MEDICAL IMAGING
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10-15 February 2018
Marriott Marquis Houston
Houston, Texas, USA

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PROGRAM CURRENT AS OF 15 OCTOBER 2017
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**Courses**

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SPIE Medical Imaging offers focused, face-to-face instruction from some of the leading minds in medical imaging research and applications.

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**CONTINUING EDUCATION UNITS**
SPIE is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU.

Earn Course Credits: SPIE has applied to CAMPEP for approval of 37.5 MPCEC hours for its courses at Medical Imaging 2018. If you attend one of our Medical Imaging courses and meet CAMPEP’s qualifications, you may apply for these credits at no charge. CAMPEP is a continuing professional education accreditation organization specific to the medical imaging community.

**SATISFACTION GUARANTEED OR YOUR MONEY BACK.**
Fundamentals of Medical Image Processing and Analysis

SC086 • Course Level: Intermediate • CEU: 0.7
$520 SPIE Members • $274 SPIE Student Members
$610 Non-Members USD
Saturday 8:30 am to 5:30 pm
This course is also available in online format.

This course gives an overview of medical image formation, enhancement, analysis, visualization, and communication with many examples from medical applications. It starts with a brief introduction to medical imaging modalities and acquisition systems. Basic approaches to display one-, two-, and three-dimensional (3D) biomedical data are introduced. As a focus, image enhancement techniques, segmentation, texture analysis and their application in diagnostic imaging will be discussed. To complete this overview, storage, retrieval, and communication of medical images are also introduced.

In addition to this theoretical background, a 45 min practical demonstration with ImageJ is given. ImageJ is a Java-based platform for medical image enhancement and visualization. It is developed by the National Institutes of Health, USA, open source and freely available in the public domain. For this course, ImageJ is appropriately configured with useful plug-ins (e.g., DICOM import, 3D rendering) and distributed on CD-ROM. Attendees are welcome to perform on their own laptop computers.

LEARNING OUTCOMES
This course will enable you to:
• identify major processes involved in formation of medical images
• recognize the imaging modality from their visualization
• classify the various medical image processing algorithms
• describe fundamental methods of image enhancement
• enhance medical images using appropriate software
• visualize all types of medical image data
• appraise efficacy and drawbacks of several techniques of image segmentation
• get familiar with the fundamental concepts of texture analysis
• explain the basic principles of medical image communication
• get started with ImageJ and self-perform fundamentals of medical image processing

INTENDED AUDIENCE
Engineers, scientists, biomedical researchers and managers who need a basic understanding of medical image processing technologies and methods. Some prior background with image processing and computer technology will be helpful.

INSTRUCTOR
Thomas Deserno (née Lehmann), PhD, is full professor of Medical Informatics at RWTH Aachen University, Germany, where he heads the Division of Image and Data Management. He lectures graduate courses on biomedical imaging and image processing, co-authored the text Image Processing for the Medical Sciences (1997), and edited the Handbook of Medical Informatics (2005) and Biomedical Image Processing (2011). His research interests include discrete realizations of continuous image transforms, medical image processing applied to quantitative measurements for computer-assisted diagnoses, and content-based image retrieval from large medical databases. He has authored over 100 scientific publications, is Senior Member of IEEE and SPIE and a member of IADMRF, serves on the International Editorial Boards of Dentomaxillofacial Radiology, Methods of Information in Medicine, World Journal of Radiology, and The Scientific World Journal, and he is Co-editor Europe of the International Journal of Healthcare Information Systems and Informatics.

Attendee testimonial: Very good overview of the subject with good references for follow-up study of the topic.

Photon Counting CT

SC1129 • Course Level: Introductory • CEU: 0.4
$300 SPIE Members • $170 SPIE Student Members
$350 Non-Members USD
Sunday 1:30 pm to 5:30 pm
This course explains the principles of photon counting detectors for spectral x-ray imaging. Typical technical implementations are described and fundamental differences to energy integrating systems are pointed out. In particular, the issues of high-rate handling and the effect of detector cross talk on energy resolution are described. Requirements on electronics for spectral imaging in computed tomography is also discussed.

A second objective of the course is to describe how energy sensitive counting detectors make use of the energy sampling of the linear attenuation coefficients of the background and target materials for any given imaging task; methods like material basis decomposition and optimal energy weighting will be explained.

The second objective highlights the interesting fact that while the spatial-frequency descriptor of signal-to-noise-ratio transfer (DQE) of a system gives a complete characterization of performance for energy integrating (and pure photon counting) systems, it fails to characterize multibin systems since a complete description of the transfer characteristics requires specification of how the information of each energy bin is handled. The latter is in turn dependent on the imaging case at hand which shows that there is no such thing as an imaging case independent system DQE for photon counting multibin systems. We also suggest how this issue could be resolved.

LEARNING OUTCOMES
This course will enable you to:
• distinguish between the proposed detector materials in terms of their main physical limitations/challenges to high-rate energy resolved photon counting
• list essential requirements on read-out electronics and predict effect on image quality if not fulfilled
• explain the physical origin of pile-up and separate between the effects of decreased energy resolution and loss of counts
• explain the physical origins of cross-talk and how it degrades performance, both in terms of resolution and noise
• compute optimal weights for the energy bins
• illustrate how poor choice of weights results in inferior image quality
• perform material basis decomposition and explain why noise in decomposed images is a poor figure-of-merit
• distinguish between system DQE and task dependent DQE and suggest solutions to allow comparison at system level between multibin energy resolved systems and other solutions

INTENDED AUDIENCE
Scientists, engineers, or managers who wish to learn more about basic strengths and challenges of photon counting detectors for spectral x-ray imaging, how the data is treated and how performance can be quantified.

INSTRUCTOR
Mats Danielsson has been developing photon counting x-ray detectors for medical imaging for 15 years and his research has resulted in detector systems in worldwide clinical use. He received his Ph.D. in experimental physics in 1996 based on work at CERN, Geneva and later did his postdoc at Lawrence Berkeley National Laboratory. In 2006 he was appointed Professor at KTH Royal Institute of Technology in Stockholm, Sweden, where he heads the physics of medical imaging research group. Dr. Danielsson is a lifetime member of SPIE.

Martin Sjölin has worked with the development of photon-counting spectral x-ray detectors since 2011. He has worked on several topics related to photon-counting spectral detectors, including: energy calibration, geometric calibration, count-rate performance, sampling and digital data compression. Martin received his PhD from KTH Royal Institute of Technology, Sweden, in 2016 with the thesis “Methods of image acquisition and calibration for x-ray computed tomography”. His current research is focused on the design and development of spectral photon-counting detectors suitable for clinical CT.

Modern Diagnostic X-ray Sources

SC1183 • Course Level: Introductory • CEU: 0.4
$430 SPIE Members • $222 SPIE Student Members
$480 Non-Members USD
Sunday 1:30 pm to 5:30 pm
During recent decades, in particular since the advent of computed tomography and the increasing use of interventional X-ray systems, progress in the development of modern diagnostic X-ray sources has been tremendous. X-ray scientists and clinicians may want to improve their background knowledge about technology, application, features, potential hazards and diagnostic opportunities in practice.

Medical physicists are often struggling with unexpected side effects. This lecture will provide a sound basis for understanding the physics of production of “clinical” X-rays for diagnostics and briefly touch...
Courses

therapeutic use. It will treat functional principles of X-ray sources including high voltage supply. Design aspects, special features, radiation protection, and modern performance metric, manufacturing technology, and cost aspects will be discussed. Why is vacuum technology not at all outdated? Will we find the X-ray LED, compact X-ray Lasers or flat panel sources in medical imaging soon? Why do hundreds of tube types populate the market? The lecture will cover system performance aspects related to the source, material boundary conditions, and manufacturing technology. The quest for affordable healthcare demands for trade-offs between value and cost, and objective comparison of tube types. Initial costs and costs of tube replacement will be discussed as well as means to extend tube life and to save natural resources. Last but not least, the lecture may spark fascination for this species of off-the-mainstream vacuum electronics light sources.

LEARNING OUTCOMES

This course will enable you to:

• summarize the international development of X-ray tubes
• classify X-ray tubes by their basic technology and explain pros’ and cons’
• describe key components of X-ray tubes like bearings, cathodes, vacuum frame, and housing
• explain methods for heat management
• recognize side-effects like vacuum discharges and off-focal radiation and identify remedies
• summarize the peculiarities of bremsstrahlung from the various types of X-ray tubes
• explain the benefits of reflection targets for imaging
• predict the X-ray tube performance in an X-ray system using documented metrics
• analyze X-ray tubes by their initial and service costs in an imaging system
• predict the impact of the X-ray tube design on the clinical work-flow
• name the implemented measures for protection against hazards of ionizing radiation
• apply modern metric in the comparison and decision making process

INTENDED AUDIENCE

Medical X-ray researchers, X-ray physicists, medical physicists, radiologists, cardiologists and other surgeons with interest in X-ray diagnostics and interventional X-ray application, students of engineering, radiology and physics, X-ray system and tube developers, X-ray manufacturing staff, bodies, suppliers and personnel responsible for quality insurance, members of standardization committees, managers responsible for costs of service. Undergraduate training in engineering or science is assumed.

INSTRUCTOR

Rolf Behling is a physicist, Fellow Scientist of the Philips group and a veteran in the field of medical imaging. During his 35-year tenure in this industry, he headed departments for vacuum technology development, was responsible for international project coordination and summarization innovation, head of marketing and field support for X-ray tubes, department head for X-ray tube development, project manager, and manufacturing process physicist. The first ever game changing X-ray tube with liquid bearing was developed under his project leadership. Rolf Behling currently heads the Philips group for advanced development of X-ray tubes and X-ray generators at Philips Healthcare in Hamburg, Germany. He is a part-time lecturer at the University of Hamburg, and has contributed numerous patents and publications in the field of vacuum technology and medical imaging.

COURSE PRICE INCLUDES the text Modern Diagnostic X-Ray Sources, Technology, Manufacturing, Reliability (CRC Press, 2015) by Rolf Behling.

Modern Methodology for Measuring Dynamic Functional Connectivity in Neuroimaging Data Analysis

SC1184 • Course Level: Intermediate • CEU: 0.4
$300 SPIE Members • $170 SPIE Student Members
$350 Non-Members USD
Saturday 8:30 am to 12:30 pm

A dynamic version of neuroimaging data analysis not only emphasizes the functional specifications of brain regions, but also focuses on the massive parallel nature of distributed and interacting regions that are hypothesized to process the functional tasks under investigation. Studying brain interactions leads to an emerging field: Functional Connectivity (FC).

FC between two brain units (neuron columns, recording sites, neurons, brain systems, regions) are generally defined as the temporal correlation among time courses. Its objective is to capture the dynamic, context-dependent processes that may lead to preferential recruitment of some units over others. Based on the traditional Time Series theory, five classical measures - Coherence, Synchronization, Mutual Information, Nonlinear correlation coefficient, and Phase-Locking value are developed to assess FC. They are applied to different neuroimaging disciplines: functional Magnetic Resonance Imaging (fMRI), Magnetoencephalography (MEG), and Electroencephalography (EEG).

To tackle problems inherent in classical measures: (a) assumptions of stationarity of Time Series and time-invariance of FC over the entire time course, and (b) the lack of directional information flow between brain units, the methods for dynamic measures of FC and real time measure of FC have been developed. Rigorous examinations from theoretical methodology perspective, statistical reasoning, and quantitative evaluations, to each measure, are presented. The relations between these measures that provide the basis for consistent assessment and interpretation on FC are given. Examples from real neuroimaging data demonstrate that FC can serve as biomarkers for brain functions.

LEARNING OUTCOMES

This course will enable you to:

• describe and summarize statistical properties of neuroimaging data (fMRI, MEG, EEG)
• list and distinguish statistical reasoning and mathematical derivation of each classical measure of FC
• classify the limitations and conditions in developing each classical measure of FC
• identify the hidden assumptions in applying classical measures to Time Series of neuroimaging data
• formulate a protocol for applying dynamic measures of FC to Time Series of neuroimaging data
• explain why the proposed Phase-Locking value can achieve a real time measure of FC for MEG data
• formulate a procedure for applying Phase-Locking value to Time Series of neuroimaging data
• design experiments for measuring FC in resting status and with repeated stimulus

INTENDED AUDIENCE

This course is intended for engineers, physicists, scientists, researchers, radiologists, as well as students, who are in the field of medical imaging, neuroimaging data analysis, and brain study.

INSTRUCTOR

Tianhu Lei received his Ph.D. in System Engineering from the University of Pennsylvania. Since then, he has been with University of Maryland, the University of Pennsylvania, and University of Pittsburgh. He has more than 25 years of experience in medical imaging and image analysis research. He is the author of the book Statistics of Medical Imaging, CRC Press, 2012 which was awarded 2013 Ziegel Prize from Technometrics.

Deep Learning for Image Understanding

SC1235 • Course Level: Intermediate • CEU: 0.7
$520 SPIE Members • $274 SPIE Student Members
$610 Non-Members USD
Saturday 8:30 am to 5:30 pm

Segmentation, detection, and classification are major tasks in medical image analysis and image understanding. Medical imaging researchers heavily use the results of recent developments in machine learning approaches, and with deep learning methods they achieve significantly better results in many real-world problems compared to previous solutions. The course aims to enable students and professionals to apply deep learning methods to their data and problem. Using an interactive programming environment, participants of the course will practically explore all required steps and learn the tools and techniques from data preparation to result interpretation. We will work on example data and train models to segment anatomical structures, to detect abnormalities, and to classify them. We will also give brief insights into adjacent fields, like interpretation of trained models, generative models, image improvement, and image reconstruction from raw data. Participants will work in dockerized environments providing select-ed deep learning toolkit installations, example data, and teaching
SimpleITK Jupyter Notebooks: NEW Biomedical Image Analysis in Python

SC1236 • Course Level: Intermediate • CEU: 0.4
$300 SPIE Members • $170 SPIE Student Members
$350 Non-Members USD
Sunday 1:30 pm to 5:30 pm

SimpleITK is a simplified programming interface to the algorithms and data structures of the Insight Segmentation and Registration Toolkit (ITK). It supports bindings for multiple programming languages including C++, Python, R, Java, C#, Lua, Ruby and TCL. Combining SimpleITK’s Python binding with the Jupyter notebook web application creates an environment which facilitates collaborative development of biomedical image analysis workflows.

In this course, we will use a hands-on approach utilizing Python based SimpleITK Jupyter notebooks to explore and experiment with various toolkit features. Participants will follow along using their personal laptops, enabling them to explore the effects of changes and settings not covered by the instructor. We will start by introducing the toolkit’s two basic data elements, Images and Transformations. We will then explore the various features available in the toolkit’s registration framework including: optimizer selection, the use of linear and deformable transformations, the embedded multi-resolution framework, self-calibrating optimizers and the use of callbacks for registration progress monitoring. Finally, we will show how to use SimpleITK as a tool for image preparation and data augmentation for deep learning via spatial and intensity transformations.

LEARNING OUTCOMES
This course will enable you to:
• describe the components that comprise the SimpleITK registration framework.
• use the SimpleITK registration framework to register their own data by selecting the appropriate components and settings.
• list all of the SimpleITK transformation types and image intensity manipulation filters.
• use SimpleITK to prepare images as input for deep learning networks, including generation of synthetic images for data augmentation.

INTENDED AUDIENCE
Students, researchers and engineers involved in biomedical image analysis with the need for convenient image IO, image registration and image manipulation via spatial and intensity transformations. Knowledge of the Python programming language is assumed.

INSTRUCTOR
Bradley Lowekamp is a Computer Scientist at MSC LLC, and the Office of High Performance Computing and Communications, US National Library of Medicine. He is the lead architect and developer of SimpleITK. He is actively involved in the development of open source software, contributing to multiple projects including 3D Slicer, ITK, and SimpleITK. Mr. Lowekamp’s interests include biomedical image analysis and software engineering.


As this is a hands-on course, participants will need to bring their own laptops.

Participants will be provided with the source code for all of the SimpleITK Jupyter notebooks (Python code) and the image data used in the course. These will be provided under an Apache 2.0 license. Instructors will email people registered for this course in advance so that we can provide them with instructions on how to install the SimpleITK Jupyter notebook environment before arriving at the conference venue. For those who do not install the environment in advance, one of the instructors will help them with the installation at the beginning of the first session.

Virtual Clinical Trials: NEW An In-depth Tutorial
SC1239 • Course Level: Intermediate • CEU: 0.4
$300 SPIE Members • $170 SPIE Student Members
$350 Non-Members USD
Saturday 8:30 am to 12:30 pm

In 2014, it was estimated that there were just 450 anatomic phantoms in the world. Today, based on advanced models of breast anatomy, an infinite number of models exist. As such, it is possible to simulate individuals and specific pathologies from the population of all humans with increasing higher accuracy. This, together with advanced models of image simulation, image processing and image reconstruction, means that we can create arbitrarily large databases of simulated images. At the same time, advances in machine observer methods mean that it is possible to conduct virtual clinical trials (VCT) using the simulated images, together with simulations of medical displays, human optical perception and cognition.

The logistics of conducting VCT with thousands of patients is similar to the logistics of organizing the data from clinical trials of similar size. As such, we have developed a standards document outlining methods for conducting VCT, storing VCT results (intermediate and final), and communicating these image data and associate metadata between VCT components. In this course, we will use our experience in conducting large-scale VCT to encourage those new to the field to adopt VCT methods and to aid those already conducting VCT. The course will have applicability to VCT for designing new medical imaging equipment and methods, to use VCT data for prototyping and/or complementing the conduct of real clinical trials, and for preparing VCT data for regulatory approvals of new systems and methods.

LEARNING OUTCOMES
This course will enable you to:
• describe the roles and methods for conducting VCT
• identify the necessary constituent software components for conducting VCT
Courses

Spectral CT Imaging

SC987 • Course Level: Intermediate • CEU: 0.4
$300 SPIE Members • $170 SPIE Student Members
$350 Non-Members USD
Sunday 8:30 am to 12:30 pm

This course provides attendees with an advanced knowledge of spectral CT imaging. The course focuses on the properties of a spectral CT measurement and the main applications in spectral CT reconstruction and spectral CT image postprocessing. Many clinical examples of spectral CT imaging applications are provided to illustrate the diagnostic outcome of this technique.

LEARNING OUTCOMES
• describe the system properties of a spectral CT system
• compare different system approaches to acquire spectral CT data, such as dual source CT, kV switching and energy-resolving detectors
• summarize various algorithms for spectral CT reconstructions and spectral CT image postprocessing
• list the relevant clinical applications of spectral CT
• explain the main challenges of spectral CT techniques

INTENDED AUDIENCE
Clinicians, scientists, and administrators from academia, industry and government.

INSTRUCTOR
Andrew D. Maidment has 30 years of experience in breast cancer research, with specific training and expertise in development of digital x-ray detectors and 3D breast x-ray imaging. Dr. Maidment has been conducting research into VCT for nearly 20 years, has extensive grant funding in VCTs, and has published extensively in this field. As an Associate Professor in Radiology at the University of Pennsylvania, he has extensive teaching experience.

Predrag Bakic has more than 20 years experience in breast cancer research, with specific training and expertise in developing and conducting VCT. Dr. Bakic’s PhD thesis was on the topic of breast anatomy models for imaging simulation.

Bruno Barufaldi received his Ph.D. from the University of Sao Paolo in 2016. For the last 2 years, he has been active in the field of VCT, designing much of the pipeline software used in the OpenVCT suite of software. The latest draft of the OpenVCT standard will be provided to participants. This document is open-source and does not have copyright restrictions. Instructors will quickly introduce the material to those unfamiliar with VCT. However, the majority of the material will be at the intermediate to advanced level to benefit those with VCT experience.

Writing for Publication

WS776 • Course Level: Introductory • CEU: 0.4
$60 SPIE Members • $50 Student Members
$110 Non-Members USD
Saturday 1:30 pm to 5:30 pm

This course teaches attendees the skills needed to create well-written scientific articles for publication in journals or proceedings. We discuss the structure of a paper and the roles of its various parts. You will learn the principles of good technical writing and how to avoid common pitfalls. We will discuss how to use writer’s aids, many of which are available online.

LEARNING OUTCOMES
• name the standards relevant for conducting VCT, including DICOM, ASME, IEEE, AAPM, etc.
• construct and design examples of VCTs to illustrate there usage
• demonstrate existing use cases
• explain the underlying statistical considerations for conducting VCT

INTENDED AUDIENCE
This material is intended for anyone who is interested in the usage of the spectral information provided by modern CT systems. Those who wish to update their knowledge on the CT measurement and reconstruction process and who work with spectral CT applications will find this course valuable.

INSTRUCTOR
Bernhard Schmidt is head of the Siemens Healthcare CT Scanner Applications and Algorithm Predevelopment Group. Over the last few years, he has been closely involved into the development of the Dual Energy product provided by Siemens.

Thomas Flohr is head of Siemens Healthcare CT physics and applications development and has been instrumental in developing multi-detector row CT and dual-source CT. He is an assistant professor at the Eberhard-Karls University, Tübingen, Germany.

Katherine Grant earned her Bachelor of Science degree in Physics from Miami University (Oxford, OH) in 2000. The Minnesota native went on to earn her PhD in Biomedical Engineering from the Mayo Clinic College of Medicine in 2005 with an emphasis in medical imaging and neurophysiology. After graduating, she was awarded a postdoctoral fellowship from the Director of Central/National Intelligence and simultaneously worked as a biomedical engineering research associate at the Mayo Clinic. Dr. Grant joined Siemens Healthcare as a Staff Scientist in 2009 and served as a scientific research collaboration manager within the Computed Tomography Applications and Algorithm Predevelopment Group. Over the last few years, he has been closely involved into the development of the Dual Energy product provided by Siemens.

Attendee testimonial:
Great course, everything is clearly explained, the instructor was (very) open for questions/suggestions. The course notes are very clear and I will definitely use them as guideline while writing my next paper!
Registration

ONSITE REGISTRATION AND BADGE PICK-UP HOURS
Texan Foyer, 4th Floor
Saturday February 10 .......................... 7:15 am to 4:00 pm
Sunday February 11 .......................... 7:15 am to 4:00 pm
Monday February 12 .......................... 7:30 am to 4:00 pm
Tuesday February 13 .......................... 7:30 am to 4:00 pm
Wednesday February 14 ........................ 7:30 am to 4:00 pm
Thursday February 15 .......................... 7:30 am to 1:30 pm

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COURSE AND WORKSHOP REGISTRATION
Courses and workshops are priced separately. Course-only registration includes your selected course(s), course notes, and coffee breaks. Course prices include applicable taxes. Onsite, please go to Course Desk after you pick up your badge.

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Conference registration prices increase by US$150 (Students, $75) and course prices increase $75 after 26 January 2018. The online form will automatically display the increased prices.

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