Alexander Lin
APh/BE 161 Project Proposal

Image segmentation: One of the comments Dr. Philips made in class was how ridiculous it was that in the electron microscopy slices of the Golgi apparatus that the different parts were traced manually rather than using a more sophisticated algorithm. I would like to explore this further by using ImageJ and a number of different contour tracing algorithms to determine the circumference of the carotid artery in a time lapse series of MRI images of the carotid artery (Figure 1). This will be used to determine change in lumen size over different time points to give a measure of strain. Current methods of strain measurement have used manually determined changes in lumen diameter given by the equation [1]:

Figure 1. Lumen diameter measurements in a single frame of a time lapse series of MRI images of the carotid artery.

$S_{CINE} = [1-(Rh_1*Rv_1)/(Rh_2*Rv_2)]/2$ where Rh_1 is the horizontal diameter at the first time point, Rv_1 is the vertical diameter at the first time point, and Rh_2 and Rv_2 are the diameters at the second time point. The automated measurements will then be compared with manual measurements. Reproducibility studies will be conducted to determine which will be the more robust measurement. Ultimately, these lumen diameter measurements will be compared to strain measurements obtained with a novel MRI imaging sequence (DENSE-MRI) which uses multiple data points across the lumen wall to track change in position over time to give circumferential strain governed by the equation [2]: $S_{DENSE} = [L_1\cos(\theta_1) – L_0(\cos(\theta_0)]/L_0\cos(\theta_0)$ (Figure 2).
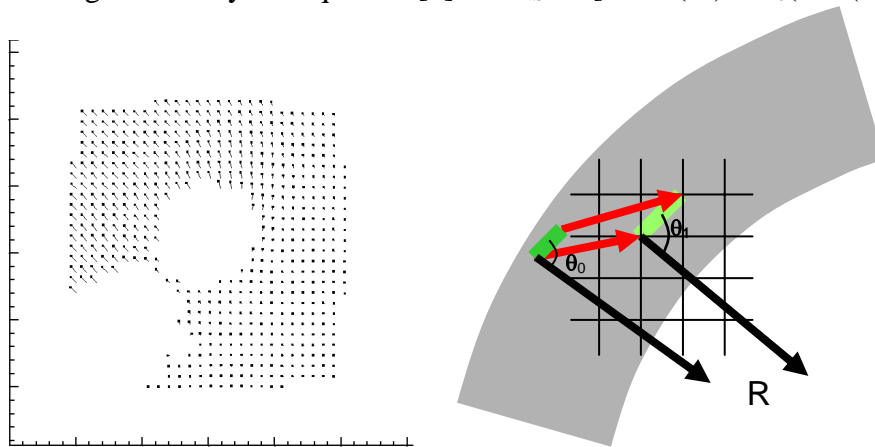

Figure 2. Left: DENSE displacement map. Right: Method for calculating strain using DENSE displacement.

Previous studies have demonstrated that atherosclerotic plaques form in areas of high strain [3]. The plaques can grow large enough to block the flow of blood through the vessel (stenosis) but of greater concern are those plaques that are fragile and may rupture causing blood clots (thrombus) to form, resulting in heart attack or stroke [4]. This study will provide multiple methods of *in vivo* strain measurements in the carotid arteries which could be used to predict the formation of these plaques so that they can be monitored and treated before they rupture.

References:
1) Younis HF et al. *Biomech Model Mechanobiol.* 2004 Sep;3(1):17-32.
2) Aletras, A.H., et al. *J Magn Reson*, 1999. 140(1): p. 41-57.
3) Thubrikar MJ, Robicsek F. *Ann Thorac Surg.* 1995 Jun;59(6):1594-603.
4) *Atherosclerosis*, in Heart and Stroke Encyclopedia. 2005, American Heart Association.