G2S3 :: July 2011 :: Waves and Imaging :: ISAR, July 7 version

Make an image from the backhoe data set. It is available at

`http://homepages.rpi.edu/~cheney/radar.html`

(scroll down to backhoe data)

The data is in Matlab-readable format; use

```
load backhoe_el000_az350to100.mat
```

to load the data for elevation zero. In your workspace you will find data for different polarizations (HH, HV, and VV) but you can just use one (or alternatively, make an image from each and add the images).

1. The easiest approach is to use data for a narrow angle (2 or 3 degrees) and simply Fourier transform in both directions. The 2D Fourier transform command is fft2; or you can do two 1D Fourier transforms using fft and transpose. The command fftshift may be useful: it plots zero frequency at the center instead of the edge.

   The command I recommend for plotting is

   ```
   pcolor(abs(<Fourier transformed data variable>))
   ```

   If you feel ambitious, you could make a movie from a sequence of small angles.

2. A better approach to deal with a wider range of angles is to view data as coming from a Radon transform via the Fourier slice theorem. In that case the data are modeled as

   $$D(\omega, \phi) = \hat{f}(\omega e_\phi),$$

   where ω is the frequency (or the wave vector via $k = 2\omega/c$ – a scaling doesn't make much of a difference) and $e_\phi = (\cos\phi, \sin\phi)$ was called θ by Frank. Use the filtered backprojection formula from Frank's lab to form an image.

3. Refine the backprojection formula above to remove the far-field approximation and take into account the radar-adapted filtering operation:

   $$f(x) = \iint e^{2i\omega\|x - e_\phi\|/c} a(x, \omega, \theta) D(\omega, \phi)\, d\phi d\omega,$$

   where a is an adequate amplitude (see Margaret's notes).