VOLUME OF INTEREST GUIDED SOURCE-DETECTOR TRAJECTORY FOR DENTAL CBCT FIELD OF VIEW EXPANSION

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BACKGROUND

- Cone beam computed tomography (CBCT) 3D imaging technique is widely used in dentistry whose main applications are in diagnostics and dental & oral surgeries.
- Small standard CBCT units are the most popular imaging devices in dental clinics however, due to their small size, these CBCT units can only rotate isocentrically, resulting in a limited field of view (FOV).
- The aim of this study is to algorithmically extend the FOV of the small device by introducing a novel source-detector trajectory with a moving isocentre.

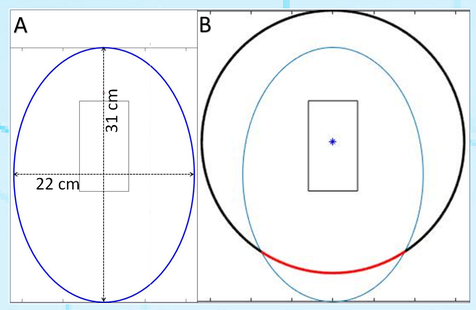

Figure 1 – **A:** The elliptical headspace of the device and the rectangular iso-centre moving region. **B:** The circular trajectory, black arc: valid positions, red arc: invalid positions

- **Image Reconstruction Conditions:** The trajectory needs to have diverse projection directions, sufficient angular coverage while satisfying the Tuy's condition for a successful reconstruction[1]. According to the Tuy's condition, each plane that traverses the object being imaged must also cross the X-ray source's (focal trajectory) path in order for a correct image to be reconstructed[2].

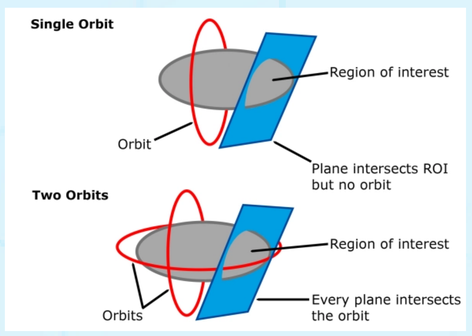

Figure 2 – Tuy's condition

- **Algorithm and Tools:** The simulated projections were reconstructed using Ordered-Subset Simultaneous Algebraic Reconstruction techniques (OSSART) and Adaptive Steepest Descent Projection Onto Convex Sets (ASDPOCS) algorithm in Tomographic Iterative GPU-based Reconstruction (TIGRE) toolkit.
- **Imaging Phantom:** An anthropomorphic head phantom with a naso-occipital length of 17 cm and a cranial width of 14 cm was used as digital phantom for the simulation of 2D projections of CBCT corresponding to different possible trajectories.

METHODOLOGY

- **Trajectory Search Space:**

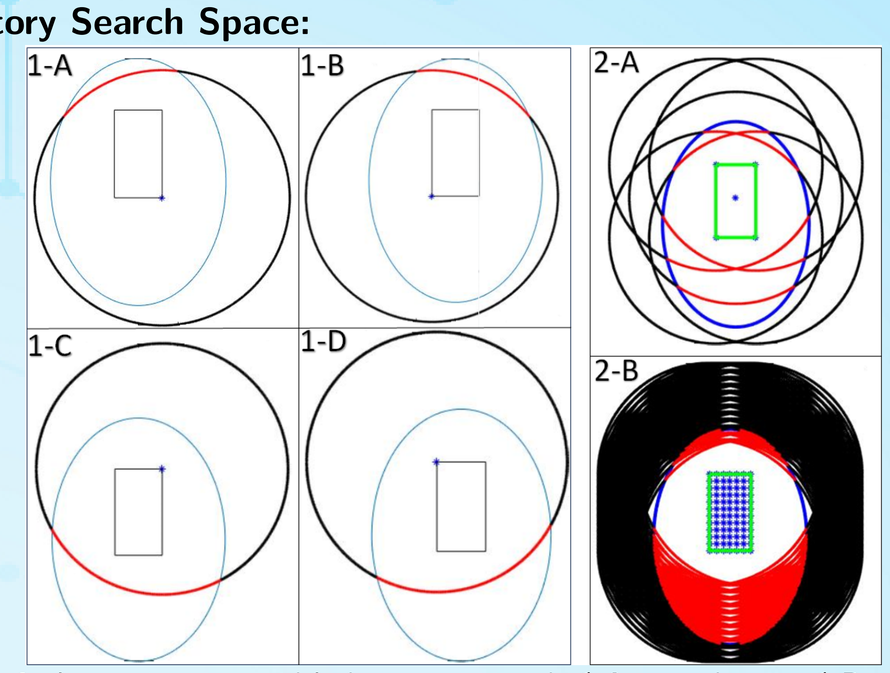

Figure 3 – Iso-centric trajectory while the iso-centre is at the **1-A:** rear-right corner **1-B:** rear-left corner **1-C:** front-right corner **1-D:** front-left corner of the iso-center moving region. Combined trajectories considering **2-A:** the corner points **2-B:** all possible points(at 1cm sampling)(This defines the search space)

- **VOI-guided Trajectory:**

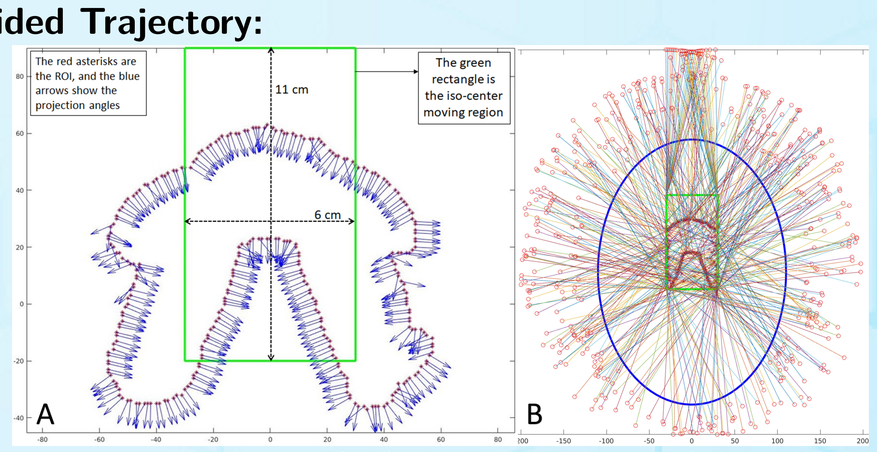

Figure 4 – **A:** The volume of interest (VOI); **B:** VOI-guided trajectory.(The straight lines connect the estimated iso-centres and the detector's positions)

RESULT

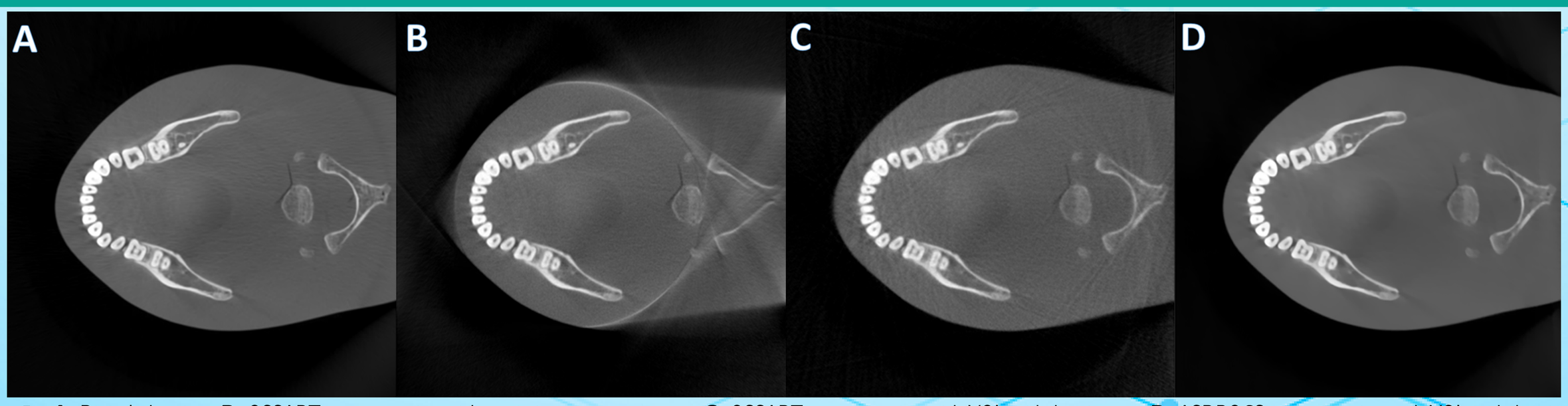

Figure 5 – **A:** Digital phantom, **B:** OSSART reconstruction with static iso-centre trajectory, **C:** OSSART reconstruction with VOI-guided trajectory, **D:** ASDPOCS reconstruction with VOI-guided trajectory

- The FOV of the standard circular trajectory is a circle of **11 cm** in the axial plane. With the VOI-guided trajectory, a FOV of **16.5 cm** along the naso-occipital and **14 cm** cranial width was achieved with **98%** and **98.5%** SSIM score for **OSSART** and **ASDPOCS** reconstructed images respectively.

CONCLUSION

- The proposed trajectory could achieve a significantly higher FOV.
- Further studies are needed to evaluate the performance of the trajectory using real projection data acquired with a CBCT device.

REFERENCES

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[2] H. K. Tuy. "An inversion formula for cone-beam reconstruction". In: *SIAM Journal on Applied Mathematics* 43.3 (1983), pp. 546–552.