Accuracy Comparison of Inertial Measurement Units (IMU)

Comparing Socially Perceptive Computing Lab's Midge IMU to a Smartphone IMU and determine usability

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1. Introduction

– Inertial Measurement Unit (IMU) is the chip used in many devices to register motion
– They are used for many applications, like sports tracking or accident detection.
– The Socially Perceptive Computing Lab at TU Delft has developed a sensor device which includes an IMU, called the Midge. The use this device to analyse human behaviour in group settings. For example to distinguish conversation groups based on sensor data.

2. Research question

How does the Socially Perceptive Computing Lab's Smart ID Sensor IMU compare to a widely used IMU (iPhone 13 Pro Max)?

Sub questions

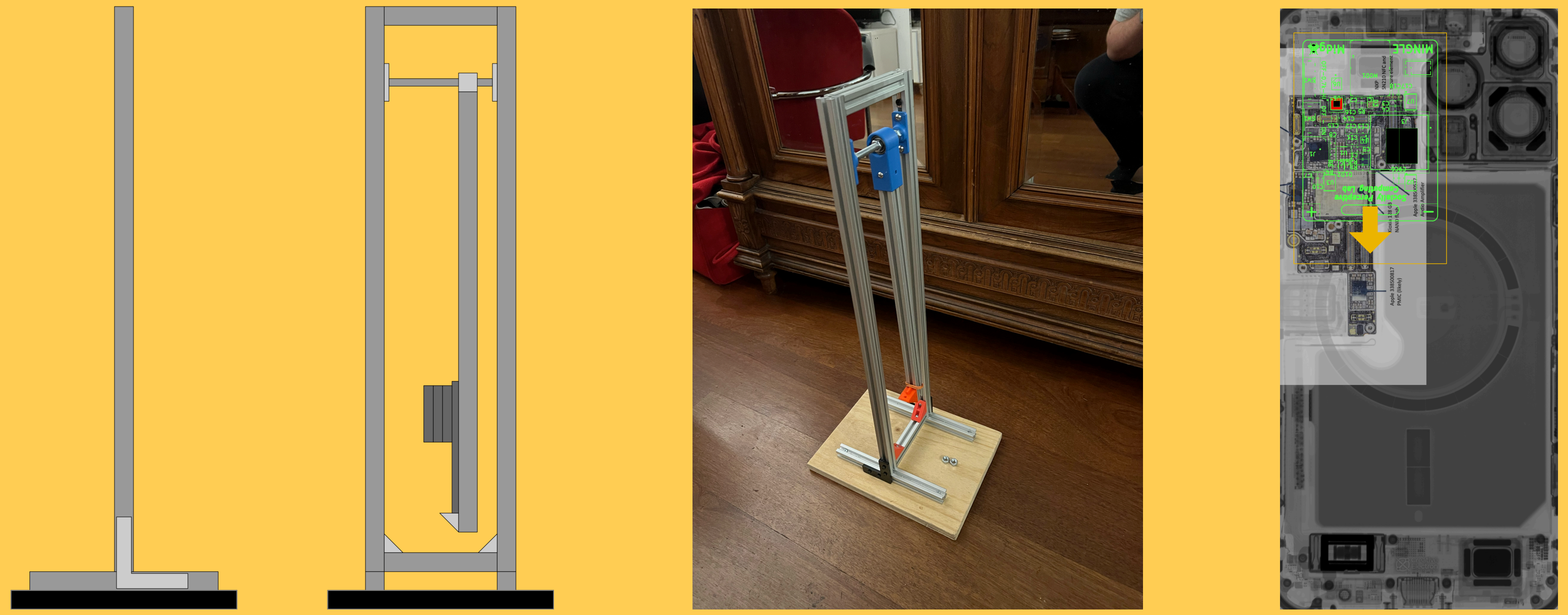
– How do they compare in measurement frequency?
– How do they compare in measurement accuracy for each of the provided measurements?
– Is the accuracy of the Socially Perceptive Computing Lab's Smart ID Sensor sufficiently accurate for it's purpose?

3. Existing research & relation

– Research has been done into the more general topic of IMU accuracy
– This research focuses specifically on the Midge device and how it compares to a specific smartphone
– Most existing research uses expensive robot arms to make testing movements, this research uses simpler but still very reproducible experiments.

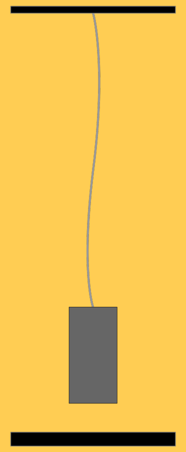
4. Experiment

Final Setup

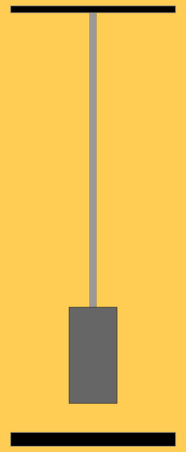


Made from 20mm aluminum extrusions and 3D-printed mounting brackets. IMU chips of devices aligned by overlaying motherboard schematics and placing the Midge on the correct place of the phone.

✓ Very sturdy
✓ Smooth swinging ball bearings
✓ Stands on it's own

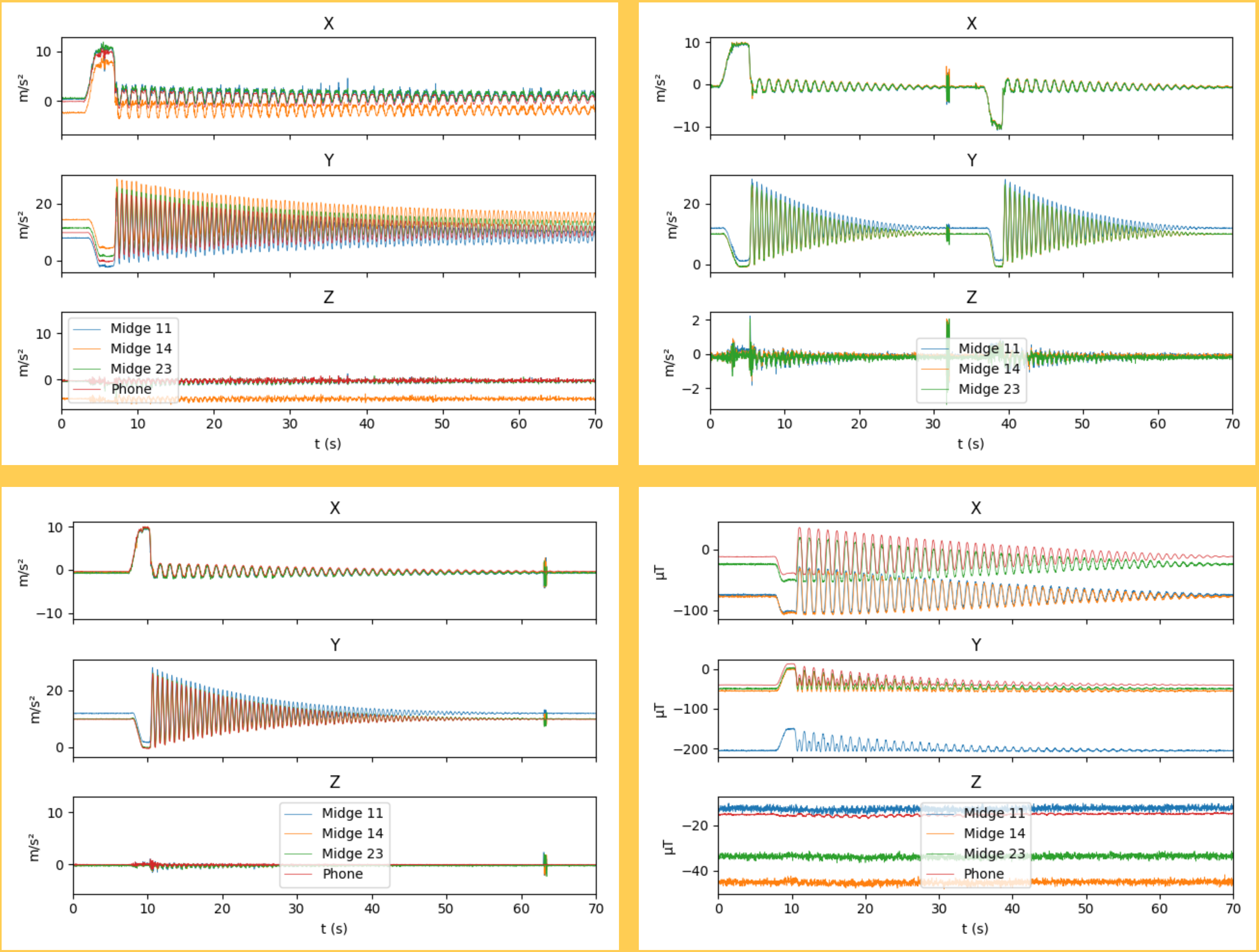


Iteration 1
⊗ String doesn't move along a single angle
⊗ String has some bounce in it



Iteration 2
⊗ Still has some side movement
⊗ Harder to mount to anything

5. Results & conclusions



Data timing was manually aligned by looking at the graphs and offsetting the data. This was required since the timestamp were not syncronized exactly and the phone used another timestamping system and had a 100Hz sampling rate instead of approximately 57Hz for the Midges.

The following was found from the data and graphs:
✓ All devices have 3 sensors with 3 axes
✓ Same patterns for all devices
⊗ Data values don't line up on all axis, up to around 20% diffrence between devices.
⊗ Some data can not be related to expected values. Example: more accelaration than normal gravity without any other movement.

Conclusion: finding patterns in this data might still be possible, but absolute values do not seem reliable. This might be enough for SPCL.