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MOTION TRACKING

ECE 6310, HW07

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METHODOLOGY:

In this lab, we were asked to write a program to detect motion along and about the principal axes (X, Y and Z) and report said values.

The following steps were undertaken as part of this lab:

- To differentiate between motion and rest for the data for given translations and rotations about an axis, we can make the variance in the data calculated about a certain window as a metric. If the variance lies below a given threshold, we classify it as rest and vice versa.
- Due to the inherent nature of data extracted from an IMU, which is very noisy, it becomes imperative to smoothen the data before performing any operations on it. Towards this end, a mean filter of a window size of 13 was used.
- A window size of 21 around each data point, was created to calculate the variance.
- The thresholds of the variance used are:
    1. Threshold for accX: 0.000041
    2. Threshold for accY: 0.00045
    3. Threshold for accZ: 0.00019
    4. Threshold for roll: 0.002
    5. Threshold for pitch: 0.000595
    6. Threshold for yaw: 0.02
- We know that the user moved the phone in a manner such that, there are discrete motions (translations or rotations) around an axis at each time. Some errors might creep in rotations or translations in some other axes while moving in another due to the nature of the human hand as it is very difficult to control the motion of the phone stably.
- If these errors are deemed significant, they are kept even though we know that they are unintended. Also, to make the filtering process easier, the translatory motions are rejected, if there is a rotation in that respective axis.
- If there are still any unwanted motions detected (very short spikes of motions), they are filtered out using a simple implementation of a low pass filter.
- If there is no motion detected around any axis, it is deemed a period of rest and vice versa.
- If there, is a period of motion, the translations about the principal axes are found out using the double integration method, which yields the translation during that period in meters and integrating the gyroscope data for the same yields the rotation in radians.

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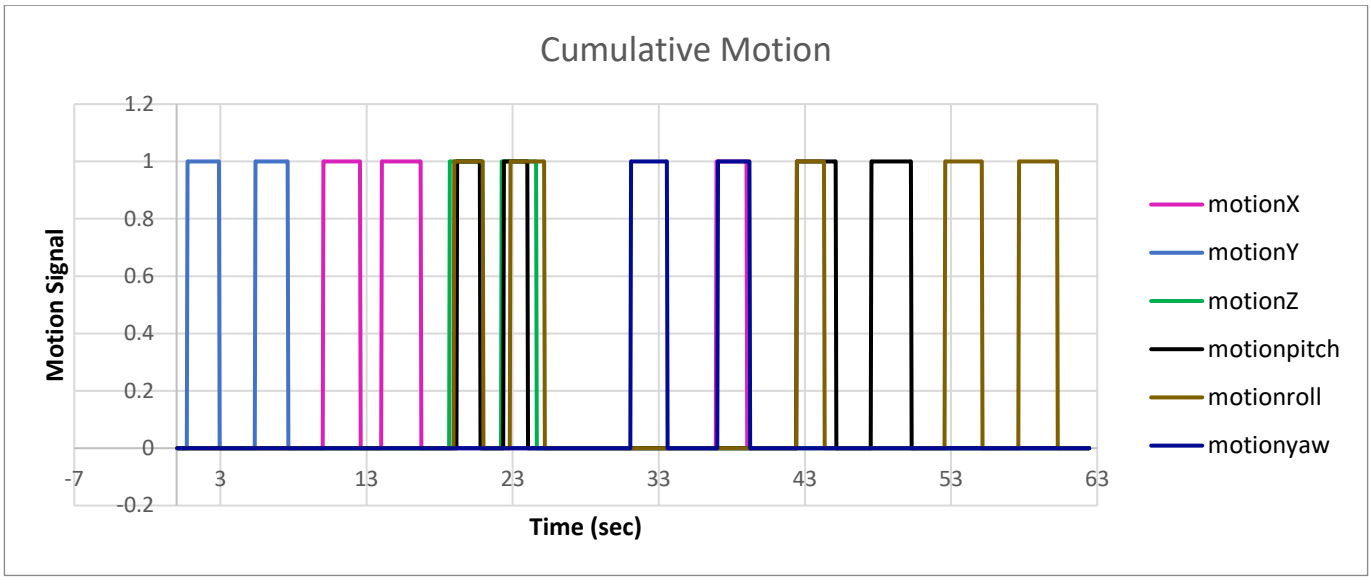
RESULTS:

Cumulative Motion Graph:



Final Motions:

	Start Time	End Time	Start Index	End Index	distX	distY	distZ	rotX (roll)	rotY (pitch)	rotZ (yaw)
	sec	sec	-	-	m	m	m	deg	deg	deg
Rest	0.05	0.7	0	13	0	0	0	0	0	0
	2.95	5.35	58	106	0	0	0	0	0	0
	7.65	10	152	199	0	0	0	0	0	0
	12.6	14	251	279	0	0	0	0	0	0
	16.75	18.65	334	372	0	0	0	0	0	0
	21	22.2	419	443	0	0	0	0	0	0
	25.2	31.05	503	620	0	0	0	0	0	0
	33.6	36.9	671	737	0	0	0	0	0	0
	39.25	42.4	784	847	0	0	0	0	0	0
	45.15	47.5	902	949	0	0	0	0	0	0
	50.3	52.55	1005	1050	0	0	0	0	0	0
	55.15	57.6	1102	1151	0	0	0	0	0	0
	60.3	62.5	1205	1249	0	0	0	0	0	0
Motion	0.75	2.9	14	57	0.415574	-0.239319	0.274583	-0.297880758	-0.991274281	-1.458922434
	5.4	7.6	107	151	0.148886	0.658753	0.285434	-1.297921293	0.080156796	1.270362023
	10.05	12.55	200	250	-0.121204	0.20357	0.378327	-0.882240413	-0.178992015	-1.537990609
	14.05	16.7	280	333	0.78933	-0.018623	0.420523	0.068869527	-0.273873826	2.403271472
	18.7	20.95	373	418	1.209935	-0.55984	-0.073102	5.699211188	9.30351679	-4.64273431
	22.25	25.15	444	502	6.095236	-3.228073	1.623137	-9.202045964	-9.765779139	3.544832583
	31.1	33.55	621	670	-0.194514	-0.135257	0.342291	0.057123892	2.632282702	89.48729864
	36.95	39.2	738	783	-0.142745	0.172425	0.164006	-0.282296306	-0.2307874	-88.30992767
	42.45	45.1	848	901	-1.343417	-12.71588	9.654045	-5.084427474	91.35508376	-4.039982709
	47.55	50.25	950	1004	-1.40864	-29.036931	25.873945	3.209022019	-90.40345816	3.099873559
	52.6	55.1	1051	1101	10.617693	-0.013916	8.222714	96.03294038	0.11757094	-4.050582428
	57.65	60.25	1152	1204	28.071731	-0.047563	26.569635	-92.33770638	-2.156727732	2.601744052

CONCLUSION:

Calculating the rotations is very easy, due to the single integration used. But calculating the translations in the Z-axis is the most difficult because, the pull of gravity of always acts on this axis and hence, the values in this axis are always negative (the pull of gravity is -1G). To mitigate this somewhat, a value of 1 was added to the data while calculating the motion. But this still does not yield completely satisfactory results. Also, since we are calculating all the motions during a period, instead of checking for valid motions, we get noisy readings in translations in X and Y, when the phone is rotated, because the effect of gravity biases these motions.