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On handling low-dose CT images in the absence of reliable DICOM header information

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Handling Low Dose CT

- **Background**
- **Capturing Dosage in DICOM**
- **Proposed Approach & Methodology**
- **Results & Discussion**
- **Author Correspondence**

Background

- **CT is important diagnostic imaging modality with millions of procedures performed each year**
- **Modern image acquisition technologies are intended to enable dose reduction in CT imaging while maintaining diagnostic information**
- **Evolving technology with newer scanners and reconstruction kernels.**
- **Low dose CT (LDCT) tend to have higher noise and less sharpness**
- **LDCT may affect performance of advanced post-processing algorithms, such as Computer-aided Detection (CAD)**

Capturing Dosage in DICOM

- **The first step is to know the dosage for each imaging procedure**

- **“Exposure”, “XRayTubeCurrent”, “KV” capture input attributes**
- **CTDoseIndex field captures overall dosage**
- **Non-Type 1 attributes – not mandatory**

- **Proposal: Radiation Dose Structured Report (RDSR)**
- **CTDIvol (mGy), DLP (mGy * cm), etc. captures dosage**
- **All new devices to encode dose in RDSR [1]**

- **Drawbacks:**
- **Old scanners may not be updated with RDSR**
- **Legacy PACS systems may not read this new SR object**

[1] D. Clunie, Extracting, Managing and Rendering DICOM Radiation Dose Information from Legacy & Contemporary CT Modalities, *DICOM Intl. Conf.*, 2010

Proposed Approach

- **Smoothing reduces noise, but in excess removes information**

→ **Algorithms like Lung CAD* expect sharp kernel**

→ **Soft kernels may affect performance such as high false positive (FP) rates [2]**

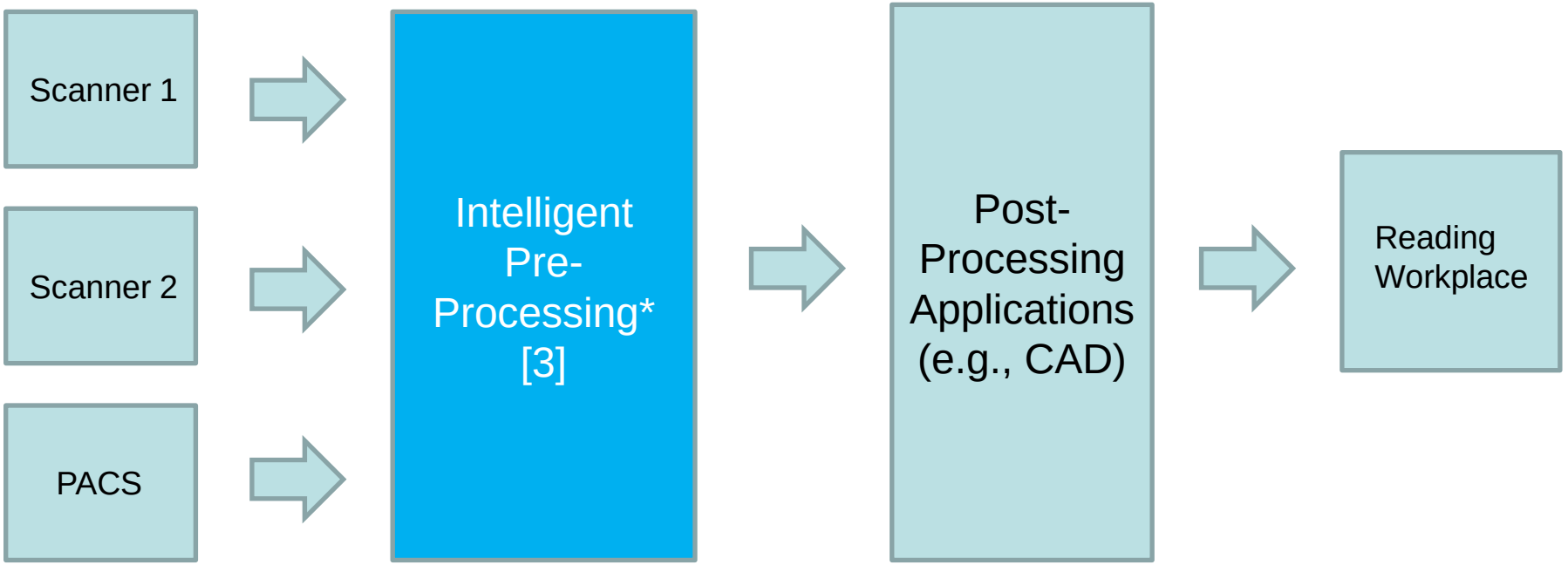
- **Need to strike balance between noise and sharpness**

- **New Idea: Intelligent pre-processing filter to adjust image quality**

[2] M. Yanagawa et al., Pulmonary nodules: Effect of ASIR technique on performance of a CAD system-comparison of performance between different-dose CT scans *Eur. J. Rad.*, **81**(10) 2012

* Lung CAD research prototype is not commercially available for sale in the USA or elsewhere and is not related to any product.

Framework



[3] L. Raghupathi et al., An Intelligent Pre-Processing Framework for Standardizing Medical Images for CAD and Other Post-Processing Applications, *Proc. SPIE Med. Imag.*, 2012

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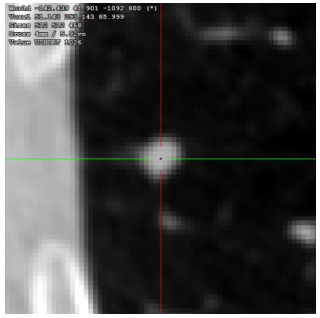
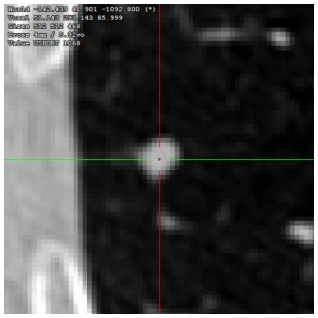
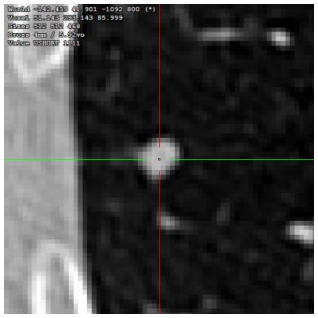
Choosing Filters



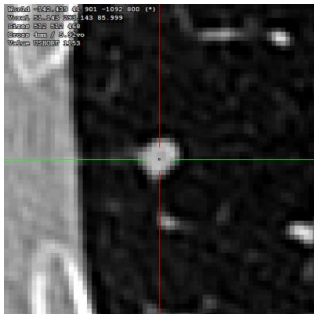
Original



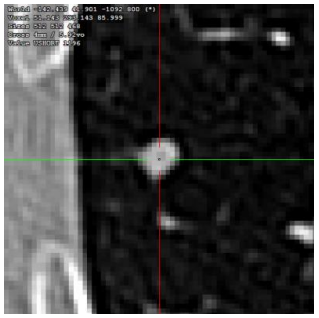
Filter 1



Filter 2



Filter 3



Filter 4

It is possible to adjust sharpness using the filters.

Key question: Which filter is best for Lung CAD* performance?

* Lung CAD research prototype is not commercially available for sale in the USA or elsewhere and is not related to any product.

Methodology

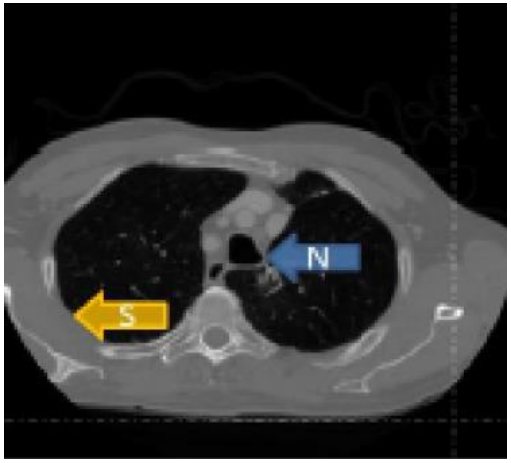
Signal/Contrast to Noise Ratio dependent on location

Use image metrics for “adaptive” pre-processing

Estimate noise (N) around air region (carina landmark)

Estimate sharpness (S) in air-body border

Iteratively filter till desired Noise to Sharpness ratio (NSR) reached



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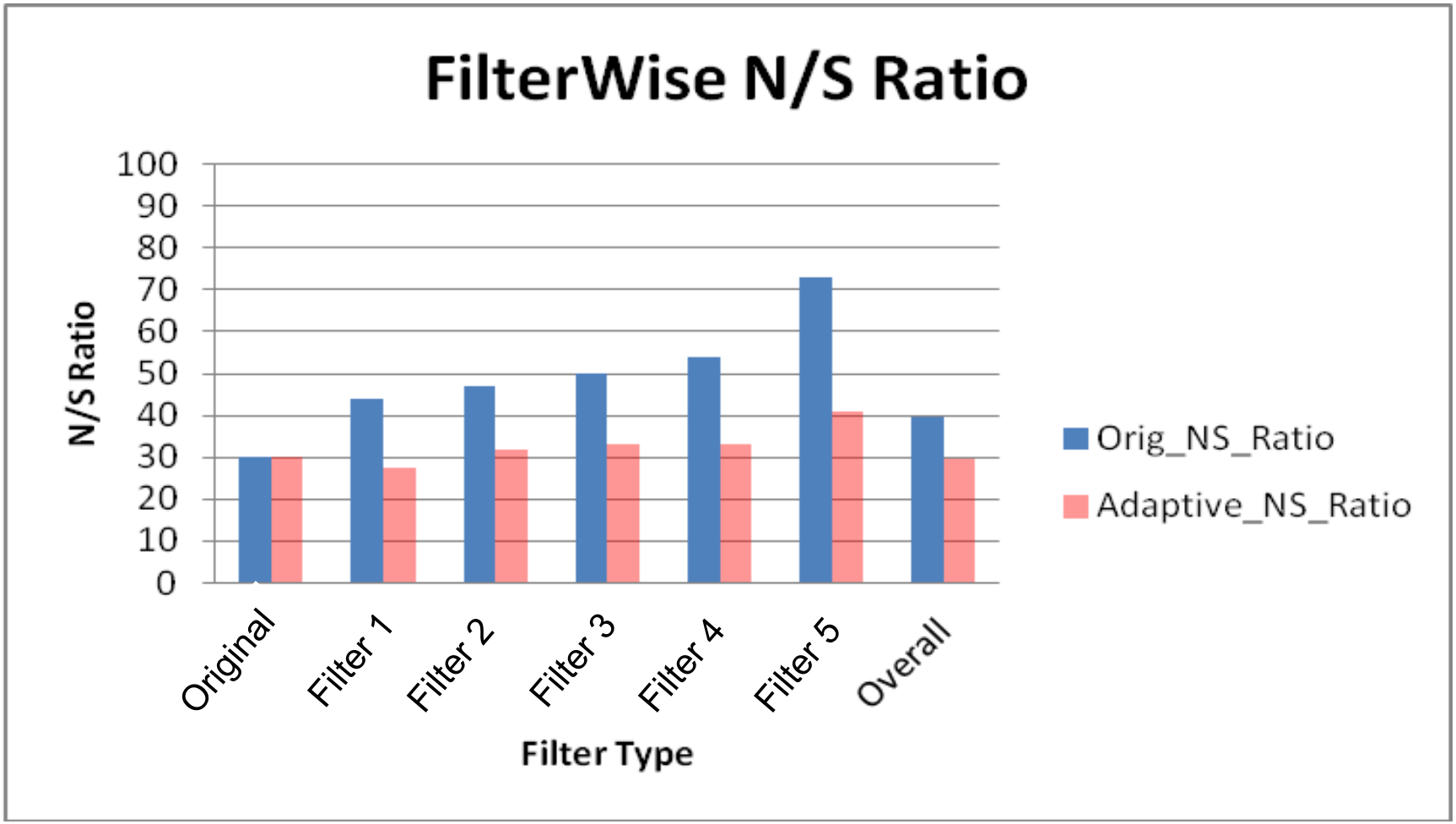
NSR Outputs



LDCT Details & Ground Truth

- **34 Siemens IRIS Kernel avg. 90 mAs, 40 solid pulmonary nodules (SPN) in 4-30mm dia.**

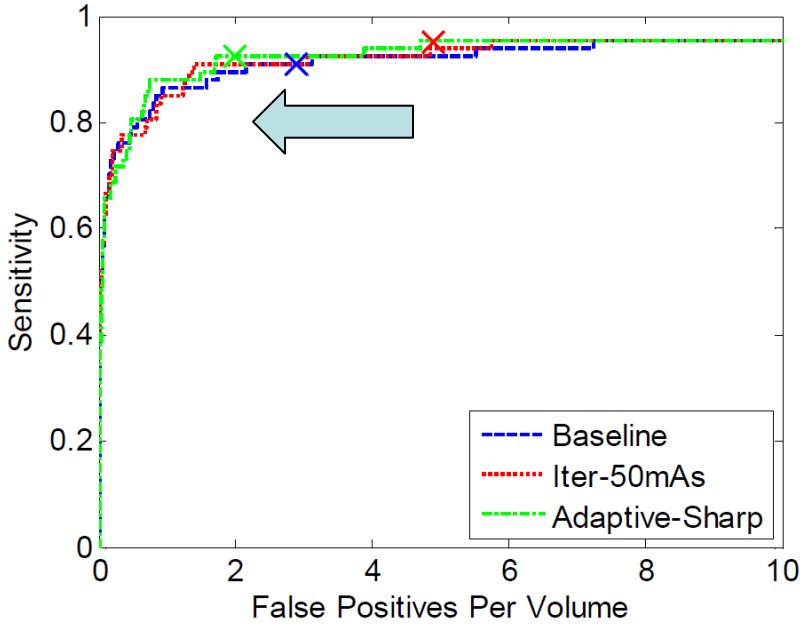
- **88 Siemens IRIS Kernel simulated at 50, 100 mAs, 67 SPN in 4-30mm dia.**

Results

Trained on large-scale CT datasets

Validation on low-dose CT images at different levels

Improved performance* (mean FP down 66%, median down 50%)



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Discussion

- **Proposed approach normalizes images with different dosage**
- **Uses measured attributes independent of acquisition parameters**
- **Demonstrated potential for improved CAD performance on LDCT**
- **Possible to extend to other post-processing applications**
- **Potential to enhance their applicability in clinical workflows**
- **Practical alternative till DICOM dosage attributes captured**

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Thank you for your attention !