Assigned Exercises – MIR 2010

Assignment #1 – Due Saturday April 3, 2010

1. Write a program to compute Machine Epsilon. [1 Point]
2. Look for Matlab functions that implement the topics discussed in this lecture and read help. [1 Point]
3. Implement code for steepest descent and conjugate gradient methods and compare results to SVD based solution (pseudo-inverse) using only a few iterations. [1 Point]

Assignment #2 – Due Saturday April 3, 2010

4. Write a program to verify the projection-slice theorem using a simple 2D phantom (e.g., a basic shape like a square). [1 Point]
5. Perform interlaced sampling on a function of your choice with known analytical Fourier transform and verify the interlaced Fourier transform theorem. [1 Point]
6. Write a Matlab program to implement the analytical Shepp-Logan phantom and test it using sampling on a uniform grid. [2 Points]

Assignment #3 – Due Saturday April 3, 2010

7. Do a literature search on the problem of nonuniform sampling in 2D and summarize your findings about the sampling criteria to avoid aliasing in less than 500 words (in addition to a list of references). [1 Point]
8. (a) Write a program to generate radial k-space sampling of the Shepp-Logan phantom. (b) Write a program to perform gridding on the generated radial k-space data to compute an image. [Parts (a)+(b) together = 2 Points]
9. In less than 500 words, describe how one can compare the quality of different reconstruction methods and/or parameters based on measurements from the generated images. [1 Point]

Assignment #4 – Due Saturday April 3, 2010

10. Verify the energy compactness transformation and generate Figure 2 (c) for any trajectory you prefer. [1 Point]
11. Assuming that we have a rectilinear sampling instead of the nonuniform sampling in this paper, how do you expect the linear system to look like? [1 Points]
12. Assume that we are constructing an NxN image, compute the exact number of computation (not an order or computation) detailing the list of computations in each step in the implementation. [1 Point]

Assignment #5 – Due Saturday April 17, 2010

13. Write a short paragraph (less than 500 words) on which partial Fourier reconstruction method you prefer and why. [1 Point]

14. Use the data set on the class web site to implement one of the methods of partial Fourier reconstruction. The data set provided is for full k-space for you to have a gold standard to your reconstruction. You should use only part of it as an input to your reconstruction (say half + 16 lines). [2 Points]

15. Do a literature search on the topic of partial Fourier reconstruction and come up with a list of all references related to the subject. [1 Point]

Assignment #6 – Due Saturday April 17, 2010

16. Write a short literature review section on the methods used for inter-slice motion correction in MRI with references. [1 Point]

17. Use the data set on the class web site to show that 2D translational motion does not affect the magnitude of k-space and that such motion can be estimated by correlation based method. [2 Points]

18. Do a literature search on the topic of motion artifacts in all medical imaging modalities and come up with a list of all references related to the subject. [1 Point]

Assignment #7 – Due Saturday May 8, 2010

19. Use one of data sets available on the class web site to reconstruct an ultrasound image. Assume any missing imaging parameters outside those given in the data set description. [5 Points]

20. Do a literature search on the topic of ultrasound beamforming and scan conversion and come up with a list of all references related to the subject. [1 Point]

Assignment #8 – Due Saturday May 15, 2010

21. Design an experiment to use compressed sensing to estimate a 1D sparse signal from its random samples. Use different degrees of undersampling and comment on the quality of your results. [2 Points]

22. Design an experiment to use compressed sensing to compute an image of a randomly sampled k-space of a Shepp-Logan phantom. Use different degrees of undersampling and comment on the quality of your results. [4 Point]