Middle East Technical University
Department of Electrical and Electronics Engineering

EE 519 Medical Imaging
2021-2022 Spring Semester

Term project II:

Implementation of Algebraic Reconstruction Techniques for fan-beam CT system.

Attenuation of x-rays as they propagate through biological tissues inside the body, and dependence of the attenuation rate on tissue characteristics can be used to reconstruct medical images. In this term project, algebraic reconstruction techniques, which are widely used for many other imaging modalities with diffracting or non-diffracting sources, will be implemented for **Fan-Beam** x-ray **Tomographic Imaging with curvilinear (equal angularly spaced) array of detectors**.

Line Integrals and Projections

A line integral is the integral of a physical parameter of the object along a line. For the case of x-ray tomography, the line integral is the total attenuation of an x-ray beam when the ray passes through the object along a straight line. A projection function can be formed, by combining a set of line integrals corresponding to multiple x-ray beams. In fan-beam projection, the object is illuminated by x-ray beams fan out from a point source and line integrals for equal angularly spaced beam paths are combined to form a projection. Calculation of projections for known attenuation coefficient distribution and incident beam intensity is defined as ***forward problem*** of x-ray imaging**. Your code to simulate measured projections of Term Project I can be adopted to generate the measured projections to reconstruct images by using algebraic reconstruction algorithms in this Term Project.**

Term Project Evaluation

- Every student is expected to prepare the project individually.
- MATLAB, Python, C++, C, …, can be used for programming. MATLAB is highly recommended for its built-in functions (e.g. FFT, convolution, and graphical tools). Program should include a graphical user interface (GUI).
- For projection and backprojection stages of the project, the developed program code is to be tested with the sample images provided via METU Class as input attenuation coefficient distributions (the same sample images as provided for term project I).
- The students are required to make a demonstration to the instructor and submit a complete final report in an IEEE manuscript (paper) format.

Minimum image size = 50x50 pixels
Minimum distance between the source and the detector array = 71 pixels
Number of detectors = VARIABLE (min.=10, max.= Length of the detector array)
Number of projections = VARIABLE (min.=2-180)

Your MATLAB program (with a GUI) should be able to reconstruct tomographic images by using ART, SIRT and SART algorithms from the simulated projections.

PROJECT REPORT:

Your report should contain at least the following illustrations:

- Images of each phantom (provided at METU Class) reconstructed using ART, SIRT and SART algorithms from the simulated projections.

Project report must be written on a scientific article format and should at least contain the parts:

- Abstract (brief summary of your work)
- Introduction (a short history about x-ray imaging, purpose and summary of report)
- Theory (mathematical background)
- Results (sample outputs for forward and inverse problems; use quantitative evaluation measures)
- Discussion and conclusion (discussion on the presented results)
- List of References (Use IEEE Transactions Bibliography Style)

This outline can be extended or subsections can be added. The logical flow of the content and use of language will also be considered during grading.

Developed algorithms will be tested using sample inputs. Note that usability of the program and quality of outputting features will be considered in determination of the demonstration grade.

Make sure that your code and report are your own work, otherwise **disciplinary action will be taken** and **zero grade will be given** to your project.

Project reports should be submitted to the instructor at the latest on the due date.
The program files will also be submitted in electronic format. Do not forget to submit all necessary files required while running the program (i.e. library files for C and C++, unit files for PASCAL or m-files for MATLAB which are not common).

The MSWord document file of the report and the software must be zipped into a single file and attached to an e-mailed to: meyub@metu.edu.tr

A pdf of the report must also be submitted via METU Class.

The following honor pledge should be added to the title page of the project report and signed by the student:

Honor pledge: I declare that each step of this term project is my own work and all information in this report has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Student's name: ……..Signature:……

Due date: June 5th, 2022, time: 23:59