INFLUENCE OF SENSITIVY AND FREQUENCY ON THE MIDGE

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1. Research Topic

- How does the sampling rate and sensitivity influence the performance of the DMP of the Midge?

- Test the effects of changing the sensitivity (FSR) of the Midge.

- Test how changing the frequency affects the performance of the Midge.

2. Background

- The DMP measurements of the Midge is comparable to a phone [1]. However this is tested mainly on the x-rotation axis of the Midge.

- Further testing was needed to find if changes in sampling rate and sensitivity influence the performance.

- The new tests should also include more degrees of freedom to mimic human motion more closely.

3. Methodology

- Analysis of the datasheet for possible configurations of the Midge.

- Perform the same movement with two Midges and an high-end Xsens IMU strapped together for the different configurations.

- Parse the measured data of the Xsens and the Midges to compare them, both in raw values, the measurements of the sensors, and the interpreted values, the quaternions.

4. Results & Discussion

Accelerometer

Midge 37

	Acc	Hz	MSE x	MSE y	MSE z
Small FSR	4	50	0.002	0.001	0.001
	4	100	0.003	0.001	0.004
	4	150	0.006	0.002	0.005
	4	200	0.002	0.001	0.006
	4	250	0.001	0.001	0.002
Large FSR	16	50	0.005	0.002	0.005
	16	100	0.001	0.001	0.002
	16	150	0.002	0.001	0.001
	16	200	0.001	0.000	0.001
	16	250	0.012	0.003	0.006

Table 1. Averaged MSE of the Accelerometer of Midge 37

Tables 1 and 2 show that the MSEs of the Accelerometer are relavitely consistent regardless of FSR and frequency.

Gyroscope

Gyr	Hz	MSE x	MSE y	MSE z
500	50	7.29	8.67	6.60
500	100	6.21	6.16	3.99
500	150	9.13	12.00	8.09
500	200	11.25	12.52	7.82
500	250	4.95	6.77	6.57
2000	50	3.81	3.00	6.33
2000	100	2.99	4.87	2.42
2000	150	3.99	3.82	2.82
2000	200	4.97	3.24	2.63
2000	250	5.10	5.65	5.47

Table 3. Averaged MSE of the Gyroscope of Midge 37

Tables 3 and 4 show that the MSEs of the Gyroscope are fluctuate more but not correlated with FSR nor frequency.

Quaternions

Acc	Gyr	Hz	MSE x	MSE y	MSE z
4	500	50	0.6686	0.2170	0.2172
4	500	100	1.3035	0.2314	0.2315
4	500	150	0.5452	0.1737	0.1740
4	500	200	2.0503	1.1427	1.1429
4	500	250	2.8344	0.1844	0.1847
16	2000	50	0.2407	1.9444	1.9447
16	2000	100	1.5593	0.2419	0.2421
16	2000	150	3.1653	3.0247	3.0248
16	2000	200	0.5476	0.0989	0.0990
16	2000	250	0.6160	0.1703	0.1706

Table 5. Averaged MSE of the Quaternions of Midge 37

Tables 5 and 6 show that the MSEs of the Quaternions are the lowest on 150 Hz regardless of FSR, for three out of four occurences.

A high MSE of the sensors does not imply an high MSE on the quaternion.

Midge 48

	Acc	Hz	MSE x	MSE y	MSE z
Small FSR	4	50	0.005	0.002	0.002
	4	100	0.004	0.002	0.005
	4	150	0.008	0.005	0.010
	4	200	0.005	0.005	0.010
	4	250	0.004	0.003	0.002
Large FSR	16	50	0.005	0.002	0.010
	16	100	0.004	0.003	0.006
	16	150	0.002	0.002	0.003
	16	200	0.003	0.002	0.003
	16	250	0.004	0.001	0.003

Table 2. Averaged MSE of the Accelerometer of Midge 48

Gyr	Hz	MSE x	MSE y	MSE z
500	50	4.86	6.39	8.44
500	100	6.28	5.44	8.41
500	150	16.27	19.01	15.38
500	200	21.75	17.17	11.90
500	250	11.39	8.65	10.08
2000	50	38.56	63.80	36.77
2000	100	8.92	11.76	7.57
2000	150	4.30	4.45	5.29
2000	200	9.10	6.93	10.41
2000	250	5.59	6.91	5.43

Table 4. Averaged MSE of the Gyroscope of Midge 48

Acc	Gyr	Hz	MSE x	MSE y	MSE z
4	500	50	0.1451	0.0945	0.0947
4	500	100	0.1161	0.1173	0.1175
4	500	150	0.1115	0.1040	0.1042
4	500	200	0.1254	0.2327	0.2328
4	500	250	0.5193	0.1734	0.1746
16	2000	50	2.4556	0.1828	0.1830
16	2000	100	2.8883	0.1453	0.1454
16	2000	150	0.1423	0.0929	0.0929
16	2000	200	0.6593	0.1589	0.1592
16	2000	250	0.2893	0.1634	0.1636

Table 6. Averaged MSE of the Quaternions of Midge 48

5. Conclusion

- Changing the FSR does not influence the performance of the sensors or the quaternions.

- Changing the frequency does not affect the performance of the sensors, but does influence the DMP.

- The DMP works best with frequency of 150 Hz.

- Increasing the frequency more, leads to a decrease in accuracy.

- Further research could be done to find out why the MSE of the gyroscope fluctuates much more than the MSE of the accelerometer.

References

[1] Bent Engbers. “A rotation experiment on the Digital Motion Processor of the Midge”. 2022. URL: http://resolver.tudelft.nl/uuid:f6e60c08-2aff-4f4a-baf5-5647711573dc.