Original Proposal:

3D Whisker Shape Parameter Extraction
Period: One course unit Spring 2020, plus full-time research either Summer 2020 or Fall 2020**Brief:** Seals use their sensitive whiskers to track wakes of fish. We would like to build a robot that has similar capabilities. To do so first requires us to quantify the geometric properties of tapered, undulated seal whiskers. Seal whiskers tend to have elliptical cross-sections and an intrinsic curvature that resembles a quadratic function. The diameter of the whisker undulates in both major and minor axes. We have already completed CT scans of ~500 whiskers. We are now in the process of segmenting the whiskers and saving them individually in surface or mesh files. The goal of this project is to use computer vision techniques to automatically calculate specific geometric properties (arclength, base diameter, average peak to peak length, average crest height, etc.) using these files. Using an equation that describes the surface of a "generic" seal whisker, we will write an efficient and global optimization algorithm to tune the parameters of that "generic" equation to the surface equation of the real whisker. As a starting point, 2D scans of the same seal whiskers will be used as a "first guess" of the parameters for the major axis of the 3D whisker.
Outcomes: By the end of the project, the student should develop code architecture that:

1. Estimates the parameters for the major axis of an undulated seal whisker based on 2D scans
2. Optimizes the parameters for a generic 3D whisker to match the shape of a real 3D whisker
3. Optional: If there is time, the student could participate in either refining the CT scanning, segmentation, and smoothing procedure, or in the analysis of the data, including principal component analysis of the parameters.

Student Background: This project is new in conception and our lab is learning a great deal about software requirement. The individual who undertakes this project will have considerable autonomy and an opportunity to experiment with different techniques, while learning alongside the lab. We are looking for a skilled programmer who ideally has experience with 3D scans/point clouds, GeoMagic, Python, PyCharm/Jupyter Notebook, and/or Matlab. Familiarity or exposure to working with surfaces and meshes is preferred. For the 2D scans, experience with OpenCV and basic image processing is ideal. Experience with Fourier Analysis would be useful but not required. (edited)