Report

- **Date:** January 25, 2024
- **Location:** UCL
- **Participants:** Alexis, Tabitha

Objectives

- Investigate and mitigate EEG noise caused by LRA-related EMI.
- Test actuator amplitude mapping.
- Discuss silicone moulding setup and process.

Activities

1. EEG Noise Testing

Setup

- At the hospital, Tabitha set up the EEG system with electrodes immersed in a saline solution.
- The Bsense device was configured to send periodic impulses to the LRA actuators.
- Two experimental conditions were tested:
    i. LRA actuators positioned close to the EEG electrodes (≈2–3 cm), without direct contact with the saline solution.
    ii. LRA actuators in direct contact with the saline solution.

Observations

- **Condition 1 (LRA close, no contact):**
  No visible noise was observed on the EEG signals when the LRA actuators were activated.
- **Condition 2 (LRA in contact with saline):**
  Significant noise appeared on the EEG signals during LRA activation.

Hypothesis

- The observed EEG noise is likely caused by direct electrical coupling between the LRA metal casing and the conductive medium (saline / body), rather than radiated EMI.

Actions Taken

- **Shielding:** Although shielding did not appear to be the primary issue, the LRA metal casing was connected to a grounded shielding wire as a precautionary measure.

Next Steps

- Test the system on-body with the shielding connection in place.
- If noise persists, electrically isolate the LRA casing from the skin using a non-conductive layer (e.g. tape).
- If insulation resolves the issue, design a dedicated non-conductive enclosure for the LRA actuators.

2. Amplitude Mapping

Setup

- Connected the Bsense device to a PC via serial.
- Used a Python script to sweep PWM duty cycle values sent to the LRA actuators.
- Assessed resulting vibration amplitude using a finger as a subjective proxy.

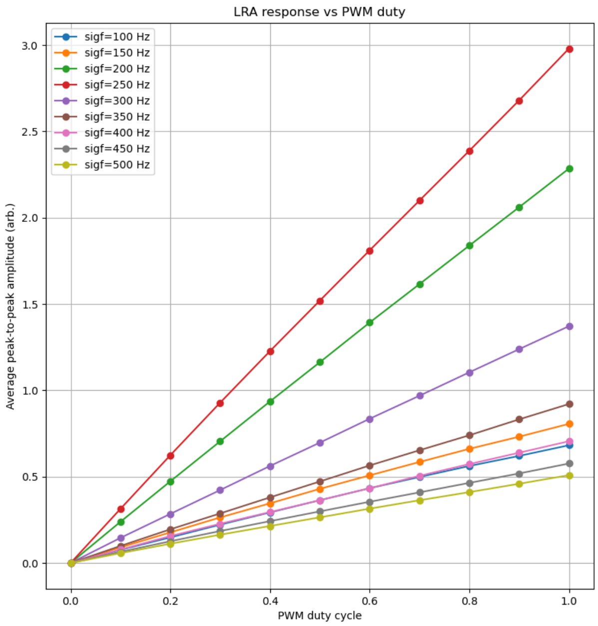
Observations

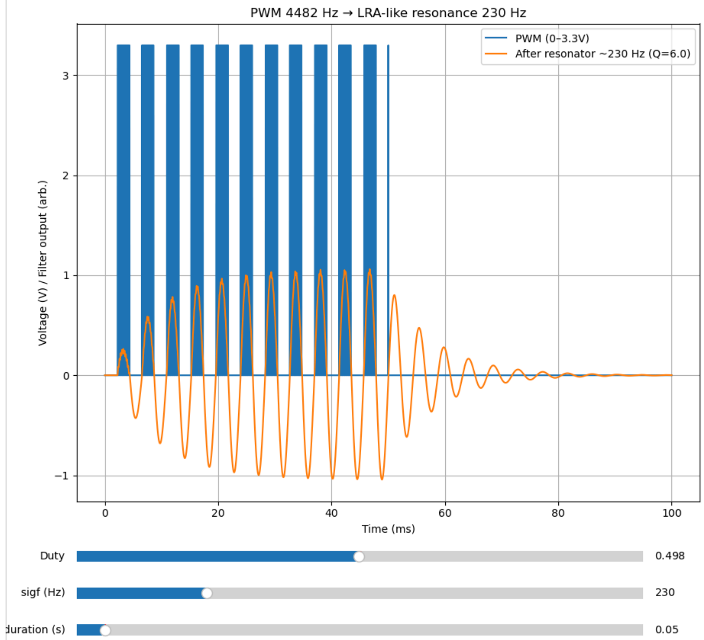
- Above approximately **0.5 duty cycle**, no perceptible increase in vibration amplitude was observed.

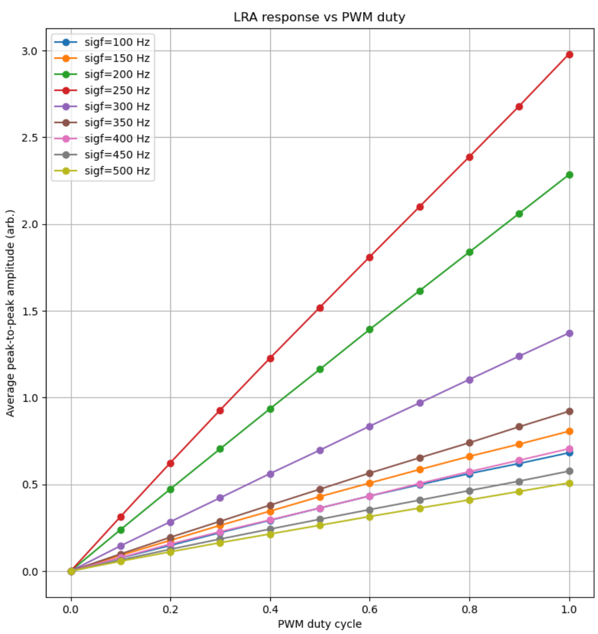
Actions Taken

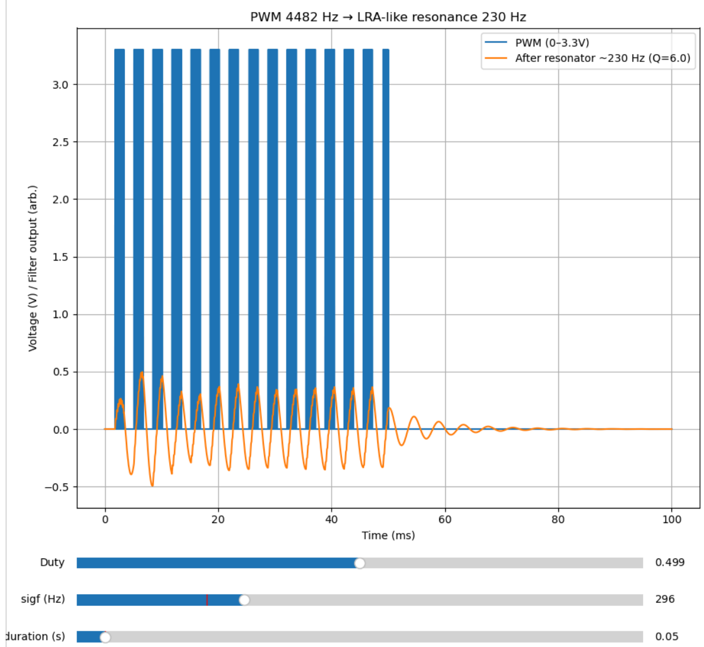
- Documented the signal generation and amplitude mapping process (see LRA_Signal_Generation.md).
- Created a simulation of the LRA response as a function of PWM duty cycle and excitation frequency.
  The model predicts a linear relationship between duty cycle and vibration amplitude (see figures below).

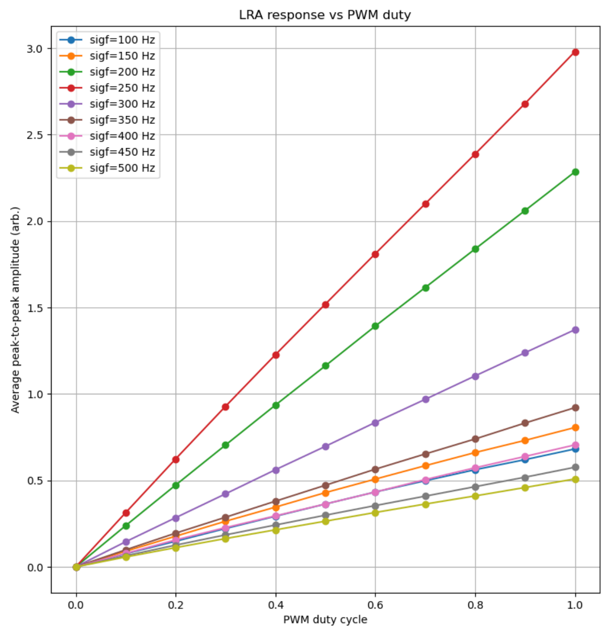
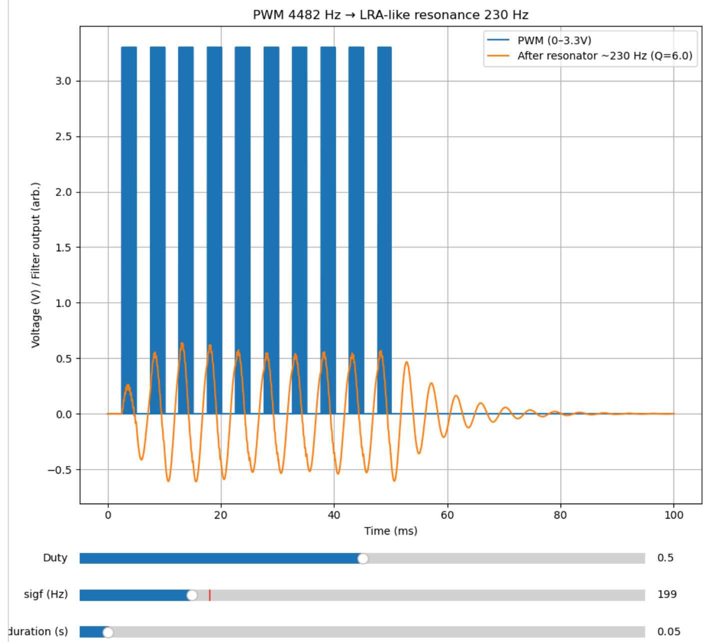
Simulation Result









Simulation Result
 

- Given the actuator's **1.8 V RMS rating** and a **3.3 V supply**, maximum usable amplitude is expected around **~70% duty cycle**; beyond this, saturation is likely.
- Firmware was updated (no PC-side changes required) so that the full user-facing duty cycle range (0–100%) maps internally to **0–50% actuator duty cycle**.
- PWM frequency was increased to **46.875 kHz**.

Next Steps

- Validate the amplitude mapping using an objective measurement setup (test bench with accelerometer).

3. Silicone Moulding Discussion

Discussed the silicone moulding workflow for the grasping sensor with Tabitha.

Process

1. Mix silicone components A and B thoroughly (1:1 ratio).
2. *(Optional)* Apply a thin layer of release agent (e.g. Vaseline) to the 3D-printed mould to facilitate demoulding.
3. Pour the silicone mixture into the mould.

4. *(Optional)* Degas in a vacuum chamber to remove air bubbles introduced during mixing (recommended but not strictly required).
5. Allow to cure at room temperature for **4–6 hours**.
6. Carefully demould the cured silicone part.

Next Steps

- Purchase silicone: Smooth-On Ecoflex 00-30.
- 3D print moulds for the sensor components.