Samei Lab

Key refereed publications with narratives:


the determination of the MTF of digital radiographic systems. *Physics in Medicine and Biology* 50:
3613-3625, 2005.

J15. Hoe CL, Samei E, Frush DP, Delong DM. Simulation of liver lesions for pediatric CT. *Radiology* 238:


984-996, 2006.

This paper applied the concept of Fourier-based detectability index to assess the impact of detector
parameters and imaging geometry on lesion detection.

J19. Samei E, Ranger NT, Dobbins III JT, Chen Y. Inter-comparison of methods for image quality

J20. Dobbins III JT, Samei E, Ranger NT, Chen Y. Inter-comparison of methods for image quality

J21. Samei E. The role of image perception in radiology (guest editorial). *Journal of American College of


J23. Samei E, Cleland EW, Roehrig H. In-field assessment of display resolution and noise: performance
evaluation of a commercial measurement system. *Journal of the Society for Information Display (JSID)*

Comparison of LCD and CRT displays based on utility for mammographic tasks. *Academic Radiology*

J25. Saunders RS, Samei E. Improving demographic decision accuracy by incorporating observer ratings


J27. Samei E, Saunders RS, Baker JA, Delong DM. Digital mammography: impact of reduced dose on

This paper investigated the impact of dose reduction (50% and 75%) on the detection and
discrimination of breast lesions with digital mammography. Results suggest that dose reduction has a
measureable but modest effect on diagnostic accuracy.


*This paper investigated the effect of dose reduction (50% and 75%) on the detectability of breast lesions and microcalcifications. Reduction in dose levels by 50% lowered the detectability of masses with borderline statistical significance. Dose reduction did not have a statistically significant effect on detection of microcalcifications.*


The authors developed a technique for 3D modeling of small lung nodules in pediatric MDCT examinations. It was shown how mathematical lung nodule models appeared indistinguishable from real nodules.


The impact of reducing dose on detection of lung nodules is evaluated in this paper. The authors found that detection accuracy at 75% dose was comparable that of full dose scans.


This paper investigated the dependency of the diagnostic quality of breast tomosynthesis on dose, number of projections, and angular span. The best performance was obtained for 15-17 projections spanning an angular of 45 degrees—the maximum tested in the study, and for an acquisition dose equal to single-view mammography.


J51. Richard S, Samei E Quantitative imaging in breast tomosynthesis and CT: comparison of detection and estimation task performance. *Medical Physics* 37(6): 2627-2637, 2010. This article was selected as Editor’s Pick as a top article in the journal issue.


The authors developed an estimability index (e’) to predict the quantitative precision of a CT system with respect to the systems resolution and noise properties. The estimability index correlated with theoretical precision acquired via MLE.


*The study aims to develop a method to estimate patient-specific radiation dose and cancer risk from CT examinations by combining a validated Monte Carlo program with patient-specific anatomical models. The organ dose, effective dose, and risk index (a surrogate of cancer risk) was estimated for clinical chest and abdominopelvic protocols.*


*This study aims to develop patient-specific radiation dose and risk estimation for pediatric chest CT exams. The dual aim of this study is to evaluate the dependence of dose and risk on patient size and scanning parameters. The reported relationships can be used to estimate patient-specific dose and risk in clinical practice for a given pediatric patient.*

J60. Samei E, Ranger NT, Dobbins III JT, Ravin CE. Effective Dose Efficiency (eDE): an application-specific metric of quality and dose for digital radiography. *Physics in Medicine and Biology* 56: 5099–5118, 2011. This article was selected Featured Article as a top article in the journal issue.


*Authors examine the effect of acquisition and reconstruction parameters on the volume estimation of lung nodules in CT. The accuracy and precision of the volume estimation was found to be dependent on slice thickness but was less impacted by kVp, pitch, and reconstruction kernel.*


*The authors assessed the uncertainties in CT dose and risk estimation associated with four types of reference computational phantoms for ten body and three neurological protocols. These reference phantoms included two sets of anthropomorphic phantoms (XCAT and ICRP 110 phantoms), and two sets of mathematical phantoms (ImPACT and CT-Expo phantoms).*

J68. Richard S, Yadava G, Murphy S, Samei E. Towards task-based assessment of CT performance: system and object MTF across different reconstruction algorithms. *Medical Physics* 39(7), 4115-4121, 2012. **This article was selected as Editor's Pick as a top article in the journal issue.**

*This study investigated a measurement method for evaluating the resolution properties (MTF) of CT imaging systems with iterative reconstruction algorithms. Results demonstrated that the object-specific MTF can vary as a function of dose and contrast.*


*This paper compares noise texture (i.e., noise power spectra) across CT systems from different manufacturers. The authors found that similar noise texture can be achieved across scanner systems for certain reconstruction kernels.*

*Noise power spectrum analysis was used to compare reconstruction kernels from two CT manufacturers. Based on respective NPS, a matching strategy was developed which allows users to achieve similar noise texture properties between the two vendors (GE and Siemens).*

J70. Li X, Samei E, Williams CH, Segars WP, Tward D, Miller MI, Ratnather JT. Effects of protocol and obesity on dose conversion factors in adult body CT. *Medical Physics* 39(11): 6550-6571, 2012. This article received the Farrington Daniels Award for the best paper published in Medical Physics in 2012.


A new phantom and analysis methodology is presented to assess advanced CT system features such as tube current modulation and iterative reconstruction. The authors show how the resolution changes with dose and contrast for iterative reconstruction. The methodology includes the assessment in the terms of task specific transfer function, NPS, and the detectability index.


The tube current modulation algorithms of two CT systems (GE and Siemens) were assessed and characterized by measuring noise in CT images of an anthropomorphic phantom.


The authors look at accuracy and precision of CT lung nodule volumetry across reconstruction algorithms (FBP, ASIR, MBIR), doses, and slice thickness. Precision between FBP and iterative reconstruction was comparable with no significant difference across dose levels, slice thicknesses, or segmentation software.


The purpose of this work was to estimate patient-specific dose and risk across pediatric and adult population for abdominopelvic CT exam. The study addresses the limitation of current CT dose estimates of failing to accurately model the variety and complexity in patient anatomy. The estimated dose coefficients are essential for CT protocol optimization and improved patient dose recording.


Highly detailed 4D reference pediatric XCAT phantoms were extended to a series of 64 pediatric phantoms of a variety of ages and height and weight percentiles, representative of the public at large. CT data was simulated from these phantoms to demonstrate their ability to generate realistic, patient quality imaging data.


Monte Carlo simulation was conducted on 59 adult XCAT phantoms for radiography, tomosynthesis, and CT chest protocols. Relationship between radiation burden and patient sizes were established and compared across modalities.


This study aimed to compute patient-specific organ doses and effective dose conversion factors for a representative collection of routinely used CT protocols across a large number (58) of adult patient phantoms. Based on the findings, the work included the development of an iPhone operating system (iOS) application as a convenient calculator for providing reasonable estimation of organ and effective doses for adult patients undergoing CT examination.


This study developed organ dose coefficients for pediatric chest and abdominopelvic CT examinations. The coefficients allow organ dose to be conveniently estimated with the knowledge of patient size and CTDIvol. Such information may aid in improved dose recording and monitoring, in dose estimation for multiplicity of CT examination protocols, and in the evaluation of dose profiles within a practice.


Textured phantoms based on lung and liver texture were designed and fabricated using 3D printing and used to demonstrate the unique (non-stationary) noise properties of the SAFIRE reconstruction algorithm in CT.


A method to virtually model lung, liver, and renal lesions was developed. This method can be used to create hybrid CT images–real patient images enriched with virtual lesion models–for image quality and human perception research in CT. A human perception experiment was performed to demonstrate the realism of such hybrid images. Based on ROC analysis, it was found that radiologists could not distinguish between real and simulated lesions.


In a comprehensive study conducted in joint collaboration with University of Maryland, Duke, and NIST, the work involves an observer study the results of which are closely correlated with task-based, frequency–based assessment of d’ across three vendors, 7 dose levels, and 6 reconstruction algorithms, standard and iterative.


*The ADMIRE reconstruction algorithm was assessed based on phantom data and a human detection experiment. The dose reduction potential of the algorithm was found to be around 50% on average.*


*This study developed a quantitative model to predict organ dose for clinical chest and abdominopelvic scans. Such information may aid in the design of optimized CT protocols in relation to a targeted level of image quality.*


*Very strong agreement between Monte Carlo simulation patient dose and Duke Dose Monitoring data was shown in this letter. When plotting model based effective dose verses clinical based effective dose, the R2 of a linear fitting was as high as 0.97.*

J118. Kiarashi N, Nolte AC, Sturgeon GM, Segars WP, Ghate SV, Nolte LW, Samei E, Lo JY, Development of realistic physical breast phantoms matched to virtual breast phantoms based on human subject data. Medical Physics 42: 4116, 2015. This article was selected as a featured paper as a top article in the journal issue.


*High resolution PET-CT images was reviewed and segmented to construct anatomically realistic pediatric phantoms. These phantoms consisted of thousands of structures, including cardiac and respiratory motions, enables virtual clinical trials for 3D and 4D CT.*


*This study performed a comprehensive physics-based assessment of a state of the art dual source CT system in terms of noise (NPS), resolution (TTF), and detectability (NPW model). The characteristics were measured as a function of radiation dose, reconstruction algorithm (ADMIRE) and patient size. The system’s tube current modulation algorithm was also assessed.*


*With a size varying phantom-Mercury Phantom 3.0, this paper examined the effect of changing dose level, tube voltage, reconstruction methods and the AEC function on the CT image quality across different sizes for a dual source CT scanner.*


J125. Tian X, Samei E. Accurate assessment and prediction of noise in clinical CT images. Medical Physics 43(1): 475-482, 2016. *This article was selected as a featured paper as a top article in the journal issue.*
This study proposed a practically applicable method to assess quantum noise in clinical images. The image-based measurement technique enables automatic quality control monitoring of image noise in clinical practice. Further, a phantom-based model can accurately predict quantum noise level in patient images. The prediction model can be used to quantitatively optimize individual protocol to achieve targeted noise level in clinical images.


A series of quantitative radiomics-based imaging features, including size, shape, sharpness, and texture features, were extracted from images of patients with liver lesions, lung nodules, and kidney stones based on CT images acquired at two radiation dose levels and reconstructed with three different algorithms. It was found that radiation dose and reconstruction algorithm strongly affected many imaging features, implying that radionics-based predictive models should be careful to account for such variability.


This paper developed a convolution-based technique to model the heterogeneous radiation field under tube current modulated CT examinations. Results suggest that organ dose could be accurately estimated for TCM examinations by combining such convolution technique with a validated Monte Carlo simulation and a library of computational phantoms.

In this study, a fully automated technique was developed to quantify spatial resolution in clinical CT images. The method is based on measuring the ESF across the patient’s skin. The authors demonstrated that spatial resolution can vary drastically amongst clinical images reconstructed with identical reconstruction parameters.


This study compares a number of observer models (e.g., NPW, CHO) with human-based low-contrast detectability data for CT images. The models are compared with humans in terms of their correlation strength, practicality, and ability to properly characterize iterative reconstruction algorithms. Both the NPW and CHO models were highly correlated with human detection performance.


This study developed and used voxel-based 3D printed textured phantoms to demonstrate that the dose reduction potential of non-linear CT iterative reconstruction algorithms is dependent on anatomical texture. It was found that the estimated dose reduction potential of the iterative algorithm was highly dependent on background texture.


Human perception experiment based on clinical CT data designed to estimate the dose reduction potential of a commercial iterative reconstruction algorithm. It was found that the actual dose reduction potential of the algorithm in question (~16%) is less than what has been reported by many phantom-based and patient-based studies (~26%-80%).
This study investigated a fully automated method for quantifying regional imparted energy and dose from clinical TCM CT exams. Results indicated that regional imparted energy (per DLP) increased with kV, but was unaffected by the TCM strength. The algorithm was tested on 40 clinical datasets with a 98% success rate.

In this article the authors developed a technique to model the propagation of contrast material in XCAT human models was developed. The models with added contrast material propagation can be applied to simulate contrast-enhanced CT examinations.

The study introduced a technique to quantify the radiation doses delivered to the patients undergoing contrast-enhanced CT examinations. The authors presented the Monte Carlo simulated radiation doses to different enhanced organs as a function of time across a population of contrast-enhanced XCAT models. Under this work, they also presented that the administration of contrast medium increases the total radiation dose.

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To extend CT image quality quantification to clinical images, the authors developed a fully automated algorithm for measuring HU distributions in four major organs in chest images: the lungs, liver, bone, and aorta. The automated algorithm performed comparably to manual measurements and can be utilized for patient-specific image contrast evaluations.


