E9 243 JAN 3:0

Computer Aided Tom ographic Imaging

Instructor

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Department: ELECTRICAL ENGINEERING

Course Time: TUE. THU. 11:30-1.00 PM

Lecture venue: To Be Announced

Detailed Course Page: http://www.ee.iisc.ac.in/SOI_2017.pdf

Announcements

The first of the 2018 session will be on 4th January in Department of Electrical Engineering in lecture class rooms.

Brief description of the course

This course is an elective course and introduces the imaging modalities followed by basic and advanced 2D and 3D reconstruction techniques. The reconstruction techniques include exact and non iterative as well as iterative techniques. It also introduces data acquisition processes, errors, and artifacts.

Prerequisites

Fundamentals of Digital Signal Processing, knowledge of solid geometry, Matrix Theory.

Syllabus

Introduction to principles of tomography and applications, tomographic imaging. Radon transform and its properties, mathematical framework. Introduction to X-ray tomography, emission computer tomography, magnetic resonance imaging systems. Projection and Fourier slice theorem. Scanning geometries: translate and rotate, translate-rotate, rotate on a circular trajectory for 2-D imaging and helical or spiral scan trajectory for 3-D imaging. Transform domain algorithms: Fourier inversion algorithms, filtered back projection algorithms â€“ reconstruction with non-diffracting sources, parallel projections and fan

projections for 2-D and cone beam projections on circular and spiral trajectory for 3-D reconstruction. Computer implementation, iterative reconstruction techniques: algebraic reconstruction techniques, statistical modeling of generation, transmission and detection processes in X-Ray CT, artifacts and noise in CT images. Image reconstruction with incomplete and noisy data, applications of Radon transform in 2-D Signal and image processing.

Course outcomes

After taking this course ...

1. The student will learn principles of tomographic imaging with different modalities such as x-ray, PET and SPECT, NMR/MRI , ultra sound and optical with non-diffracting and diffracting energy sources.

2. Learn principles of non-invasive medical imaging techniques and non destructive techniques for industrial imaging.

3. Understand projections and projection slice theorem

4. various types of data acquisition in tomography - parallel beam, fan-beam and cone-beam as well as circular and helical trajectories of the source and detectors. First to 4th generation of CT.

5. Learn transform domain non-iterative 2D and 3D reconstruction techniques for non diffracting radiation sources

6. Understand Fourier inversion technique and Fourier methods of reconstruction techniques

7. Learn the statistical nature of the radiation energy generation, propagation, and detection. The errors and artifacts due to the practical limitations of these processes.

8. Exposed to a class of Algebraic Reconstruction Techniques (ART) and its variants.

9. Some applications of Tomographic principles in signal processing and image processing.

Grading policy

20% for the assignments

30% for the mid-term examination

50% for the term project and final examination

Assignments

6 assignment problem sets evenly distributed over the term will be given which need to be implemented and demonstrated.

Resources

Kak A C, and Slaney M, Principles of Computerized Tomographic Imaging, IEEE Press, 1988.

Herman G T, Image Reconstruction from Projections, Implementation and Applications: Topics in Applied Physics, Vol 32, Springer Verlag,
1979.,

Natterer F, The Mathematics of Computerized Tomography, SIAM Classics In Applied Mathematics, Vol. 32, 2001.

Natterer F, and W ubbeling F, Mathematical Tools in Image Reconstruction, SIAM, 2001