Computational Electromagnetics: HW 3

Instructions: 1. You can solve this homework individually, or in groups of two. 2. Make reasonable assumptions, STATE them, and include any references you might have used. 3. **[5 pts]** are reserved for neat and systematic presentation of results. 4. Plagiarism $\Rightarrow$ Course fail.
Total points: **[60]**. **Issued:** 01 Apr 2015, **Due:** 20 April 2015.

In this exercise, you will use integral equation methods to compute the radar cross-section of an aircraft of your choice. The objective is to give you a feel for the sort of design choices that need to be made to solve real world problems. Proceed in these steps:

1. Obtain a 2D view of the aircraft. There are many such images available on the internet. One site with a lot of examples is: https://www.fiddlersgreen.net/shop/category/name/Aircraft.html. Look for a side view image such as the bottom most part of Figure 1.

2. Assume that the entire body of the aircraft can be modelled as a PEC, so that the interior of the aircraft need not be modelled. Obtain an outline of the side view using Matlab or any other image processing tool.

3. Now, discretize the outline into segments of length $\approx \lambda/15$ and compute the 2D RCS of the aircraft for TM polarization. Be sure to write down the problem formulation properly starting from the operator viewpoint, then the matrix elements, and finally the expression for the radar cross-section.

4. Assume the aircraft is illuminated by a S-band radar wave (3 GHz) at 45° from the x-axis, and that the aircraft is level with the ground and heading in the direction of the radar. Plot the RCS at all angles, and mention what the radar would measure.

Fig. 1. Views of Sukhoi-27. Credit: http://www.fiddlersgreen.net/models/aircraft/Sukhoi-Su27.html

5. Make suitable assumptions about the scale of your model (i.e. ratio of simulated aircraft size to actual aircraft size). First attempt a 1:1 model, and if it doesn't work (due to the size of the matrix becoming too large), attempt the closest scale that is feasible. Tip: keep your image fixed, and change the wavelength to get the correct size/wavelength ratio. For e.g. the physical dimension of an aircraft might be around 20m, and the radar wavelength is 10cm at 3GHz. If your image is now 20cm, then chose a wavelength of 1mm to simulate a 1:1 model. If you shrink your image to 10cm, OR increase your wavelength to 2mm, you have simulated a 1:2 model.

IMP: Point (2) above can be done collaboratively by the entire class. There are 10 bonus points for the group which implements (2) first *and* makes the code available to the rest of the class. This code must take as input a side view, a discretization parameter, and outputs the coordinates of the discretized contour in a usable format.