ESE 650 Project 2: Orientation Tracking

*Due Date: **2/12/2015 at 1:30pm** on Canvas, and in class*

In this project, you will implement a Kalman filter to track three dimensional orientation. Given IMU sensor readings from gyroscopes and accelerometers, you will estimate the underlying three-dimensional orientation by learning the appropriate model parameters from training data given by a Vicon motion capture system. You should then be able to generate a real-time panoramic image from camera images using the 3D orientation filter.

1. DOWNLOAD DATA. A set of IMU data will be available at https://upenn.box.com/2015ese650-project2-train. One of data files contains the raw IMU readings sampled in time. Another set of data gives the corresponding tracking information from the Vicon motion capture system. There will also be a file containing RGB images from a camera. Download these files and be sure you can load and interpret the file formats.

2. SENSOR CALIBRATION. Note that the biases and scale factors of the sensors are unknown, as well as the registration between the IMU coordinate system and the Vicon global coordinate system. You will have to figure them out.

3. IMPLEMENT KF. You will write a filter to process this data and track the orientation of the platform. You can try to use a Kalman filter, EKF or UKF to accomplish this. You will have to optimize over model parameters. You can compare your resulting orientation estimate with the "ground truth" estimate from the Vicon. A simple plotting program called "rotplot.m" is also provided to help you visualize your results.

4. FOR TESTING, make sure that your program can process new datasets containing only IMU readings without Vicon estimates. Your program should then filter this data, and then generate and display the estimated orientation.

5. VISUALIZATION. You should then construct and display a panoramic image by stitching the associated RGB camera images in a proper way based on the estimated orientation.

6. SUBMISSION. You will upload to Canvas a written description of your algorithm in PDF form and a zip file of your code by 1:30 pm. Use the naming convention “project1_[YourPennKey].pdf” and “project1_[YourPennKey].zip”.
   Also, you will upload to Canvas a file containing the test results (graph, stitched image, etc) in PDF form by 6 pm.

7. PRESENTATION. You are expected to bring your own laptop or use the classroom computer. The classroom computer has MATLAB installed but no compatibility is guaranteed. The projector has a VGA port and you may need a VGA adaptor for your laptop. During the presentation, you will be asked to present your algorithm and run your code on a set of test data. The test data will be released both online and on a USB flash disk prior to the presentations. **Clearly presenting your approach and having good algorithm performance are equally important.**