EE 438 Digital Signal Processing with Applications
Tomographic Image Reconstruction Project
November 10, 1995

The objective of the course project will be to develop an efficient and accurate algorithm for image reconstruction from projection data. Specifically, you will be provided with sinogram data in matlab form, and you must reconstruct the image cross-sections with the highest quality and the minimum computation. Each sinogram with contain a $M \times N$ matrix of projection measurements $p(i, j)$ which corresponds to an angle of $\theta = \pi(i-1)/M$ and displacement of $t = \left(j - \frac{N+1}{2} \right)$. Each projection, $p(i, j)$, is the number of photons which pass through the object without being absorbed. The number of photons which enter the object is known as the dosage and is denoted by λ_t. The value of λ_t will also be specified with each sinogram. The data set will be available from the directory /home/albrecht/bouman/bouman/ee438/project .

A variety of data sets will be provided for you to test your algorithms. In each case, the true image cross-section is formed by no more than 4 regions, each with a fixed density. Your results will be judged based on criteria which include:
1) The accurate reconstruction of these regions and there boundaries.
2) The accurate estimation of each regions density.
3) The algorithms robustness to noise.
4) The algorithms robustness to small numbers of projection angles.
5) The computational speed of the algorithm and implementation.
4) The creativity of your approach.
5) The quality of the proposal and final report.
6) The quality of the final poster presentation.

Each group should formulate their own approach to the problem. For example, one group may emphasize computational simplicity, while another may attempt to achieve the maximum accuracy and robustness. You are encouraged to use methods taught in class, lab or learned through independent study. **Remember, that an overly ambitious project that fails will receive a lower grade than a simple project that works.**

There will be three parts to the project. Each part is outlined below.

Project Proposal
Due date: November 20
Page limitation: 3 pages

The project proposal should give a clear and detailed plan for the implementation of the reconstruction algorithm. It should include

1) A mathematical description of all algorithms to be used.
2) A description of critical tasks.
3) A statement of each group members responsibilities in the project.
4) A time line with completion dates for each critical task.

Project Report
Due date: December 6

The Final Report should contain the following (some of these items may be lifted from earlier reports):

1) *Abstract* (1/2 page) - A brief explanation of your approach.

2) *Theory* (3 pages) - A detailed explanation of your approach. This section should focus on the novel aspects of your work, and refer to course notes, laboratories, or outside references when possible.

3) *Implementation* (1 pages) - A brief description of the software modules that were developed.

4) *Results* (1 page + figures) - This section should present the results of computer experiments. Graphical presentation is preferred. It should include performance and CPU times for the example data sets provided.

5) *Conclusions* (1/2 page) - This section should summarized the strengths and weaknesses of your method. It should also make recommendations for further development of this method.

6) *Appendix A* - List of who did what.

7) *Appendix B* - Complete listing of source code for the method.

Final Presentation
Due date: December 8
Time: Two shifts from 7:00-9:00 PM(?)

Each group will present and demonstrate their algorithm and software during a one hour "poster session". During this session each group will be expected to give a 15 minute presentation to an instructor. During this presentation, you will be expected to do the following:

1) Present your method using a poster as a visual aid. This presentation should be 5-10 minutes in length and should concentrate on the most important and novel aspects of your work.

2) Demonstrate your software accuracy and computation speed using data sets provided at the presentation. These data sets will be new, so you should be sure that your software is **bug free**. You will be expected to provide the instructor with a hard copy of your results and the computation time for each example data set.