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HIGH-RESOLUTION BRAINSTEM MRI RECONSTRUCTION AND ANATOMICAL PARCELLATION VIA ADVANCED SAMPLING OPERATORS

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ABSTRACT

High-resolution Magnetic Resonance Imaging (MRI) of the human brainstem is indispensable for the early detection and clinical tracking of neurodegenerative disorders. However, due to its deep anatomical location and susceptibility to physiological motion artifacts, reconstructing raw MR signals and parcellating its complex subcortical structures often introduce severe geometric blurring and pixel-level noise. To overcome these limitations at the software level, this study introduces a rigorous mathematical framework utilizing specialized sampling operators and exponential sampling series to optimize image reconstruction and structural boundary definition.

In this presentation, we focus on leveraging these advanced sampling operators to develop robust, edge-preserving algorithms that suppress noise while maintaining structural connectivity during brainstem MR image reconstruction. We will demonstrate how these sampling-based workflows can enhance the anatomical and functional parcellation of small brainstem nuclei, preserving delicate geometric features without requiring hardware alterations. Furthermore, we discuss the translational potential of this framework into clinical practice, showing how precise operator-driven feature extraction can serve as a non-invasive quantitative biomarker to assist in early-stage neuro-diagnostics. By bridging pure approximation theory with advanced neuroimaging data processing, this framework establishes a scalable computational foundation to improve the precision of clinical brainstem health assessments.

***K*eywords** Sampling Operators · Brainstem MRI

References

[1] Aral A., Acar T., Kursun, S., Generalized Kantorovich forms of exponential sampling series,Analysis and Mathematical Physics, 12(2), 2022.

[2] Turgay M., Acar T., A new generalization of bivariate sampling Kantorovich operators and applications to image processing, Mathematical Methods in the Applied Sciences, 48(16): 15413-15432, 2025.

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