 3.5D: AN ALGEBRAIC RECONSTRUCTION TECHNIQUE TO RECOVER 4D CONTRAST DYNAMICS FROM 3D BRAIN ANGIOGRAPHIES

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1. Abstract

Several neurosurgical procedures require accurate reconstruction of the cerebral vascular tree, as well as the classification of arteries and veins, to increase the safety of the intervention. We propose ART-3.5D, a novel approach to recover the dynamic information from standard Cone Beam Computed Tomography Angiography scans based on the post-processing of both the segmented angiogram and the raw data-set. The method was applied to five datasets for which a measure of the sensitivity, specificity and accuracy with respect to two ROIs manually segmented is given.

2. Clinical background and aims

- Arteries main organs at risk in surgical planning and navigation;
- Necessity to label the angiograms in the field of cerebrovascular diseases diagnosis and treatment;
- Aims of this study is the labeling of arteries and veins in 3D brain angiography based on the extension of standard ART for contrast dynamics information recovery;

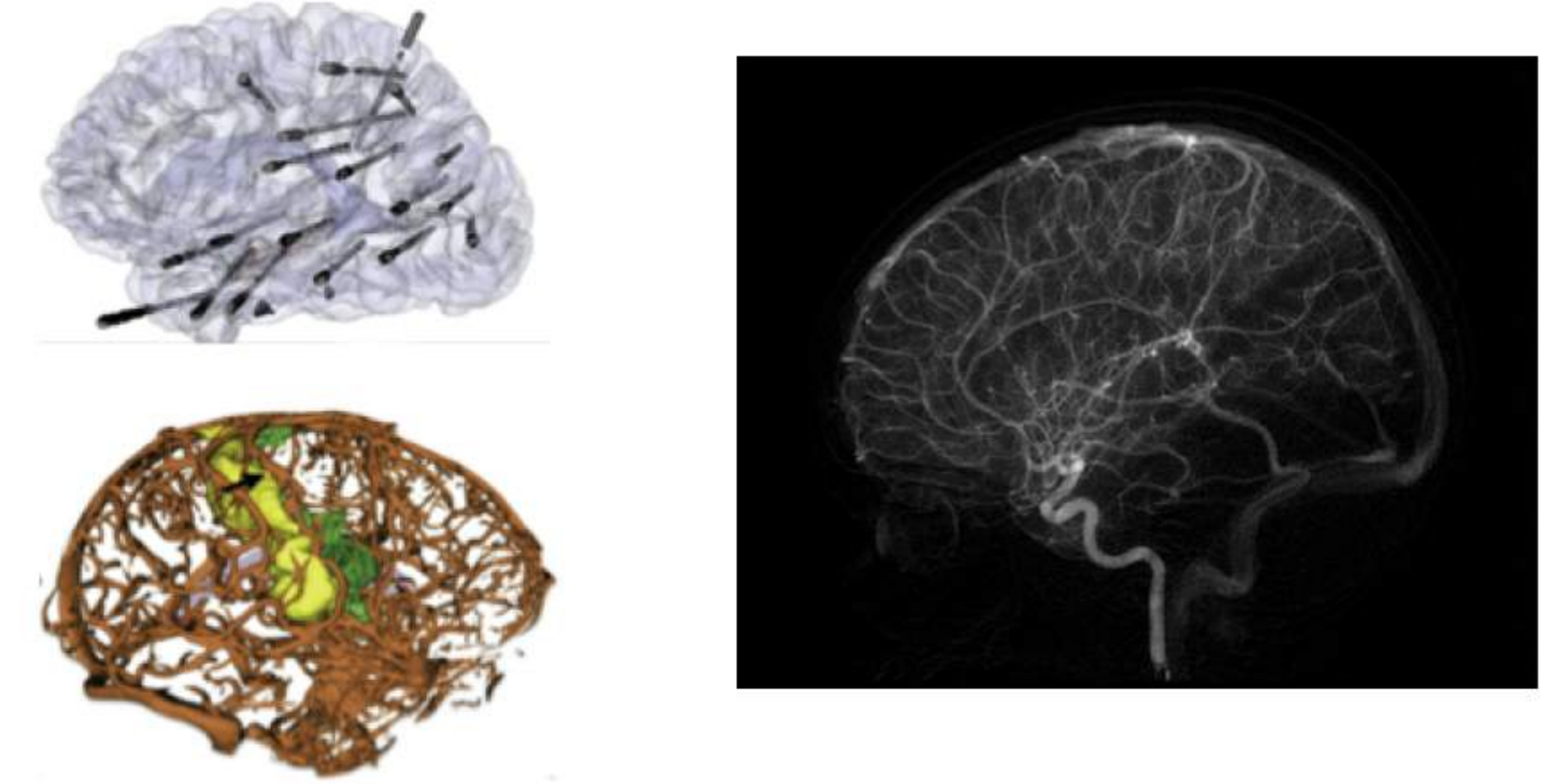


Fig. 1: On the left, possible clinical scenarios are presented (SEEG, AVMs diagnosis [1]). On the right a raw data view with contrast dynamic enhanced.

3. Methodology workflow

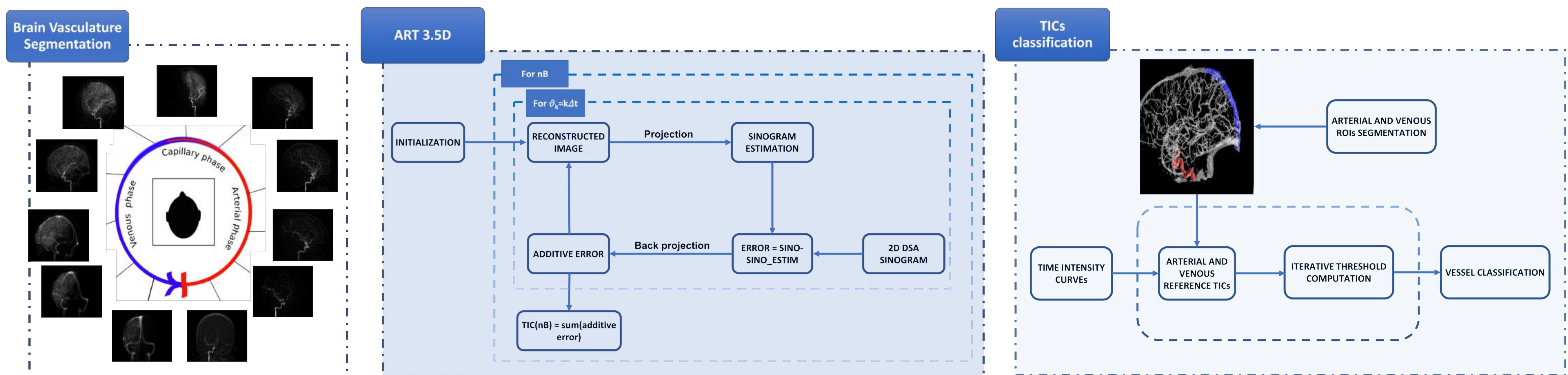


Fig. 2: ART3.5D is a voxel-wise classification algorithm which require brain vessel tree segmentation both in the projection and volume domains as inputs. The output of ART3.5D is a series of Time Intensity Curves which are classified according to a threshold iteratively computed and which allows the labelling of arteries and veins.

4. Evaluation protocol

- Five raw datasets (volume size: 384×1024 pixels for 391 views) were analyzed;
- The scans were acquired with an Oarm 1000 System (Medtronic) before and after the Contrast Medium injection;
- Two $18.26 \times 18.26 \times 8.33$ mm Regions Of Interest (ROIs) including large-diameter artery or vein are segmented manually and used as ground truth to compute SE, SP, ACC indexes;

6. Conclusions

1. A semi-automated voxel-wise classification of brain arteries and veins was proposed
2. A limitation of the proposed study could be seen in the low quality of the projection data which result to be strongly affected by beam-hardening
3. As future work, the introduction of a refined preprocessing pipeline with the aim to increase the quality of the DSA in both volume and projection domain.

5. Results

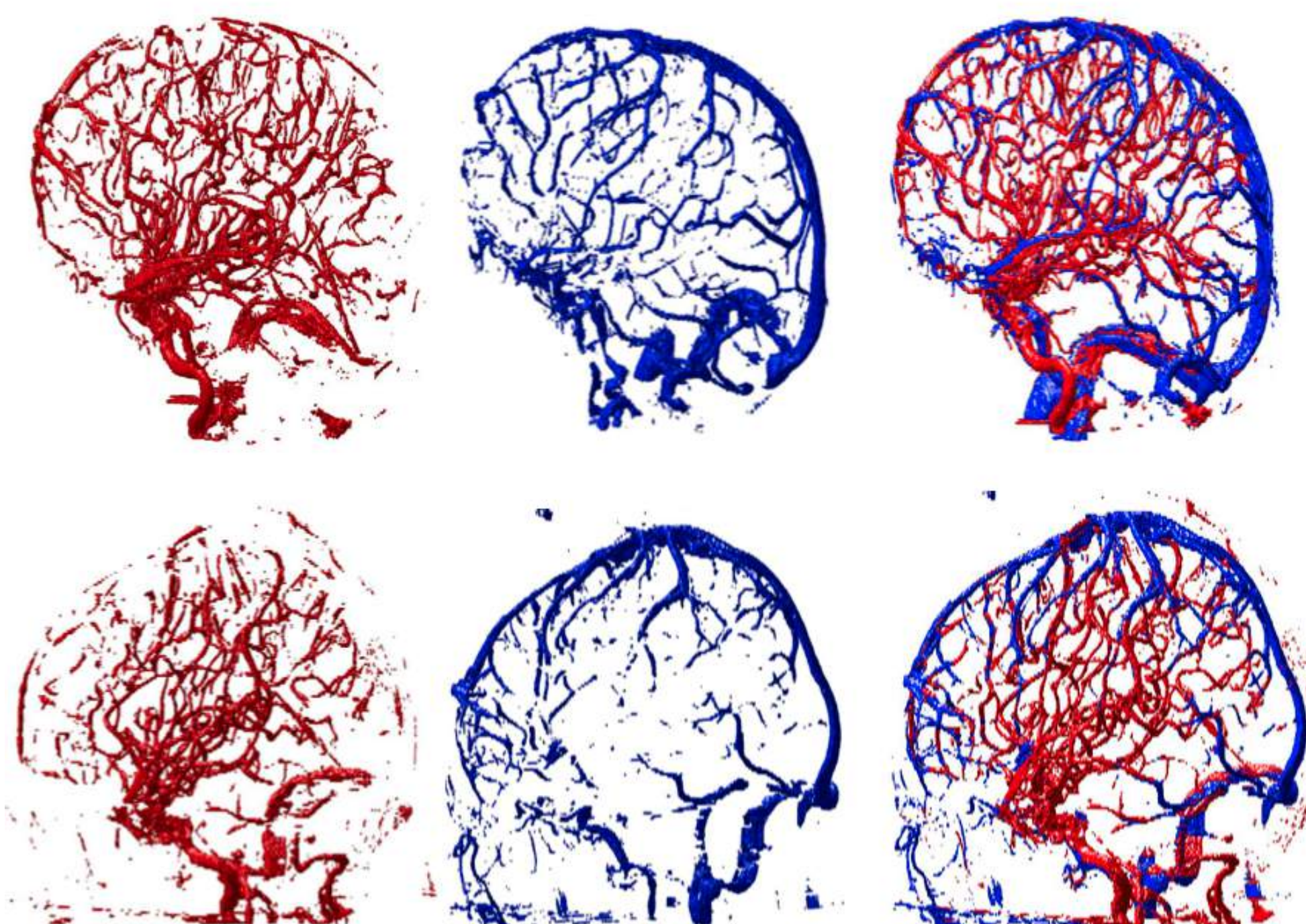


Fig. 3: The figure shows the venous tree (blue) and the arterial tree (red)

Dataset	SP [%]	SE [%]	ACC [%]
Patient 1	98.08	95.88	97.17
Patient 2	99.24	95.58	97.61
Patient 3	92.85	94.06	93.24
Patient 4	97.02	92.20	95.26
Patient 5	97.83	88.35	94.13

Fig. 4: Table reporting SE, SP, ACC

7. Acknowledgement

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8. References

- [1] F. Cardinale and et al., "Cerebral angiography for multimodal surgical planning in epilepsy surgery: description of a new three-dimensional technique and literature review," *World neurosurgery*, 2015.