**Department of Electronic and Telecommunication Engineering**
**University of Moratuwa, Sri Lanka**


# Brain-Computer Interface for Locked-In Pediatric Patient

Main Supervisor:

Dr. Pranjeevan Kulasingham

| Members: | Group 21 |
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**Final Year Project Monthly Report (Month 2)**
submitted in partial fulfillment of the requirements for the course module EN4203/BM4201

**October 23, 2025**

# 1 Summary of Individual Work Carried Out, Problems Encountered and Solutions

## 1.1 Gammune D.J.T

My main task this month was to select and prepare a suitable dataset for our signal processing pipeline. I reviewed several public datasets and selected the **MAMEM dataset** for developing our SSVEP-based BCI, as it includes 14 EEG channels and the specific frequencies we plan to use. I began the initial analysis by **visualizing the channel-wise EEG data using Python** and also started setting up the **EEGLab toolbox in Matlab** for more advanced analysis. A key part of my work was defining the **two-stage signal processing pipeline**: (a) signal pre-processing and artifact removal, and (b) feature extraction and output classification. This provides a clear roadmap for our algorithm development.

## 1.2 Kumarasinghe R.D

This month, my work focused on rapid prototyping the custom headset. I began by **preparing the 3D printer in the BME lab**, which is necessary for the multiple iterations required for a patient-specific fit. I then printed the first initial head cap design and tested it with an elastic band, finding that it **fit very well**. This successful test allowed me to proceed with the next iteration. My main accomplishment was designing and printing the **first full iteration of the headset**, which successfully integrates the BCI screw-type electrodes. This new design allows the electrodes to be adjusted for good scalp contact, which is a crucial step toward a functional prototype.

## 1.3 Weerasinghe C.N

My focus this month was on the physical electrode hardware and ensuring signal quality. I sourced the **original BCI screw-type electrodes** and worked with the design team to integrate them into the new 3D-printed headset. During this process, I identified a major challenge: we must be able to **verify the quality of the electrode-scalp contact** to get reliable data. To address this, I researched a method for an **electrode impedance check**. I found that the **ADS1299 chip** (which is in our AFE) has a built-in "Lead-Off Detection" feature. This feature can be used to inject a small 6 nA AC current to measure impedance, ensuring it's below the required 5-10 k$\Omega$ for SSVEP experiments.

## 1.4 Wijewickrama W.K.D.D

This month, I worked on firmware planning based on new hardware requirements and finalized administrative tasks. My main technical task was to **investigate the firmware implementation for the "Lead-Off Detection" feature** of the ADS1299 chip. While the hardware team identified this feature for impedance checking, it requires firmware to control it. I began scoping the development needed to programmatically **inject the 6 nA AC current and measure the resulting voltage** at the amplifier. This will allow us to calculate impedance in real-time.

## 2 Overall Project Monthly Update

This month marked a significant transition from planning to practical prototyping and data exploration. The team prepared the BME lab's **3D printer for rapid prototyping**, which was immediately used to print the first head cap design. This initial test was successful, confirming a good fit. This was quickly followed by the **first full headset iteration**, which successfully integrated adjustable, screw-type electrodes.

In parallel, the signal processing groundwork began. The **MAMEM dataset was selected** as the primary resource for algorithm development. The team has already begun **visualizing this data in Python** and is in the process of setting up the EEGLab toolbox in Matlab for more advanced analysis. A formal **two-stage signal processing pipeline** (pre-processing/artifact removal and feature extraction/classification) was defined.

## Declaration

We declare that the information provided in this report is a true and accurate record of the work carried out during the stated month.

| Name | Signature | Date |
|---|---|---|
| Gammune D.J.T | | 24/10/2025 |
| Kumarasinghe R.D | | 24/10/2025 |
| Weerasinghe C.N | | 24/10/2025 |
| Wijewickrama W.K.D.D | | 24/10/2025 |

## Supervisor's Comments and Signature

**Comments:**

24/10/2025

**Dr. Pranjeevan Kulasingham**
Supervisor Signature

Date