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Lab 7

Calculating Gyroscope Values and Distances

After saving all data to local arrays, windows of size 5 were created of every datapoint, and this window was used to determine variance values for each direction of motion and each rotational direction. These variances were then compared to thresholds determined through trial-and-error as well as viewing the data provided to know when motion should be detected. If motion was detected, the cumulative distance and rotation in each direction is tracked until motion is no longer detected. The values for gyroscope rotation was achieved by simply integrating gyroscope values by multiplying by the sample time (0.05s), which yielded the rotation in radians. The radians were converted to degrees for ease-of-use in the table. Calculating the distance linearly was more complicated as the acceleration in each direction was integrated and brought from gravity units to meters. Then, each velocity generated from the integration of acceleration is averaged and multiplied by the total sample time (0.25s) to integrate into distance in each axis of motion. The distances were printed out in millimeters in the table for ease-of-use. The data output from the program at each detected instance of motion can be seen in Figure 2.

Data Explained

In Figure 1, the table generated from the program's output can be seen with values deemed as significant instances of motion highlighted in green. I included any distance over ±10mm as significant instances of motion from the accelerometers and any angle over ±15° as significant rotational motion. As can be seen clearly in Figure 1, essentially all significant motion detections occur in pairings of similar positive and negative values, implying that the device was moved or rotated in such a way, and then returned to its original state. This is especially apparent in the pitch, roll, and yaw values which all are rotated at around +90° and -90° at some point implying the phone was rotated in each of these directions at these specific times. The data extracted here was obtained with a rotational variance threshold of 0.01 and an acceleration variance threshold of 0.005 which were both determined by adjusting the threshold based on the obtained variance values until reasonable matching motions were obtained (i.e. rotations of 90°).

Possible Errors

The rotational data is likely to be somewhat accurate, as it only involved an integration of rotation from a gyroscope, while acceleration involves double integration into distance. Accelerometers are not reliable for determining distance as they require double integration, thus losing most of the features of the original distance if it is not already known. This explains why the X, Y, and Z distances may not make any sense , such as only moving the phone by less than 10mm in any given direction for the first 19.30s. Due to this, the distance measurements cannot truly be trusted for this program, while the rotational values should be fairly accurate for each detected motion.

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Time of Motion	DistX[mm]	DistY[mm]	DistZ[mm]	Pitch[deg]	Roll[deg]	Yaw[deg]
1.10s-2.80s	7.155303	2.541181	-0.368241	-1.173994	-0.291702	-2.325777
5.65s-7.70s	-8.208601	-3.049595	-0.782261	0.117857	-1.330801	1.233668
10.90s-12.25s	7.156236	-1.19442	0.801922	-0.237924	-0.494632	-2.239852
14.75s-16.10s	-8.154393	0.937405	0.017762	-0.630624	0.904828	2.190403
16.15s-16.80s	5.510406	2.343044	-0.121502	0.079538	-0.184063	0.395136
19.30s-20.65s	11.657278	-6.06556	-1.49069	9.581911	6.416958	-3.270447
22.80s-24.85s	-11.801208	3.400077	-9.385258	-9.872067	-9.615731	3.338743
31.20s-33.95s	-0.31496	-2.006588	6.913245	2.639198	0.082179	89.455912
37.50s-39.20s	-5.977707	1.452369	-2.847745	-0.09019	-0.515895	-87.808703
43.10s-45.15s	3.674849	-51.150702	48.494573	90.966279	-4.230076	-4.044889
48.00s-50.05s	0.663567	50.449749	-50.58151	-90.039841	2.471644	3.089428
53.25s-54.95s	55.076962	0.531788	60.283624	-0.034738	94.932356	-3.24761
58.15s-60.20s	-53.111521	1.664524	-50.129178	-2.213304	-92.152849	2.672047

Figure 1: Table of calculated distances and angular rotation

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bshumin@DESKTOP-2F1JAJ7:~/compvis/lab7$ ./lab7 acc_gyro.txt
Time of Motion  X               Y               Z               pitch           roll            yaw
1.10s-2.80s     +7.155303       +2.541181       -0.368241       -1.173994       -0.291702       -2.325777
5.65s-7.70s     -8.208601       -3.049595       -0.782261       +0.117857       -1.330801       +1.233668
10.90s-12.25s   +7.156236       -1.194420       +0.801922       -0.237924       -0.494632       -2.239852
14.75s-16.10s   -8.154393       +0.937405       +0.017762       -0.630624       +0.904828       +2.190403
16.15s-16.80s   +5.510406       +2.343044       -0.121502       +0.079538       -0.184063       +0.395136
19.30s-20.65s   +11.657278      -6.065560       -1.490690       +9.581911       +6.416958       -3.270447
22.80s-24.85s   -11.801208      +3.400077       -9.385258       -9.872067       -9.615731       +3.338743
31.20s-33.95s   -0.314960       -2.006588       +6.913245       +2.639198       +0.082179       +89.455912
37.50s-39.20s   -5.977707       +1.452369       -2.847745       -0.090190       -0.515895       -87.808703
43.10s-45.15s   +3.674849       -51.150702      +48.494573      +90.966279      -4.230076       -4.044889
48.00s-50.05s   +0.663567       +50.449749      -50.581510      -90.039841      +2.471644       +3.089428
53.25s-54.95s   +55.076962      +0.531788       +60.283624      -0.034738       +94.932356      -3.247610
58.15s-60.20s   -53.111521      +1.664524       -50.129178      -2.213304       -92.152849      +2.672047
bshumin@DESKTOP-2F1JAJ7:~/compvis/lab7$
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Figure 2: Terminal output of the program