Record Nr. UNINA9910728386703321 Autore Hsieh Scott Titolo Photon Counting Computed Tomography [[electronic resource]]: Clinical Applications, Image Reconstruction and Material Discrimination // edited by Scott Hsieh, Krzysztof (Kris) Iniewski Cham:,: Springer International Publishing:,: Imprint: Springer,, Pubbl/distr/stampa 2023 3-031-26062-7 **ISBN** Edizione [1st ed. 2023.] 1 online resource (271 pages): illustrations Descrizione fisica IniewskiKrzysztof (Kris) Altri autori (Persone) Disciplina 616.0757 Soggetti Electronics Solid state physics Harmonics (Electric waves) X-rays Electronics and Microelectronics, Instrumentation **Electronic Devices** Harmonics and X-Ray generation Lingua di pubblicazione Inglese **Formato** Materiale a stampa Livello bibliografico Monografia Nota di bibliografia Includes bibliographical references and index. Nota di contenuto Intro -- Contents -- Editors Biography -- Part I Clinical Applications --Medical Photon-Counting CT: Status and Clinical ApplicationsReview --1 Introduction -- 2 Principles of Medical Photon-Counting CT -- 2.1 Properties of Solid-State Scintillation Detectors -- 2.2 Properties of Photon-Counting Detectors -- 2.3 Challenges for Photon-Counting Detectors in Medical CT -- 3 Pre-clinical Evaluation of Photon-Counting CT -- References -- Coronary Artery Calcifications Assessment with Photon-counting Detector Computed Tomography --1 Introduction -- 2 The Agatston Score (AS) for CAC Scoring -- 2.1 Definition of the Agatston Score -- 2.2 Phantom Inserts for AS Performance Assessment -- 2.3 Impact of the Blooming Artifact -- 3 Comparison of EID-CT and PCD-CT for Calcium Scoring -- 3.1

Agatston Score Values -- 3.2 Noise Reduction -- 3.3 Resolution Increase -- 3.4 Dose Robustness -- 3.5 Discussion and Limits -- 3.6 Clinical Implications -- 4 Spectral Information for Calcium Scoring --

4.1 Virtual Monoenergetic Images (VMIs) -- 4.2 Material Classification -- 5 Conclusion -- References -- MARS for Orthopaedic Pathology -- 1 Introduction -- 2 Background -- 2.1 Conventional Imaging Modalities for Orthopaedic Applications -- 2.2 Spectral Photon-Counting CT with the MARS Imaging System -- 3 Applications of MARS Spectral Photon-Counting CT -- 3.1 Acute Fractures -- 3.2 Evaluation of Fracture Healing -- 3.3 Bone-Metal Interface Imaging -- 3.4 Bone Marrow Oedema Measurements -- 3.5 Bone Quality Measures: Bone Structure and Material Maps -- 4 Summary -- References -- MARS for Molecular Imaging and Preclinical Studies -- 1 Introduction -- 2 Background -- 3 Molecular Imaging Applications -- 3.1 Infectious Disease: Pulmonary Tuberculosis -- 3.2 Cancer -- 3.3 Characterization of Atherosclerotic Plaque -- 3.4 Bone Health -- 3.5 Cartilage Health. 3.6 Crystal-Induced Arthropathies -- 4 Summary -- References --Quantitative Breast Lesion Characterization with Spectral Mammography: A Feasibility Study -- 1 Introduction -- 2 Materials and Methods -- 2.1 Spectral Mammography System -- 2.2 Dual-Energy Calibration -- 2.3 Phantom and Tissue Validation -- 2.4 Image Processing -- 3 Results -- 4 Discussions -- 5 Conclusions --References -- Quantitative Breast Imaging with Low-Dose Spectral Mammography -- 1 Introduction -- 2 Theory -- 2.1 Theoretical Conversion -- 2.2 Experimental Conversion -- 3 Dual-Energy Material Decomposition Using Spectral Mammography: A Simulation Study -- 4 Dual-Energy Breast Density Quantification Using Spectral Mammography: A Phantom Study -- 4.1 Spectral Mammography System -- 4.2 Tissue-Equivalent Phantoms -- 4.3 Results -- 5 Quantification of Water and Lipid Density with Dual-Energy Mammography: Validation in Postmortem Breasts -- 5.1 Image Acquisition and Processing -- 5.2 Chemical Analysis -- 5.3 Results --5.4 Discussions -- 6 Conclusions -- References -- Part II Image Reconstruction and Material Discrimination -- An Overview of CT Reconstruction with Applications to Photon Counting Detectors -- 1 Reconstruction Fundamentals -- 2 Spectral Reconstruction -- 3 Take-Home Messages: Reconstruction for Detector Scientists -- References -- On the Choice of Base Materials for Alvarez-Macovski and DIRA Dual-energy Reconstruction Algorithms in CT -- 1 Introduction -- 2 Theory -- 2.1 The Physics of Incoherent Scattering -- 2.2 The Physics of Polyenergetic Computed Tomography (CT) Measurements -- 2.3 Alvarez and Macovski's Method -- 2.3.1 Solution of the Equation System -- 2.3.2 Reconstruction of Base Material Images and Monoenergetic Images -- 2.4 Dual-energy Iterative Reconstruction Algorithm (DIRA) -- 2.4.1 Computation of Forward Polyenergetic Projections in DIRA. 2.4.2 Choosing the Two Effective Energies in DIRA -- 2.4.3 Computation of Forward Monoenergetic Projections in DIRA -- 2.4.4 Base Material Decomposition in DIRA -- 2.4.5 Summary of DIRA -- 3 Methods -- 3.1 Visual Investigation of the Dimensionality of Relevant Materials -- 3.2 X-ray Spectra and Phantoms -- 3.3 Setup for the AM Algorithm -- 3.4 Setup for DIRA -- 4 Results -- 4.1 Analysis of Reconstructed Data for the Phantom Without an Iodine Insert -- 4.2 Analysis of Reconstructed Data for the Phantom with an Iodine Insert --5 Discussion -- 6 Conclusion -- References -- Spectral Imaging in Photon-Counting CT with Data Acquired in Interleaved/Gapped Spectral Channels -- 1 Introduction -- 2 Signal Detection, Material Decomposition, and Spectral Imaging in Photon-Counting CT -- 3 Spectral Channelization for Data Acquisition in 2-MD-Based Spectral Imaging -- 3.1 Benchmark Spectral Channelization -- 3.2 Spectral Channelization Using Half Source Spectrum -- 3.2.1 Spectral

Channelization with Two Abutted Channels -- 3.2.2 Spectral Channelization with Two Gapped Channels -- 3.3 Spectral Channelization Using Full Source Spectrum -- 3.3.1 Interleaved Spectral Channelization and Pre-reconstruction Data Merge -- 3.3.2 Interleaved Spectral Channelization and Post-reconstruction Data Merge -- 3.4 Scan Techniques, Basis Materials, and Phantom for Image Quality Assessment -- 4 Image Quality Evaluation and Verification -- 4.1 Material Decomposition and Image Formation in Benchmark Spectral Channelization -- 4.2 Material-Specific Imaging in Interleaved/Gapped Spectral Channelization -- 4.3 Virtual Monochromatic Imaging in Interleaved/Gapped Spectral Channelization -- 5 Closing Remarks -- References -- One-Step Basis Image Reconstruction in Spectral CT Based on MAP-EM Algorithm and Polar Coordinate Transformation -- 1 Introduction -- 2 Materials and Methods.

2.1 MAP-EM Statistical Reconstruction Algorithm -- 2.2 Direct Iterative Material Decomposition Method Based on MAP-EM Algorithm -- 2.3 Simulation Setup -- 2.4 Evaluation Metrics -- 2.5 Calculation of Theoretical Decomposition Coefficients -- 3 Experimental Results --3.1 Evaluation of Regularization Parameter -- 3.2 Comparison of the Basis Images -- 3.2.1 Comparison of the Noise Levels () -- 3.2.2 Comparison of the Gray Level Distributions in the Decomposition Coefficient Images -- 3.2.3 Comparison of Contrast Noise Ratios --3.2.4 Comparison of Error Levels of the Decomposition Coefficients --3.2.5 Comparison of the Reconstruction Time of Basis Images -- 4 Discussion -- 5 Conclusion -- References -- Quantitative Analysis Methodology of X-Ray Attenuation for Medical Diagnostic Imaging: Algorithm to Derive Effective Atomic Number, Soft Tissue and Bone Images -- 1 Introduction -- 2 Energy-Resolving Photon-Counting Detector to Realize Quantitative Analysis of an Object -- 3 Issues That Need to Be Considered to Achieve Accurate Material Identification --3.1 Beam Hardening Effect Depends on Effective Atomic Number -- 3.2 Response of Multi-Pixel-Type Energy-Resolving Photon-Counting Detector -- 3.3 Procedure to Correct for the Beam Hardening Effect and Detector Response -- 4 Material Identification Method Leading to Innovations in Imaging Technology -- 4.1 Novel Method to Derive Effective Atomic Number Image and Extract Mass Thickness Images Related to Soft Tissue and Bone -- 4.2 Spillover Effect on Applications -- 5 Summary -- References -- K-Edge Imaging in Spectral Photon-Counting Computed Tomography: A Benchtop System Study -- 1 Computed Tomography Evolution -- 1.1 Conventional CT -- 1.2 Dual-Energy CT -- 1.3 Spectral Photon-Counting CT -- 2 Contrast Agents --2.1 Iodinated Contrast Medium -- 2.2 K-Edge Materials for Clinical Applications.

2.3 K-Edge Imaging and Energy Binning -- 3 K-Edge Imaging Studies -- 3.1 I, Gd, and Ho K-Edge Imaging -- 3.2 3D Image Reconstruction -- 3.3 Image Quality Results -- 4 K-Edge Imaging Optimization for Multi-contrast Imaging -- 4.1 K-Edge Imaging Optimization Setup and Parameters -- 4.2 Optimization Results -- 5 Conclusions -- References -- Image Domain Performance Evaluation of a Photon-counting ASIC Using a Multilayer Perceptron Network -- 1 Introduction -- 2 Statistical Metric -- 3 Method -- 3.1 Physics Simulation -- 4 ASICs -- 4.1 Multilayer Perceptron -- 4.2 Image Domain Evaluation -- 5 Results -- 6 Summary -- References -- Index.

Sommario/riassunto

This book will provide readers with a good overview of some of most recent advances in the field of CT technology for X-ray medical imaging, especially as it pertains to new detectors. There will be a good mixture of general chapters in both technology and applications in medical imaging and industrial testing. The book will have an in-depth

review of the research topics from world-leading specialists in the field. The conversion of the X-ray signal into analogue/digital value will be covered in some chapters. The authors also provide a review of CMOS chips for X-ray image sensors. Covers a broad range of topics, including an introduction to novel spectral Computed Tomography; Includes in-depth analysis on how to optimize X-ray detection; Discusses analysis of electronics for X-ray detection.