

X-RAY DARK-FIELD CT RADIOMICS FOR LUNG PHANTOM ASSESSMENT

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1. INTRODUCTION

Dark-field X-ray imaging generates contrast through small-angle X-ray scattering sensitive to lung tissue alterations [1]. This study evaluates phantom materials for their capacity to replicate texture characteristics beyond first-order metrics [2].

2. METHODS

Experiments were performed at 80 kVp and 550 mA using a human-scale dark-field CT system [3]. Ex vivo porcine lungs were ventilated at 10 mbar as a biological reference. A total of 102 contrast features was extracted with PyRadiomics 3.1.0 from 16 segmented axial CT slices across 15 samples. Feature values averaged across slices were normalized to z-scores and subjected to principal component analysis (PCA).

3. RESULTS AND CONCLUSION

The first principal component accounts for half of the total variance in both contrasts and is dominated by first- and second-order entropy-related features. Lung specimens are nearly indistinguishable in attenuation features, most closely resembling granular materials. Dark-field features reveal physiological subtleties and show the closest phantom similarity to closed-cell polymers and wool. The added value of multi-contrast analysis is highlighted by the strong correlation (Pearson's $R = 0.79$, $P = 4.59 \cdot 10^{-4}$) between the first principal components of both contrasts, indicating a shared axis of bulk variance complemented by contrast-specific information. These findings demonstrate that dark-field radiomics enables meaningful material characterization to support the development of physically plausible lung phantoms.

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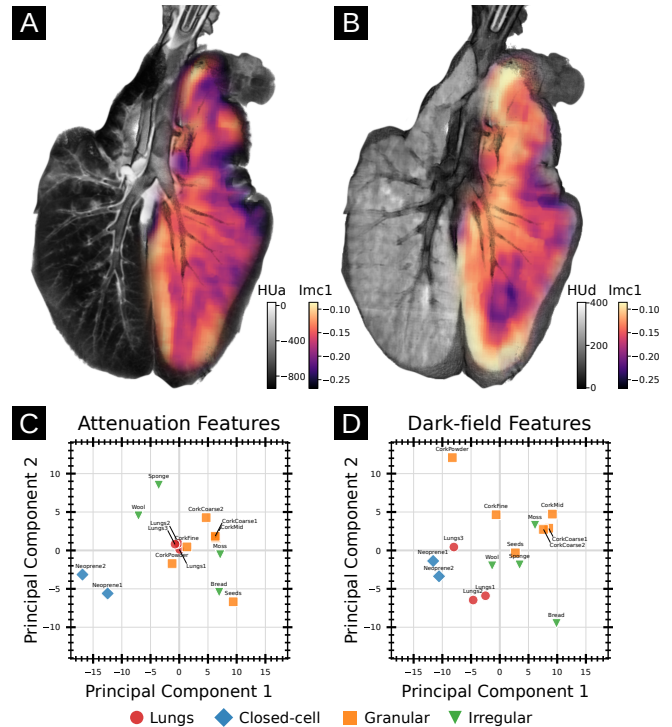


Fig. 1. Informational measure of correlation 1 (Imc1) partially overlaid on attenuation (A) and dark-field (B) Hounsfield units (HUa and HUD) highlights the complexity of lung tissue. PCA of attenuation (C) and dark-field (D) features provides an estimate for phantom similarity.

4. REFERENCES

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