ATLAS A.I.

Building Your Big Data Roadmap
into the Future of Smart Mobility

Sampling Analysis
2018-01-02

General Analysis

Basic Format

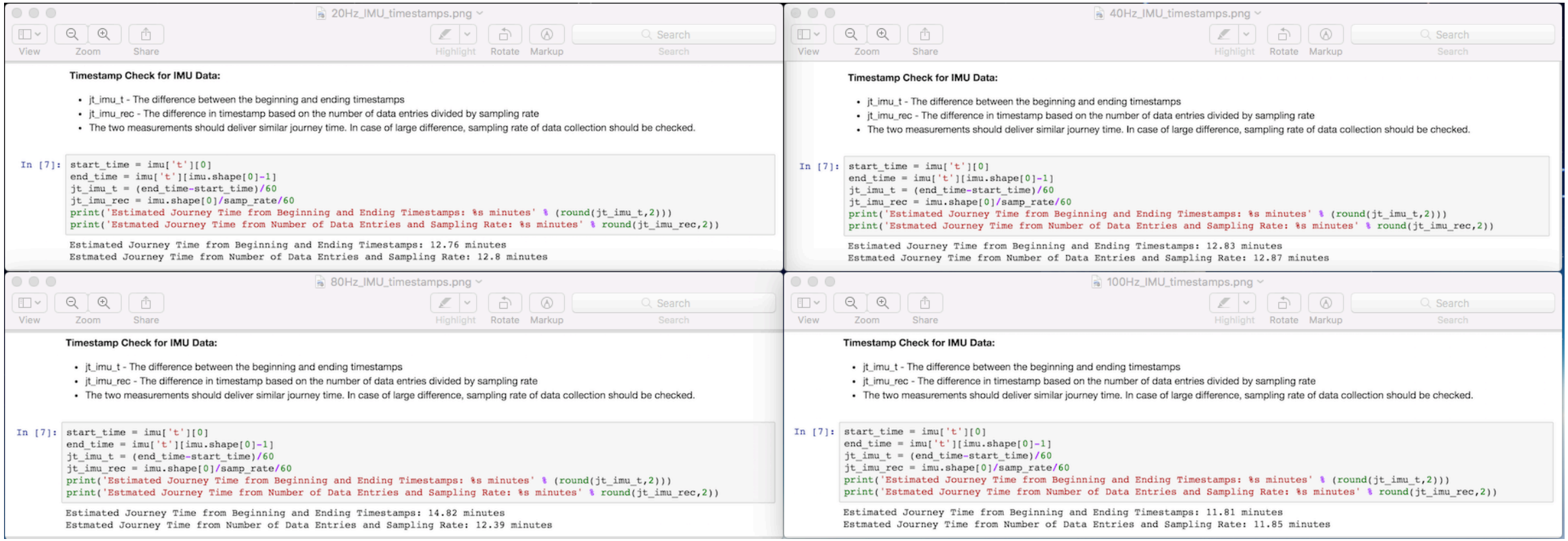
20Hz	40Hz
80Hz	100Hz

Sampling rates of 20Hz, 40Hz, 80Hz and 100Hz are collected and compared in terms of number of data entries both for IMU and GPS, rotation rate, acceleration, lateral force, course and speed.

60Hz was collected, but he collection tool PowerSense failed to produce the file with the right sampling rate.

The following slides follows the same layout of charts.

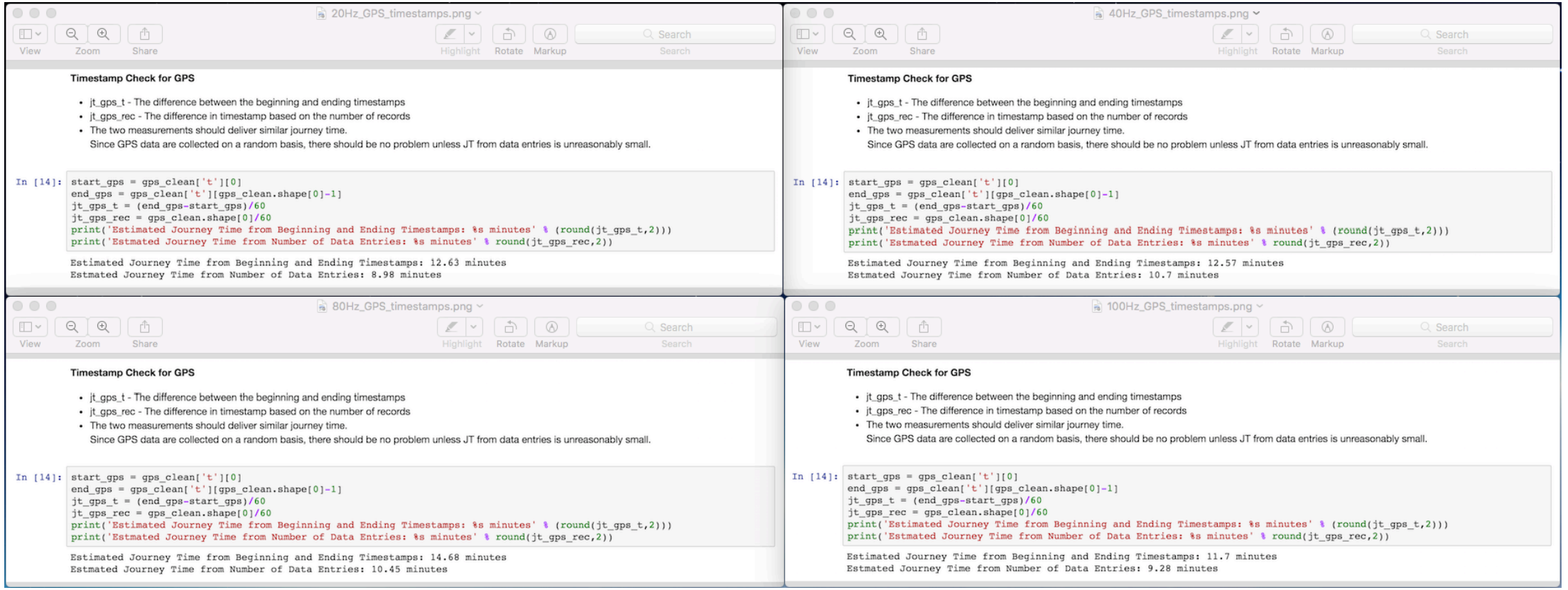
IMU Timestamp Check



The difference between beginning and ending timestamps is compared to the estimated time difference derived from the number of data entries over sampling rates, in order to check the intervals of data entries.

All sampling rates produce acceptable intervals of data entries.

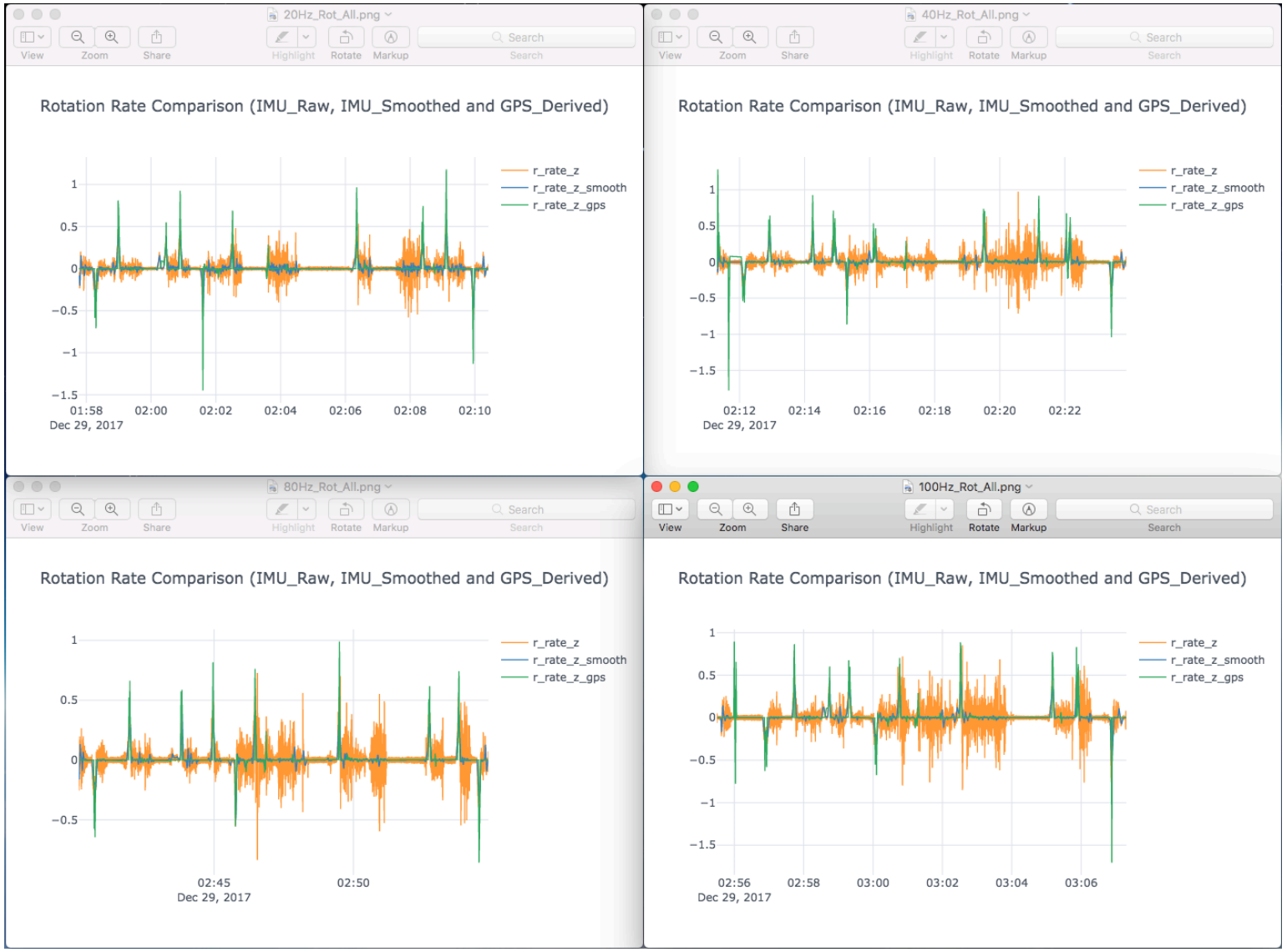
GPS Timestamp Check



The difference between beginning and ending timestamps is compared to the estimated time difference derived from the number of GPS data entries, in order to check the intervals of GPS data entries.

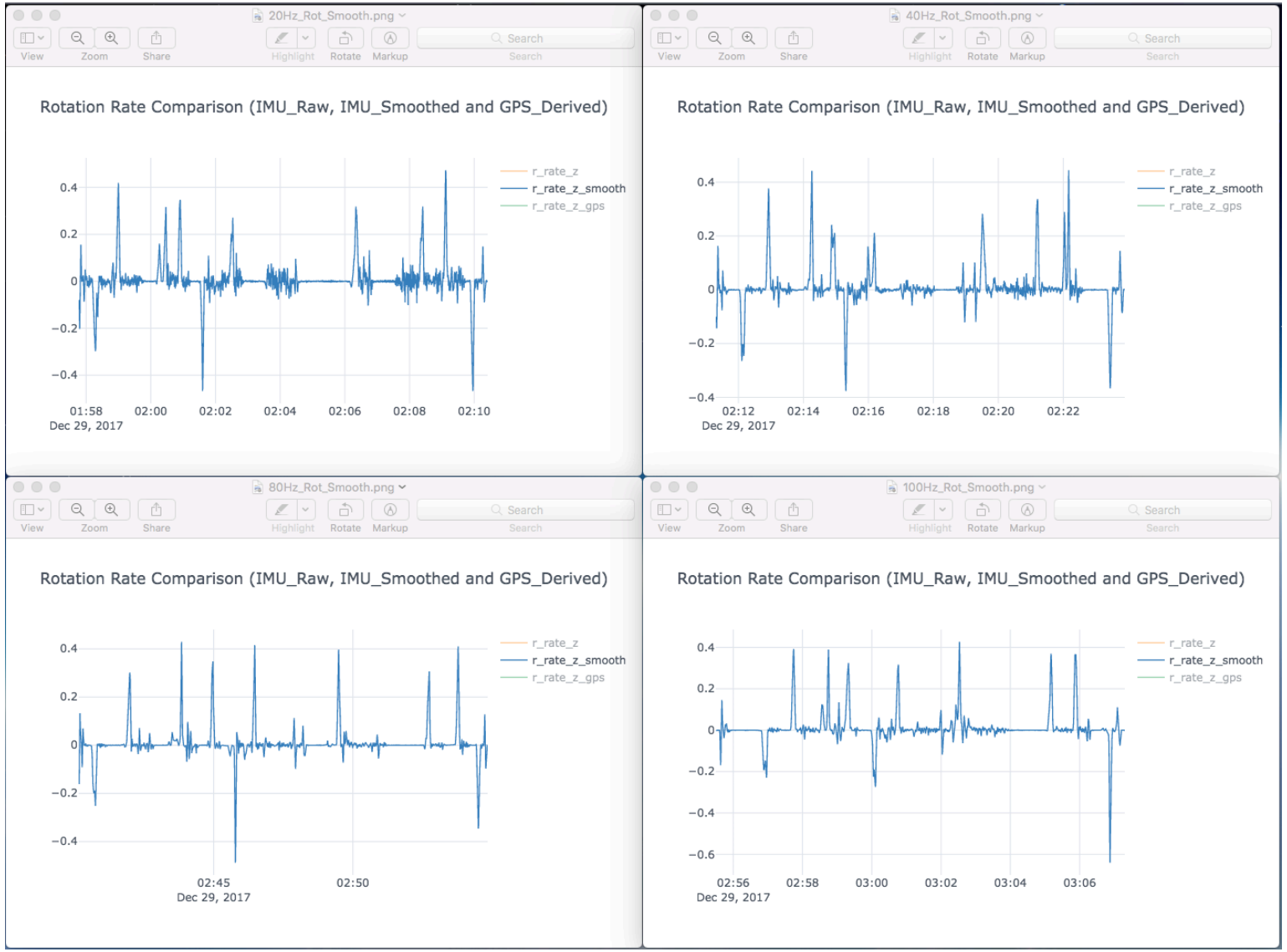
Since GPS generates data entry points randomly, the interval issue is beyond control. But analysis suggests that GPS receives data 1.5 second/entry.

Rotation Rates – Raw, Smoothed and GPS Derived



Rotation rates derived from GPS courses are consistent with those collected from IMU.

Rotation Rates – Event Patterns

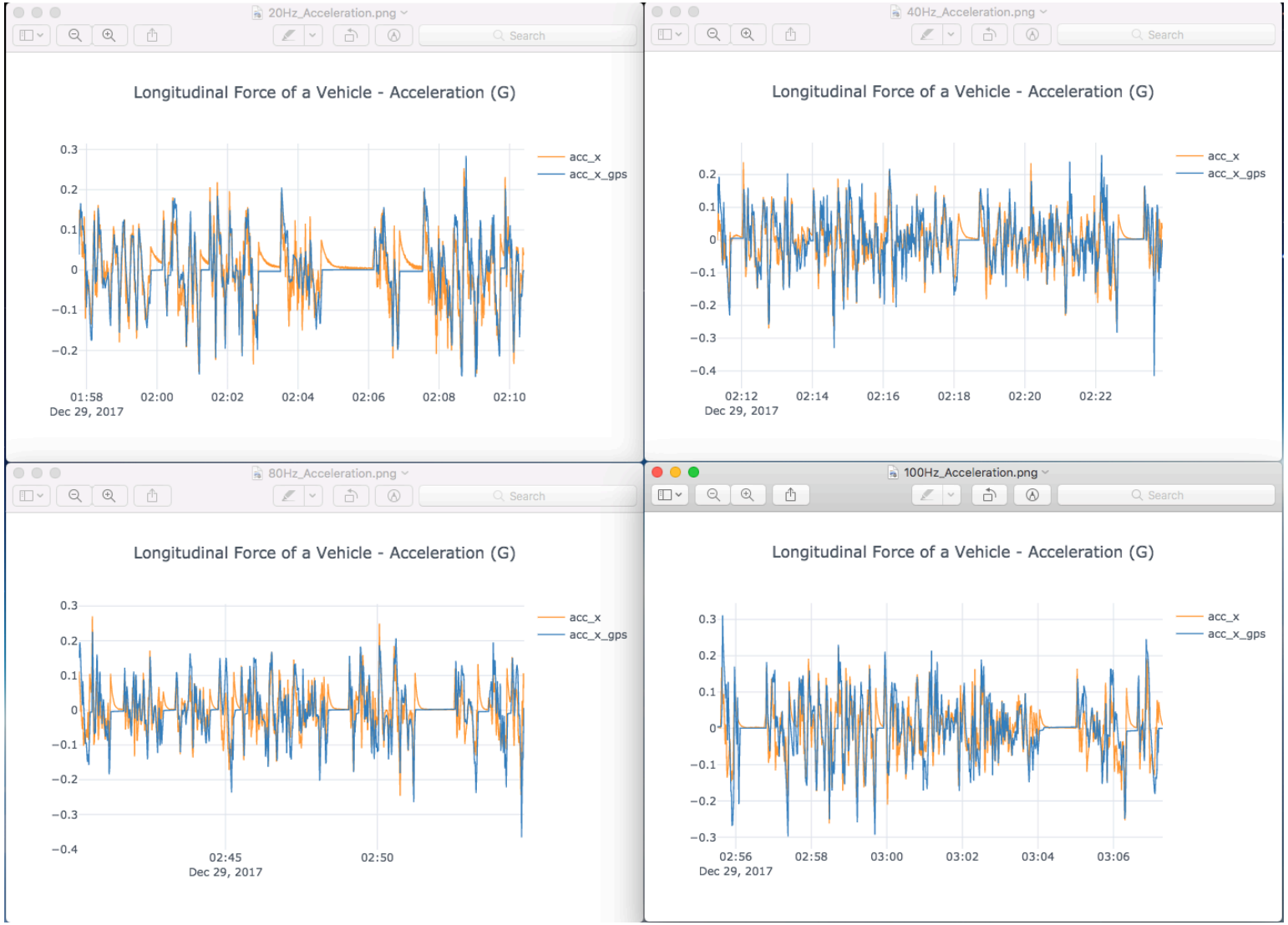


Smoothed rotation rates are used to detect events. The same smooth factor is applied for each sampling rate, i.e. 20Hz uses 20 as smooth factor.

Higher the sampling rates, less the noise after smoothing process.

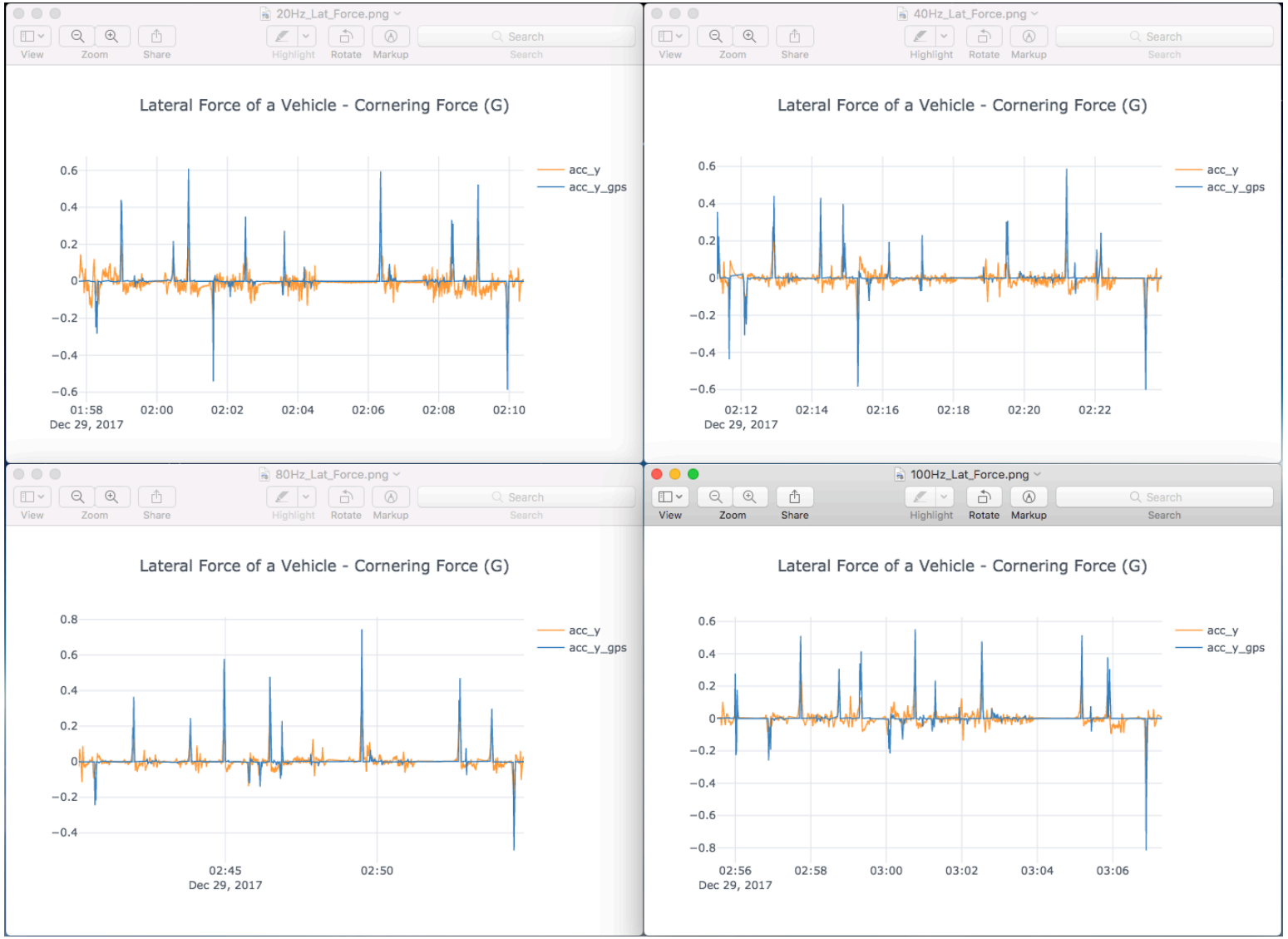
A further investigation in smooth factor will conducted.

Acceleration



Accelerations derived from GPS courses are consistent with those collected from IMU.

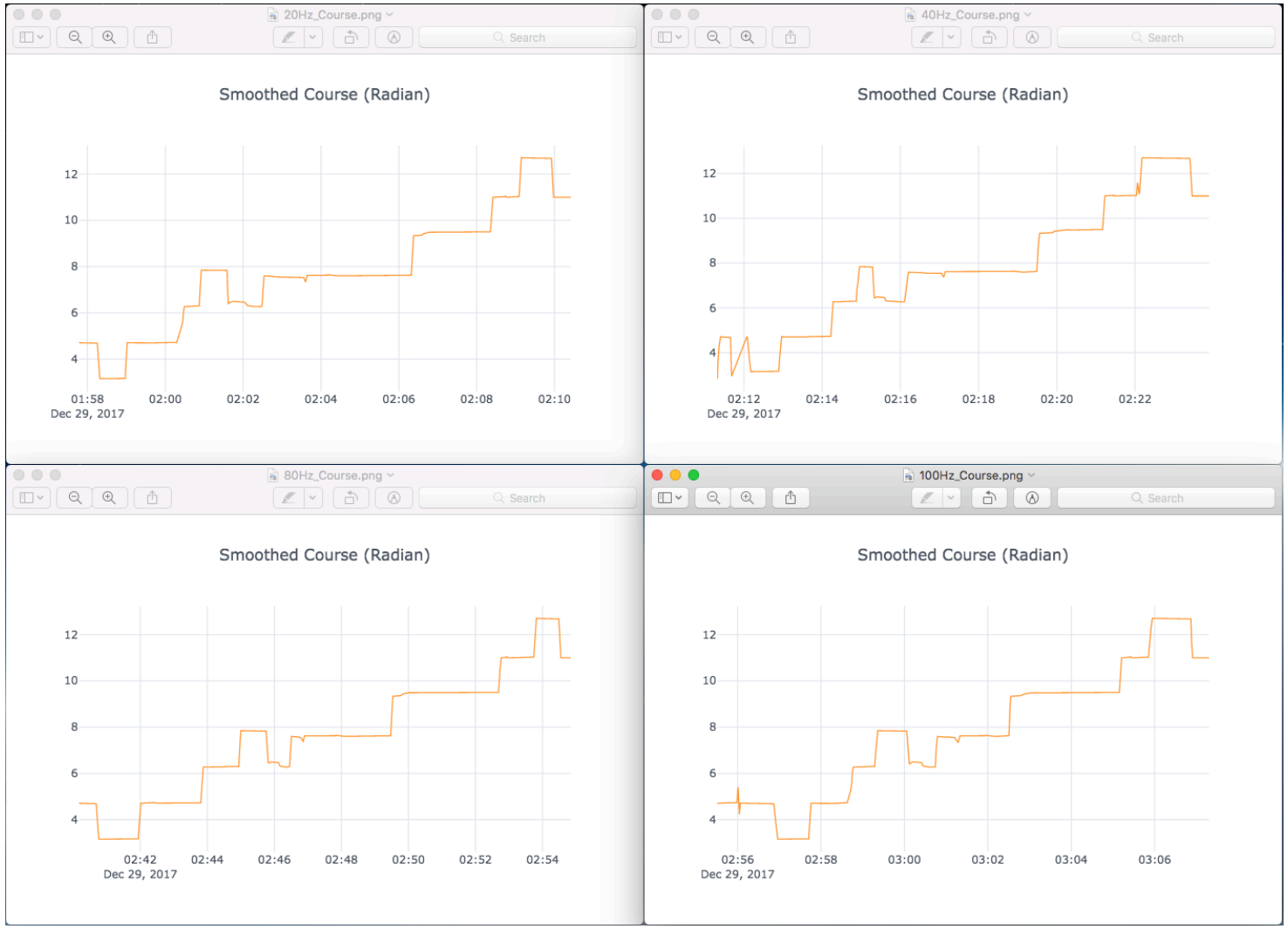
Lateral Force



Lower the sampling rates, higher the noise it produces.

Accelerometer does not produce the same patterns derived from GPS data.

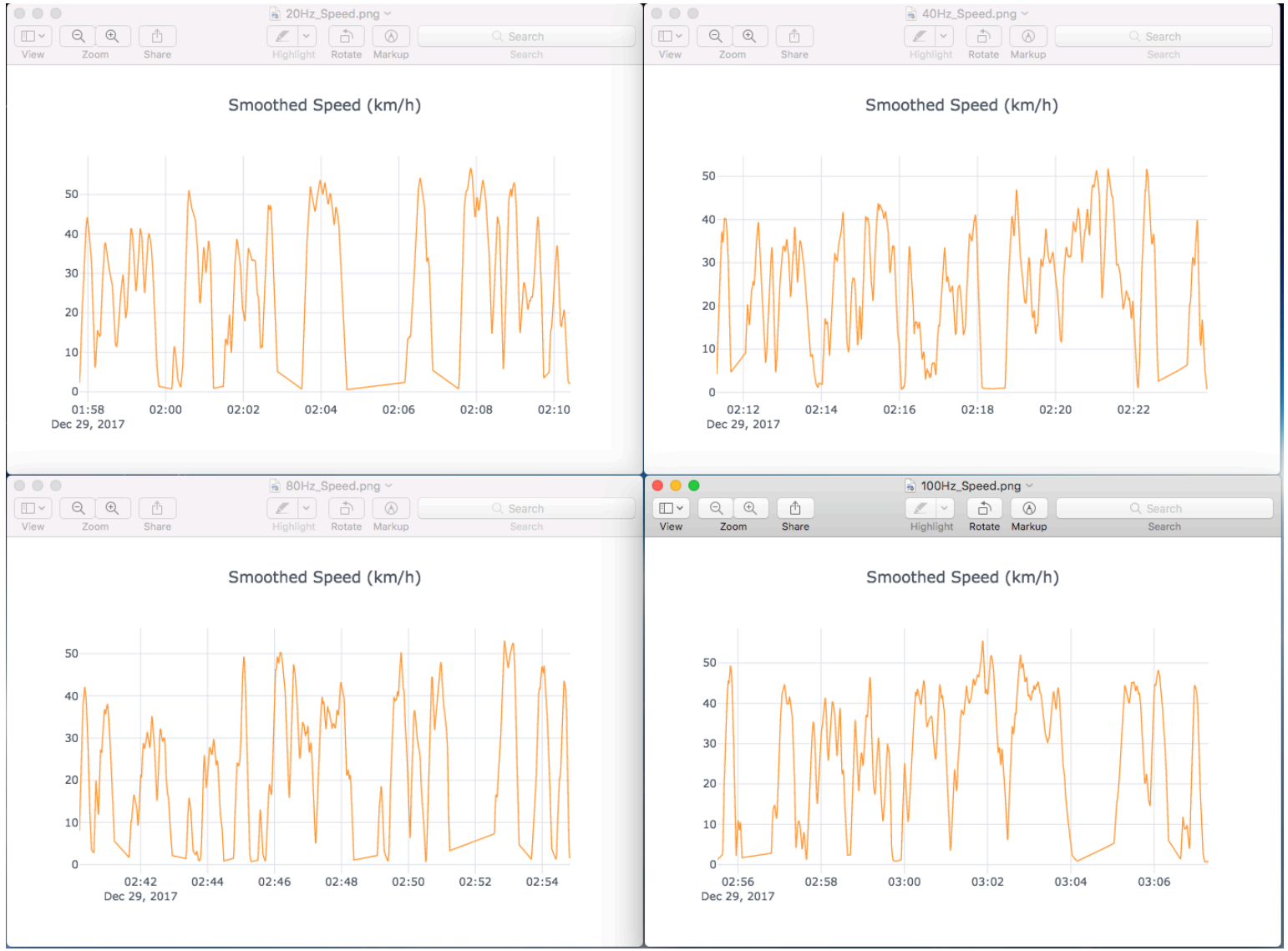
Course



Course is derived from GPS, which is irrelevant to sampling rates.

Smooth factor does not affect courses.

Speed

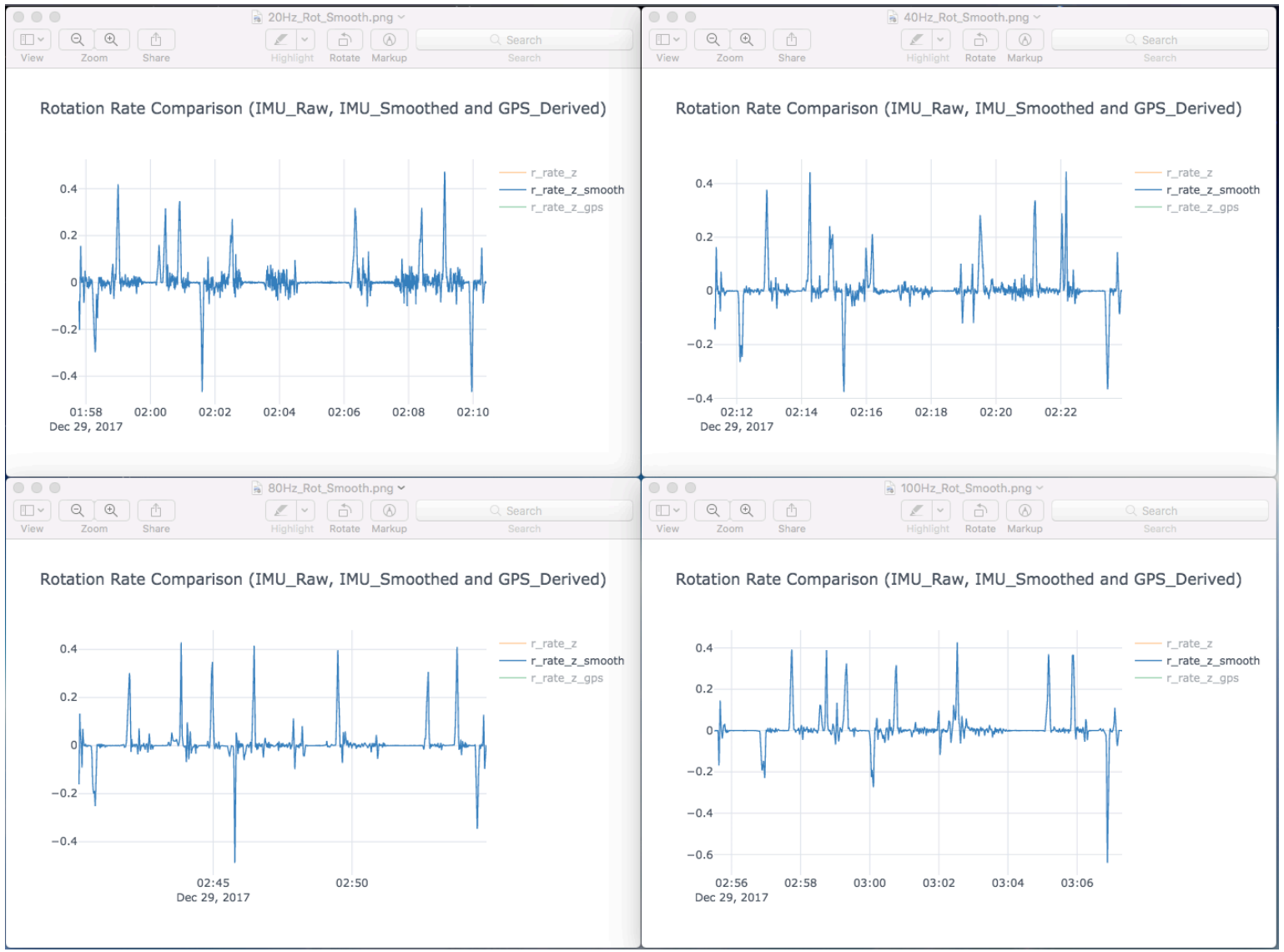


Speed is derived from GPS, which is irrelevant to sampling rates.

Smooth factor does not affect speeds.

Smooth Factor

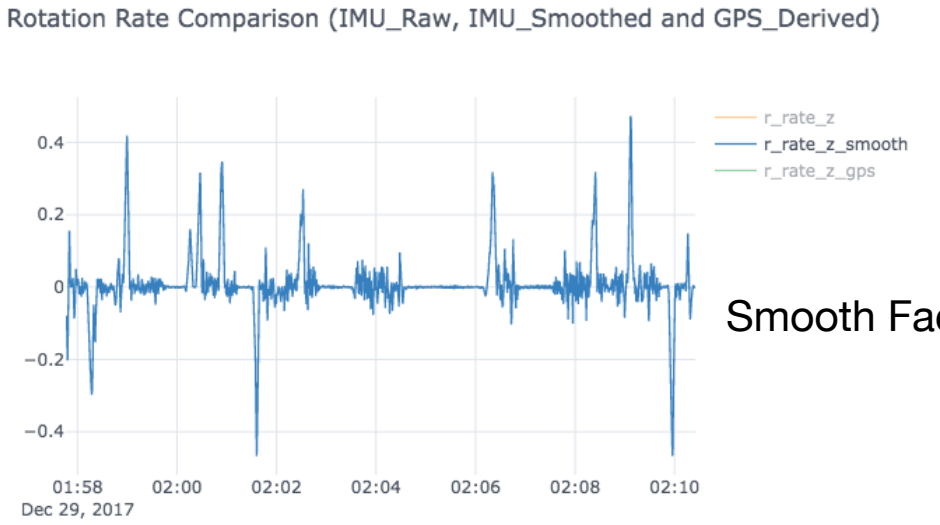
Rotation Rates – Event Patterns



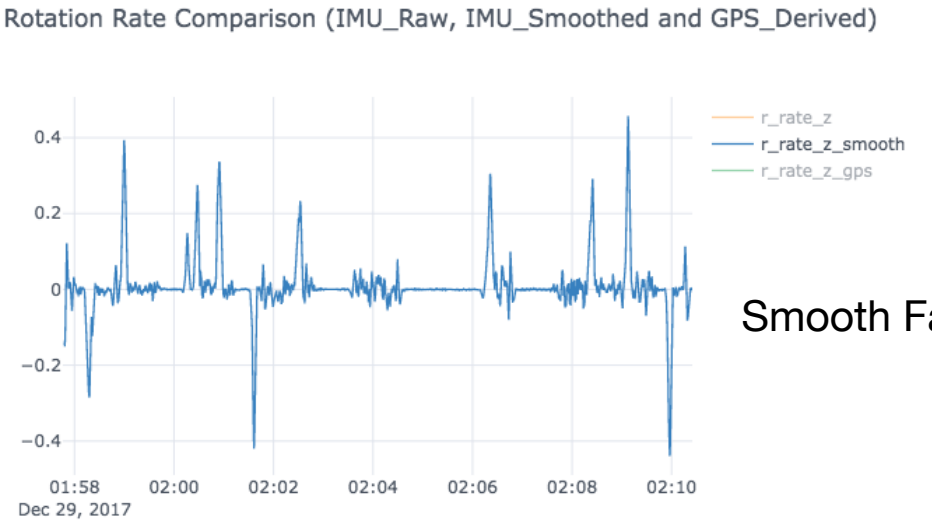
Smoothed rotation rates are used to detect events. The same smooth factor is applied for each sampling rate, i.e. 20Hz uses 20 as smooth factor.

Higher the sampling rates, less the noise is produced after smoothing process.

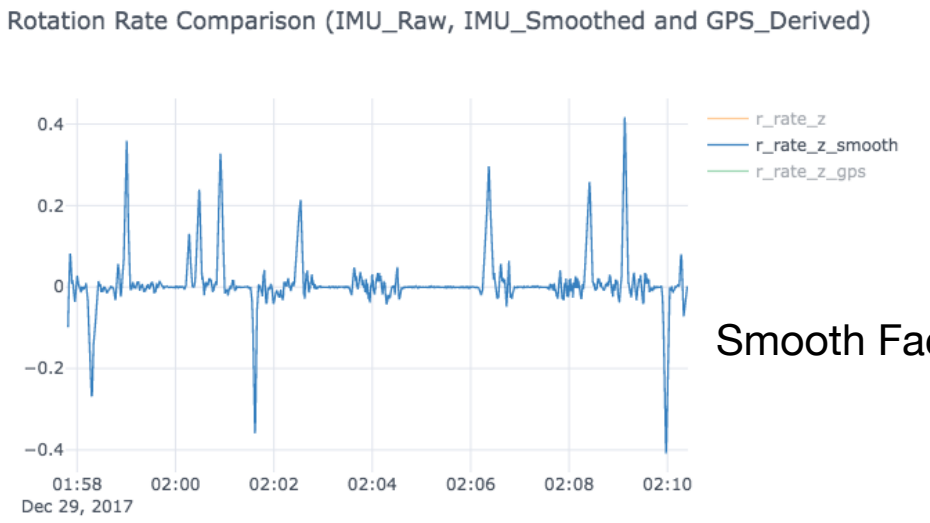
20Hz Sampling Rate with Different Smooth Factors



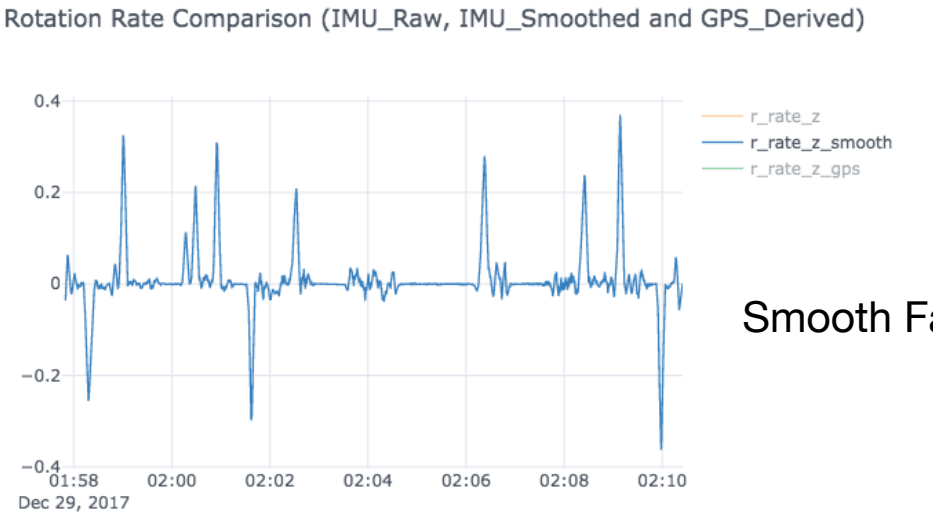
Smooth Factor: 20



Smooth Factor: 40



Smooth Factor: 60



Smooth Factor: 80

Impact of Smooth Factors on Events

20Hz Smooth Factor: 20

	type	prob	d	s_utc	e_utc
0	LCR	0.6846	3.7860	2017-12-29 01:57:49.057490	2017-12-29 01:57:52.843530
1	LTT	0.9685	10.4116	2017-12-29 01:58:11.973020	2017-12-29 01:58:22.384620
2	RTT	0.9969	7.5720	2017-12-29 01:58:55.412660	2017-12-29 01:59:02.984680
3	RTT	0.8225	4.7325	2017-12-29 02:00:13.025830	2017-12-29 02:00:17.758320
4	RTT	0.9739	6.6255	2017-12-29 02:00:23.786020	2017-12-29 02:00:30.411520
5	RTT	0.9980	6.6256	2017-12-29 02:00:50.387950	2017-12-29 02:00:57.013590
6	LTT	0.9965	6.6255	2017-12-29 02:01:32.233670	2017-12-29 02:01:38.859180
7	LCR	0.6472	3.7860	2017-12-29 02:01:46.281730	2017-12-29 02:01:50.067730
8	RTT	0.9584	8.5184	2017-12-29 02:02:25.835380	2017-12-29 02:02:34.353820
9	RTT	0.9826	10.4114	2017-12-29 02:06:15.085540	2017-12-29 02:06:25.496940
10	LCL	0.6790	4.7325	2017-12-29 02:06:41.786650	2017-12-29 02:06:46.519120
11	RTT	0.9788	8.5184	2017-12-29 02:08:18.428440	2017-12-29 02:08:26.946820
12	RTT	0.9994	6.6255	2017-12-29 02:09:03.561110	2017-12-29 02:09:10.186580
13	LTT	0.9987	7.5718	2017-12-29 02:09:52.977970	2017-12-29 02:10:00.549810
14	LCR	0.7374	5.6789	2017-12-29 02:10:14.697270	2017-12-29 02:10:20.376200

20Hz Smooth Factor: 40

	type	prob	d	s_utc	e_utc
0	LCR	0.6164	4.7325	2017-12-29 01:57:49.655290	2017-12-29 01:57:54.387840
1	LTT	0.9595	11.3581	2017-12-29 01:58:11.873390	2017-12-29 01:58:23.231490
2	RTT	0.9964	7.5720	2017-12-29 01:58:55.811190	2017-12-29 01:59:03.383200
3	LCR	0.6297	7.5720	2017-12-29 02:00:13.523980	2017-12-29 02:00:21.095970
4	RTT	0.9692	6.6255	2017-12-29 02:00:24.084910	2017-12-29 02:00:30.710410
5	RTT	0.9957	7.5722	2017-12-29 02:00:50.288320	2017-12-29 02:00:57.860470
6	LTT	0.9957	6.6255	2017-12-29 02:01:32.731830	2017-12-29 02:01:39.357330
7	RTT	0.9523	8.5184	2017-12-29 02:02:26.134270	2017-12-29 02:02:34.652710
8	RTT	0.9812	10.4114	2017-12-29 02:06:15.683320	2017-12-29 02:06:26.094730
9	LCL	0.6128	4.7325	2017-12-29 02:06:42.284800	2017-12-29 02:06:47.017280
10	RTT	0.9750	8.5184	2017-12-29 02:08:18.528070	2017-12-29 02:08:27.046450
11	RTT	0.9984	7.5720	2017-12-29 02:09:03.361850	2017-12-29 02:09:10.933810
12	LTT	0.9984	7.5718	2017-12-29 02:09:53.575750	2017-12-29 02:10:01.147580
13	LCR	0.6874	6.6254	2017-12-29 02:10:14.697270	2017-12-29 02:10:21.322690

20Hz Smooth Factor: 60

	type	prob	d	s_utc	e_utc
0	LTT	0.9544	11.3581	2017-12-29 01:58:12.570820	2017-12-29 01:58:23.928910
1	RTT	0.9924	8.5185	2017-12-29 01:58:55.811190	2017-12-29 01:59:04.329710
2	RTT	0.9285	8.5185	2017-12-29 02:00:23.885650	2017-12-29 02:00:32.404160
3	RTT	0.9911	8.5187	2017-12-29 02:00:50.288320	2017-12-29 02:00:58.806990
4	LTT	0.9893	7.5720	2017-12-29 02:01:32.931090	2017-12-29 02:01:40.503100
5	RTT	0.9339	9.4649	2017-12-29 02:02:26.134270	2017-12-29 02:02:35.599200
6	RTT	0.9728	11.3579	2017-12-29 02:06:15.782950	2017-12-29 02:06:27.140860
7	RTT	0.9649	9.4649	2017-12-29 02:08:19.026220	2017-12-29 02:08:28.491090
8	RTT	0.9963	8.5184	2017-12-29 02:09:03.361850	2017-12-29 02:09:11.880300
9	LTT	0.9978	7.5718	2017-12-29 02:09:53.974270	2017-12-29 02:10:01.546100
10	LCR	0.6338	6.6254	2017-12-29 02:10:15.195420	2017-12-29 02:10:21.820840

20Hz Smooth Factor: 80

	type	prob	d	s_utc	e_utc
0	LTT	0.9395	12.3046	2017-12-29 01:58:12.471190	2017-12-29 01:58:24.775790
1	RTT	0.9906	8.5185	2017-12-29 01:58:56.209720	2017-12-29 01:59:04.728240
2	RTT	0.9185	8.5185	2017-12-29 02:00:24.383810	2017-12-29 02:00:32.902320
3	RTT	0.9889	8.5187	2017-12-29 02:00:50.886120	2017-12-29 02:00:59.404790
4	LTT	0.9853	7.5720	2017-12-29 02:01:33.329620	2017-12-29 02:01:40.901630
5	RTT	0.9258	9.4649	2017-12-29 02:02:26.632430	2017-12-29 02:02:36.097360
6	RTT	0.9610	12.3044	2017-12-29 02:06:16.081840	2017-12-29 02:06:28.386250
7	RTT	0.9594	9.4649	2017-12-29 02:08:19.524370	2017-12-29 02:08:28.989240
8	RTT	0.9953	8.5184	2017-12-29 02:09:03.959640	2017-12-29 02:09:12.478090
9	LTT	0.9947	8.5183	2017-12-29 02:09:53.974270	2017-12-29 02:10:02.492580

The increase of smooth factor reduces the noise, but also reduces the likelihood of detecting a event.

Conclusion

Accuracy by Sampling Rates

20Hz – Accuracy: 70.6%	
True Positive 12	False Negative (Type II Error) 4
False Positive (Type I Error) 1	True Negative 0

40Hz – Accuracy: 93.3%	
True Positive 14	False Negative (Type II Error) 1
False Positive (Type I Error) 0	True Negative 0

80Hz – Accuracy: 77.8%	
True Positive 14	False Negative (Type II Error) 4
False Positive (Type I Error) 0	True Negative 0

100Hz – Accuracy: 82.4%	
True Positive 14	False Negative (Type II Error) 3
False Positive (Type I Error) 0	True Negative 0

40Hz sampling rate delivers the best performance in detection of events with 93.3% accuracy. It also has the least Type II error.

Accuracy = (True Positive + True Negative)/(True Positive + True Negative + Type I + Type II)

Type I error is preferred over Type II error, as detecting a wrong event (most likely lane changes) is better than omitting a event.

Conclusion

- 20Hz sampling rate produces high level of noise, making detection model difficult to identify patterns even when smooth factor is applied. The accuracy is around 70%.
- With a fixed 20Hz sampling rate, different smooth factors are applied to investigate the impact of smooth factors. The increase of smooth factor is able to reduce noise, but also reduces the likelihood of detecting a event (damping the wave-like patterns).
- 40Hz sampling rate delivers the best performance in detection of events with 93.3% accuracy. It also has the least Type II error.

- Suggestion: A sampling rate of 40-60 may be suitable for a good pattern recognition model, subject to capacity of data upload at frontend.