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

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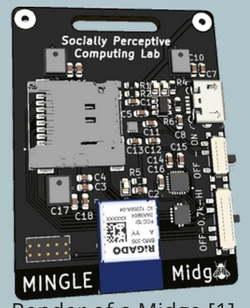


Render of a Midge [1]

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

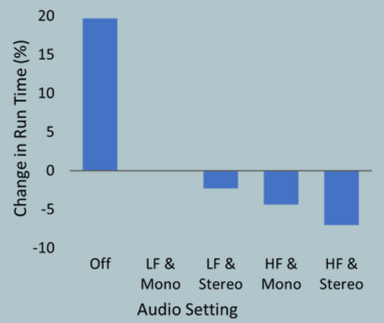
2. Research Question

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?

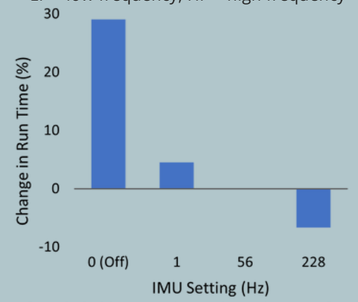
3. Methodology

- 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

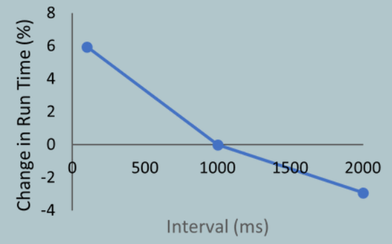
4. Results



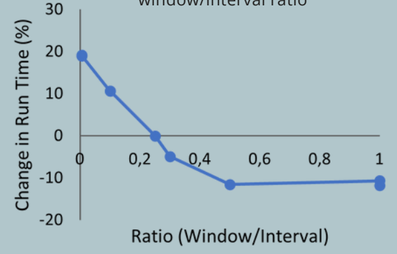
Graph 1: Measured run time changes for different microphone settings compared to LF Mono baseline
LF = low frequency, HF = high frequency



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)
  - Rotation (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

5. Formulae

Battery Run Time:

IMU: $1-\left(On\left(2\times10^{-6}\times IMU^{2}-1\times10^{-3}\times IMU+4.62\times10^{-2}\right)+(1-On)\times-2.977\times10^{-1}\right)$

LF/HF: $7.67\times10^{-2}\times MIC^{2}-2.735\times10^{-1}\times MIC+1.1968$

Mono/Stereo: $1-MS\times\left(7.1\times10^{-3}\times MIC^{2}+2.09\times10^{-2}\times MIC\right)$

BLE: $Min\left(\left(1-\left(6.567\times10^{-1}\times\left(\frac{WIN}{INT}\right)^{2}-9.634\times10^{-1}\times\left(\frac{WIN}{INT}\right)+1.949\times10^{-1}\right)\right)\times\left(1+\left(5\times10^{-5}\times INT-5.8\times10^{-2}\right)\right),1.19\right)$

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:

$MIC\times\left((2-MIC)\times1.5\times10^{-1}+(MIC-1)\times2.37\right)+2\times1.46\times10^{-3}\times IMU+Min(IMU,76)\times1.46\times10^{-3}\times Max(IMU,56)\times1.46\times10^{-3}$

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)

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