Hello folks,

Here is what's been going on in medical physics and related areas the last 24 hours. Here's what you might find interesting today.

TOP PICKS

Uncertainty Quantification and Likelihood-Free Inference

Beyond Uncertainty: Generalizable Failure Monitoring for Surgical Segmentation under Acquisition Degradation -- This paper tackles a clinically critical problem: surgical segmentation models can fail silently under image degradation, and standard uncertainty-based monitors miss *confident* failures. The authors introduce TCSR-Monitor, a post-hoc framework that combines Mondrian **conformal calibration** with observable shape, temporal-consistency, and image-quality cues beyond confidence alone. The key novelty is the use of complementary signals (circularity, temporal coherence) alongside entropy to detect failures that confidence metrics miss, validated with a leave-one-corruption-out protocol that explicitly tests generalization to unseen degradations. The zero-shot transfer to SAM2 demonstrates feature portability, though the authors are refreshingly honest about remaining false-alarm limitations at moderate corruption levels. This matters because reliable deployment-time monitoring is a prerequisite for clinical translation of segmentation models, and conformal methods are still underexplored in surgical settings.

Imaging Physics and Reconstruction

TR-GS: High-Fidelity Sparse-View CT Volumetric Rendering via t-Distribution Gaussian Splatting and Ray-Confidence Modeling -- This work replaces standard Gaussian primitives in 3D Gaussian Splatting with **Student's t-distribution primitives** whose degrees of freedom are regulated by a ray-confidence model tied to local observability. The idea is that heavy-tailed distributions are more robust to unreliable observations in sparse-view CT, and the confidence mechanism adaptively controls how much each ray contributes based on how well it is constrained by the available projections. A confidence-guided wavelet regularizer balances high-frequency detail preservation against noise. This is a principled, physics-motivated departure from standard 3DGS for CT reconstruction, and the uncertainty-aware primitive design could transfer to other inverse problems in medical imaging.

Shared-Structure 4D Spectral Gaussian Representation for Sparse-View Spectral CT Reconstruction -- The authors propose a **factorized 4D Gaussian representation** that separates shared spatial geometry (learned from full-spectrum structural projections) from spectral attenuation variation (predicted by a Gaussian-wise Spectral Density Curve Network). This factorization avoids redundant per-channel geometry optimization and enables continuous spectral interpolation from discrete measurements, allowing queries at unobserved energy bins. The architectural primitive -- treating spectral CT as a shared-geometry, per-Gaussian spectral-density problem -- is not reducible to a standard CNN/Transformer and is specifically designed for the multi-channel inverse problem. Results across six datasets with 50 views show consistent improvements over the strongest Gaussian baseline.

Novel Architectures and Objectives for Imaging

The Right Prior for the Right Deformation: Rethinking Continuous Deformable Image Registration -- This is a systematic validation study comparing **implicit deformation priors** across B-Spline, INR-based dense fields (SIREN), INR-predicted B-Spline control points, and multiresolution schemes on two distinct registration tasks: inter-subject brain MR (OASIS) and intra-subject lung CT (DIR-LAB 4DCT). The key finding is that registration accuracy depends strongly on whether the induced prior matches the target motion pattern -- B-Spline locality works for moderate but locally complex brain deformations, while dense INR and multiresolution schemes are needed for large coherent respiratory motion. The paper provides mechanistic insight

into *why* different continuous parameterizations succeed or fail, rather than just reporting benchmark numbers, and offers prior-deformation matching as a practical design principle.

Back tomorrow with more!

P.S. In the most recent submission window: physics.med-ph: 4 papers cs.CV: 100 papers