



Figure 1: A 3D rendered image of the Midge [2]

Categorizing the performance of the rotation vector produced by the Digital Motion Processor of the midge.

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1. Background

- Studying human behavior is complex
 - Behavior changes when observed [3]
 - Collecting data is difficult
- Mobile sensors may provide a solution

2. Definitions

- The Midge (cf. Figure 1)
 - Mobile device
 - Contains a DMP
 - Developed by Socially Perceptive Computing Lab at Delft University of Technology
 - Used to study human interaction in a natural social context (like a congress)
- Internal Measurement Unit (IMU)
 - Measures acceleration, rotation and gravitational forces
- Digital motion processor (DMP)
 - Combines data from sensors in the IMU (Like the rotation vector)
- Rotation Vector
 - Describes rotation direction & speed
- Rotation definitions
 - Euler angles
 - 3 dimensional, prone to gimbal lock (cf. Figure 2)
 - Quaternions
 - 4 dimensional, difficult to visualize

4. Method

- Create a precise controllable rotating platform
- Connect phone and sensor to platform
- Experiment with slow constant rotation single direction

5. Results

- Experiment parameters:
 - Constant speed
 - Almost instant start and stop
 - 1200 steps at 0.9° per step (3 full rotations)
 - Step speed 75 Hz (16 seconds for 3 full rotations)

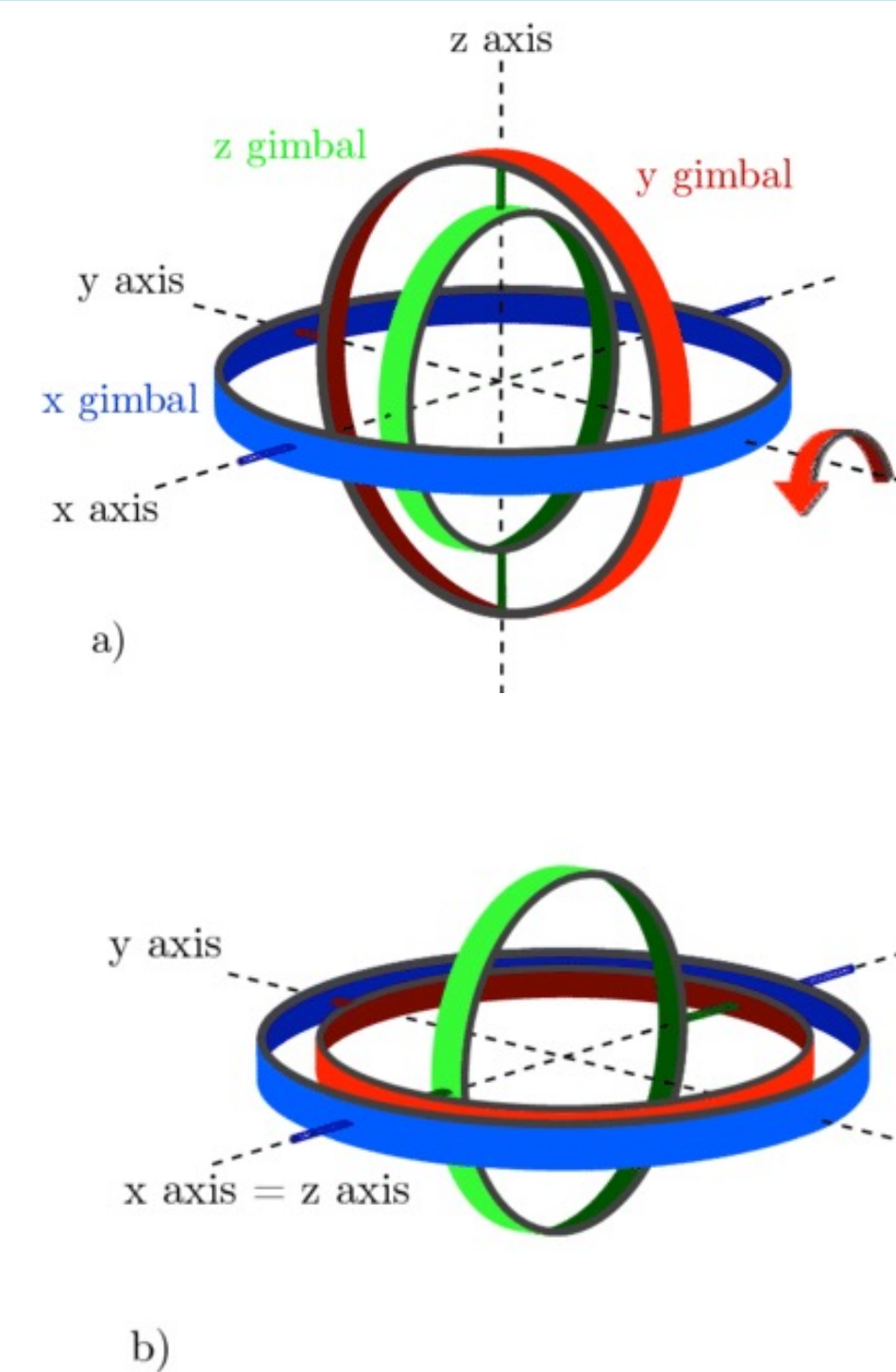
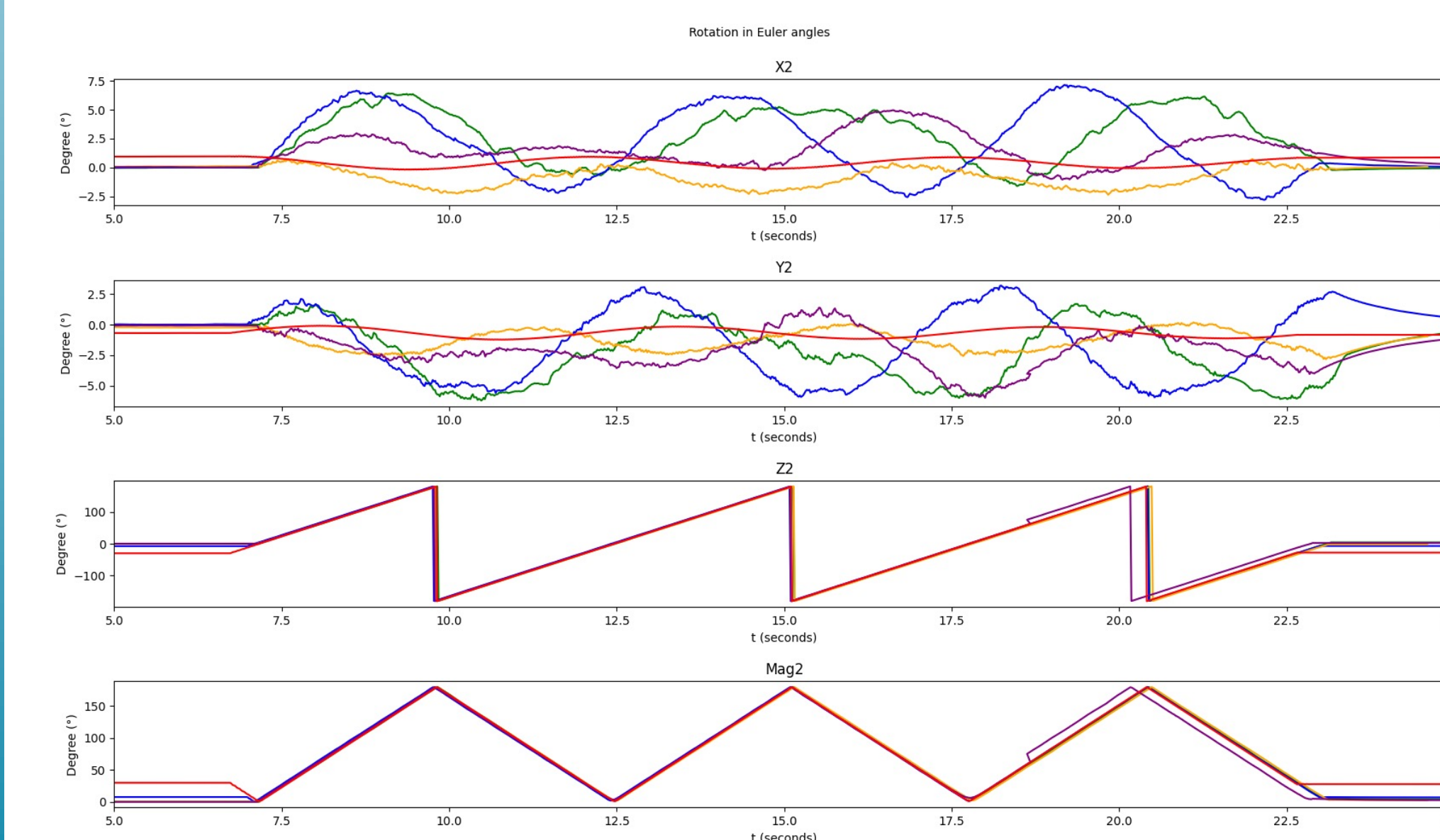
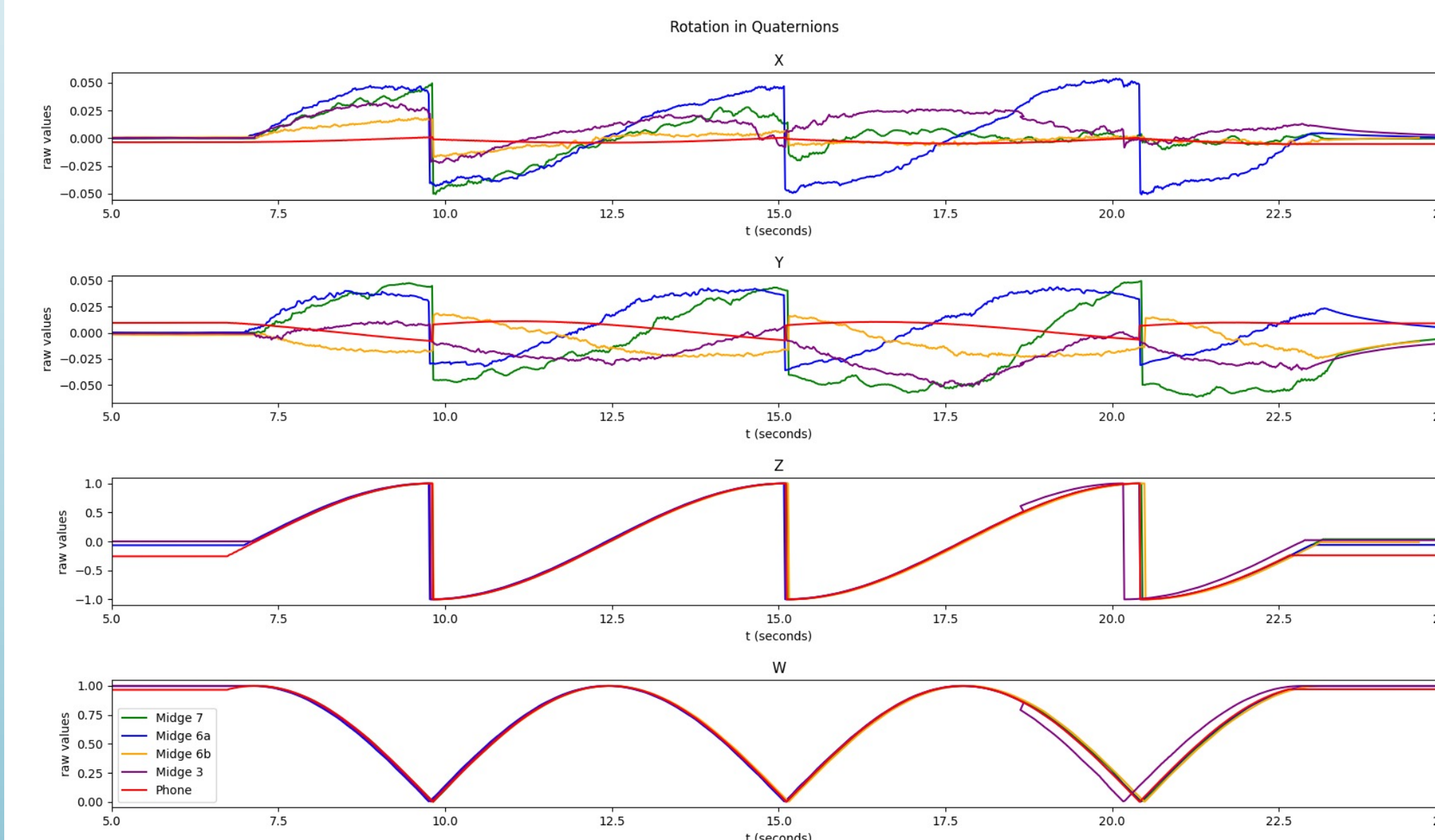


Figure 2: Gimbal lock [1]

6. Conclusions

Visual analysis:

- Phone data shows expected results:
 - Large change in one axis (Z2)
 - Small changes in remaining axis (X2,Y2)
 - Constant speed rotation (Z2)
- The Midges are consistent on Z & Z2
 - When compared to the mobile phone
 - When compared to each other
 - Main axis of rotation
- More noise in X,X2,Y & Y2
 - When compared to the mobile phone
 - When compared to each other
 - Small changes ($<10^\circ$)
 - Not main axis of rotation,
 - difficult to control
- Midges maybe be less accurate in detecting smaller ($<10^\circ$) changes

7. Limitations

- Single axis of rotation tested
- Single speed tested
- Single direction tested
- One other DMP tested

8. References

- [1]. J. Zeitlhöfner, "Nominal and observation-based attitude realization for precise orbit determination of the Jason satellites," Ph.D. dissertation, Jun. 2019, p. 16. [Online]. Available: <https://mediatum.ub.tum.de/doc/1535899/file.pdf>
- [2]. <https://github.com/TU-Delft-SPC-Lab/midge-code>
- [3]. J.-M. Hoc, "Towards ecological validity of research in cognitive ergonomics," Theoretical Issues in Ergonomics Science, vol. 2, no. 3, pp. 278–288, 2001. doi:10.1080/14639220110104970. eprint: <https://doi.org/10.1080/14639220110104970>. [Online]. Available: <https://doi.org/10.1080/14639220110104970>

3. Research Question

How does the Midge compare to a modern mobile phone regarding the accuracy and reliability of the rotation vector from the DMP in the Midge?