

ECE 4310/6310 Introduction to Computer Vision

Lab #7 – motion tracking

In this project each student must calculate motion using accelerometers and gyroscopes. A file of data recorded using an iPhone is available at the course website. There are 7 columns in the file, containing the following data:

time x_acc y_acc z_acc pitch roll yaw

The units for time are seconds. Data was sampled at 20 Hz, so there are 0.05 seconds between each row. The units for the accelerometer data are gravities (G). The units for the gyroscope data are radians per second.

The iPhone was moved individually along or about each axis independently for a period of 2-3 seconds. Between each motion, the iPhone was held at rest for 2-3 seconds. The goal of the lab is to automatically segment the data into periods of motion and periods of rest, and calculate the motion along and about each axis during the periods of motion.

To segment the data, you should use a window and calculate the variance of the data along all 6 axes. When those variances are all less than some threshold, the iPhone is at rest, and when any of the 6 variances is greater than the threshold, the iPhone is in motion. It is up to you to determine an appropriate window size and threshold(s). Note that the units are different for accelerometers and gyroscopes, so the thresholds will almost certainly be different. You may consider smoothing the data first, especially for visualization during debugging, but it is not required.

To calculate the motion, the data must be integrated (gyroscopes) or double integrated (accelerometers). For the gyroscopes, this can be accomplished by multiplying the data by the time between samples. For the accelerometers, you must calculate three values: the velocity at the end of a sampling period, the average velocity during the sampling period, and then the distance traveled during the sampling period. Assume the initial velocity is zero. The velocity at the time of a data sample is equal to the velocity at the time of the previous sample plus the acceleration reading multiplied by the time between samples. This assumes constant acceleration, which is okay because the sampling interval is small. The average velocity during the sampling period is the average of the initial and final velocities. The distance traveled during the sampling period is the average velocity multiplied by the time between samples.

The following table is a helpful guide. Assume the sampling interval is 1 second, distance units are meters, velocity is meters/second, and acceleration is meters/second/second.

time	accel (data)	velocity (at end of sampling period)	average velocity (during sampling period)	distance moved (during sampling period)	cumulative distance moved
initial	-	0	0	0	0
0	2	2	1	1	1
1	1	3	2.5	2.5	3.5
2	4	7	5	5	8.5

For each detected period of motion, your program should report the total linear distance along each axis and the total angular rotation about each axis. Note that some axes will lend themselves to easier calculations than others. (Why?)

You must write a brief report that includes the times and indices of the detected periods of motion. This should take the form of a table, with each row indicating a period of motion (or rest) and each column providing the linear distances and angular rotations for each axis during each detected period of motion (in other words, how did the iPhone move during that period of time).

The report due date is given at the web site. Reports will be collected in class.