

Conference Abstracts

Ray-by-Ray Computed Tomography (RBYRCT): A Novel Adaptive Imaging Technology to Address Cancer Health Disparities through Ultra-Low-Dose, Targeted Diagnostics

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Background

High-dose radiation exposure remains a significant barrier to widespread CT screening, contributing to **health disparities** in cancer care by increasing patient reluctance and risk. Furthermore, the reliance on expensive, high-throughput CT hardware limits access to state-of-the-art diagnostics in low-resource or global health settings. Ray-by-Ray Computed Tomography (RBYRCT) is a novel adaptive acquisition framework designed to address these fundamental constraints by enabling **real-time dose control** and **computational efficiency**.

Methods

We implemented a two-phase RBYRCT algorithm to evaluate its capacity for dose sparing: (1) a **scout scan phase** performed global, ultra-low-dose sampling to locate potential lesions, and (2) an **irradiating phase** that adaptively directed subsequent X-rays through any detected Region of Interest (ROI) using a **Min-hit criterion** based on real-time reconstruction feedback (Multiplicative Algebraic Reconstruction Technique, MART). We quantified efficiency using the newly defined **Dose Concentration Ratio (DCR)**, which

measures the ratio of dose concentrated in the ROI versus normal tissue.

Results

The RBYRCT framework demonstrated superior performance:

1. **Convergence:** The method achieved faster convergence and lower reconstruction error than conventional fan-beam CT at equal total dose, enabling high-quality images from fewer rays.
2. **Dose Sparing:** The adaptive irradiating phase resulted in high **Dose Concentration Ratios (DCRs)**, successfully steering the majority of X-ray dose to targeted potential lesions while minimizing overall dose to surrounding tissues.

Conclusion

RBYRCT's ability to achieve high diagnostic fidelity with **ultra-low, targeted radiation dose** directly mitigates the risk and anxiety associated with screening, thereby reducing barriers to early detection. Furthermore, the computational efficiency of the RBYRCT algorithm supports the deployment of sophisticated imaging capabilities on lower-cost hardware, driving **equity in cancer care delivery** by making advanced diagnostics

more accessible in resource-constrained
communities globally.