

Render of a Midge [1]

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EFFECTS OF CHANGING THE MIDGE'S RECORDING SETTINGS ON BATTERY LIFE AND STORAGE

1. Background

- Sensor device created by Socially Perceptive Computing Lab
- Analyses group behaviour
- Sensors:
 - Inertial Measurement Unit (IMU) (1-228 Hz)
 - Microphone:
 - Low Frequency (LF) & Mono/Stereo
 - High frequency (HF) & Mono/Stereo
 - Bluetooth Low Energy (BLE): Scan Interval & Scan Window

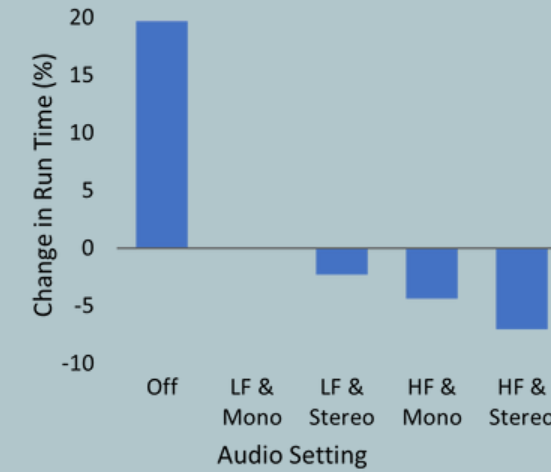
2. Research Question

What are the maximum sampling frequencies the Midge's sensors can operate at whilst not exceeding data storage and battery limitations in a given time frame?

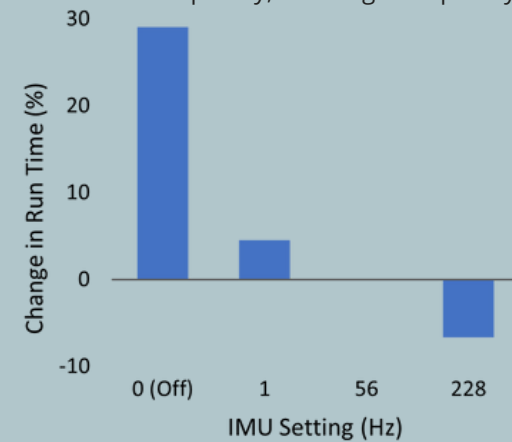
3. Methodology

- Measure if external factors influence battery consumption and data generation
- Run Midges at different settings to analyse run times
- Use run time data to find the amount of data being generated for different settings
- Extrapolate expected values for intermediate frequencies by analysing the data from the experiments

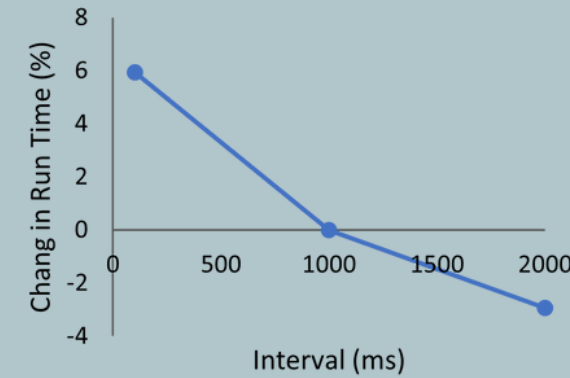
4. Results



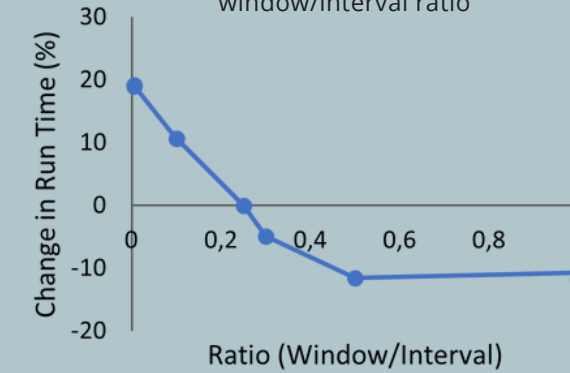
Graph 1: Measured run time changes for different microphone settings compared to LF Mono baseline
LF = low frequency, HF = high frequency



Graph 2: Measured run time changes for different IMU settings compared to baseline of 56Hz



Graph 3: Measured run time changes compared to baseline for different BLE interval settings from data with the same window/interval ratio



Graph 4: Measured run time changes compared to baseline for different window/interval ratio's with a fixed interval

MB generated per minute for each component:

- IMU: 1.46KB per sensor at 1 HZ (scales linearly to sampling frequency)
 - Accelerometer (1-228Hz)
 - Gyroscope (1-228Hz)
 - Magnetomer (1-76Hz)
 - Gyroscope (56-228Hz)
- Microphone:
 - LF: 149.5KB
 - LF & Stereo: 149.5KB
 - HF: 2.33MB
 - HF & Stereo: 2.33MB
- BLE: window 250, interval 1000
 - 1 Midge within range: 0.4KB
 - 7 Midges within range: 5.5KB

6. Limitations

- Uncontrollable room temperature
- Limited testing time:
 - Small sample size
 - Large range of bluetooth settings
 - Combination of settings
- Small amount of Midges

7. Conclusion

- Midge on default settings lasts 29-34 hours
- No combinations of settings wil exceed storage limitations before battery runs out except HF
- Compared to (default) baseline settings:
 - ~5% run time can be gained/lost through changing IMU sampling frequencies
 - HF will run ~7% shorter (when not limited by storage)
 - LF stereo recording lasts ~2% shorter
 - HF stereo recording lasts ~10% shorter
- BLE settings need further testing

8. References

[1] https://github.com/TUdelft-SPC-Lab/spcl_midge_hardware/blob/master/Media/v2.3.jpg

5. Formulae

Battery Run Time:

$$\text{IMU: } 1 - (On(2 \times 10^{-6} \times IMU^2 - 1 \times 10^{-3} \times IMU + 4.62 \times 10^{-2}) + (1 - On) \times -2.977 \times 10^{-1})$$

$$\text{LF/HF: } 7.67 \times 10^{-2} \times MIC^2 - 2.735 \times 10^{-1} \times MIC + 1.1968$$

$$\text{Mono/Stereo: } 1 - MS \times (7.1 \times 10^{-3} \times MIC^2 + 2.09 \times 10^{-2} \times MIC)$$

$$\text{BLE: } \min \left(\left(1 - \left(6.567 \times 10^{-1} \times \left(\frac{WIN}{INT} \right)^2 - 9.634 \times 10^{-1} \times \left(\frac{WIN}{INT} \right) + 1.949 \times 10^{-1} \right) \right) \times \left(1 + (5 \times 10^{-5} \times INT - 5.8 \times 10^{-2}) \right), 1.19 \right)$$

Multiplying the above four formulae with each other and a baseline time of a Midge gives an estimation of total run time

Amount of data recorded per minute in MB excluding BLE:

$$MIC \times ((2 - MIC) \times 1.5 \times 10^{-1} + (MIC - 1) \times 2.37) + 2 \times 1.46 \times 10^{-3} \times IMU + \min(IMU, 76) \times 1.46 \times 10^{-3} \times \max(IMU, 56) \times 1.46 \times 10^{-3}$$

On = 0 for IMU off, 1 for IMU on. IMU = sampling frequency of IMU (Hz). MIC = 0 for off, 1 for LF, 2 for HF.

MS= 0 for Mono, 1 for Stereo. WIN = scan window (ms). Interval = scan interval (ms)