ATS 2024 Highlights

Respiratory Structure and Function Early Career Professionals

Get to know members of the RSF Assembly

Mostafa Ismail, MS

(He/Him/His)
PhD Candidate, Function and Metabolic Imaging Group
Bioengineering and Radiology departments
University of Pennsylvania
mostafai@seas.upenn.edu
https://www.linkedin.com/in/mostafaee/

Is your research clinical, basic science or translational?

Translational & Clinical

Tell us about your research?

My research focuses on exploring dynamic imaging capabilities for diagnosing and early detection of pulmonary complications, particularly in lung transplantation. I work with chest radiographs, CT scans, and hyperpolarized xenon MRI, developing image analysis tools and using machine/deep learning techniques to improve image acquisition and analysis. I hypothesize that dynamic imaging during free-breathing can overcome the limitations of current diagnostic methods (PFTs/static imaging) and provide a more physiologically accurate assessment of lung function.

Where do you see yourself in 5 years?

I envision two potential paths that align with my passion for both teaching and research: 1) Academic Career: Teaching and conducting research to inspire students and advance imaging techniques for better pulmonary diagnostics; 2) Industry Leadership: As a director of research in a top tech company, leading teams to innovate at the intersection of technology and healthcare.

What do you find is the major benefit of RSF Assembly Membership?

The major benefit of RSF Assembly Membership is access to like-minded researchers who aspire to advance respiratory medicine through innovative ideas. Additionally, the RSF scholarship provides financial support to attend conferences, enabling members to present their research, receive feedback, and network, thereby enhancing their professional development and career opportunities.

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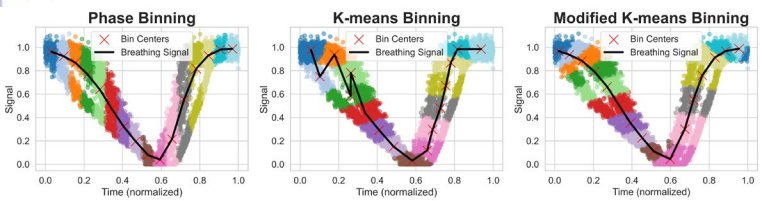
(A)



(B)

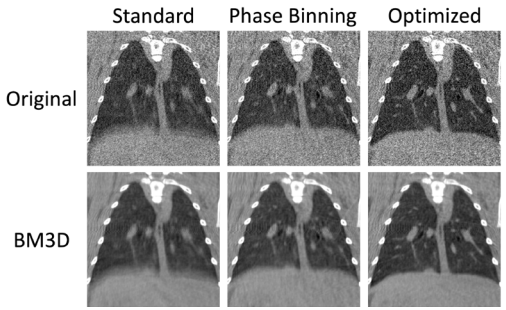


Figure 1 (A) Phase binning vs. K-means binning vs. modified K-means binning. The phase bins does not consider the signal amplitude. Unlike the other methods, our modified approach combines the benefits of amplitude and phase binning and accounting for periodicity (the wrap-around at times 0 and 1. (B) The optimized image for the rabbit shows more visible blood vessels, sharper diaphragm, and less overall blurring than images generated with the other methods.

Optimizing Spatiotemporal Resolution In Dynamic Imaging Using Phase Binning-guided K-means Clustering

Objective: Assessing the dynamic interplay of continuous air and blood flow that constitutes lung function requires imaging at high spatial and temporal resolution. While dynamic imaging during free-breathing holds promise for revealing the complexities of this process, but is plagued by motion artifacts—a limitation exacerbated in small animal studies, where lung motion, especially in animals with compromised lung function, is sufficiently rapid as to surpass the capabilities of conventional scanning protocols to capture it accurately. In this study, we introduce a novel imaging approach that employs supervised clustering to mitigate motion artifacts in cone-beam micro-CT, enabling fast imaging with exceptional spatiotemporal precision. Additionally, we introduce the use of Block-matching and 3D filtering (BM3D) for denoising x-ray projection images to further improve image quality.

Methods: 4D micro-CT (MIlabs u-CT, Utrecht, Netherlands) images were acquired in a moving phantom at both a constant simulated breathing rate and while varying the inhale/exhale ratio, as well as in a healthy, free-breathing White-New-Zealand rabbit at 55KV/0.37mA/20ms. 11520 projection images were acquired over 10 min (32 projections per degree) and distributed into 16 bins using: 1) standard Milabs reconstruction software, 2) phase-binning, and 3) an optimized binning method that employs modified k-means clustering to effectively combine phase- and amplitude-binning. The modified clustering method is guided by phase-binning, the representative breathing signal from which (pre)defines a set of possible centroids. The final centroids must lie on the representative breathing signal obtained using phase-binning, as shown in Figure 1.B. Finally, we also used BM3D to denoise the raw projection images.

Results: Figure 1.A compares the results of phase-binning vs. k-means clustering vs. our modified binning. The phase-binning produces an uneven bin distribution (many bins in the end-exhale phase, very few bins during inhalation and exhalation), while the k-means does not have this problem. However, the k-means binning produced unrealistic representative breathing signal and does not account for periodicity. Our modified k-means approach results in more accurate representative breathing signal and account for periodicity. Figure1.B shows that the denoised optimized image shows more visible blood vessels, a more sharply delineated diaphragm, and less overall blurring than when using the other methods tested.

Conclusion: Comparing binning techniques for dynamic imaging, we found that our proposed modified k-means clustering proved superior in reducing motion artifacts when imaging variable breathing patterns, resulting in optimized image quality.

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