MUSMET Recording Suite

Version 1.3.0

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Contents

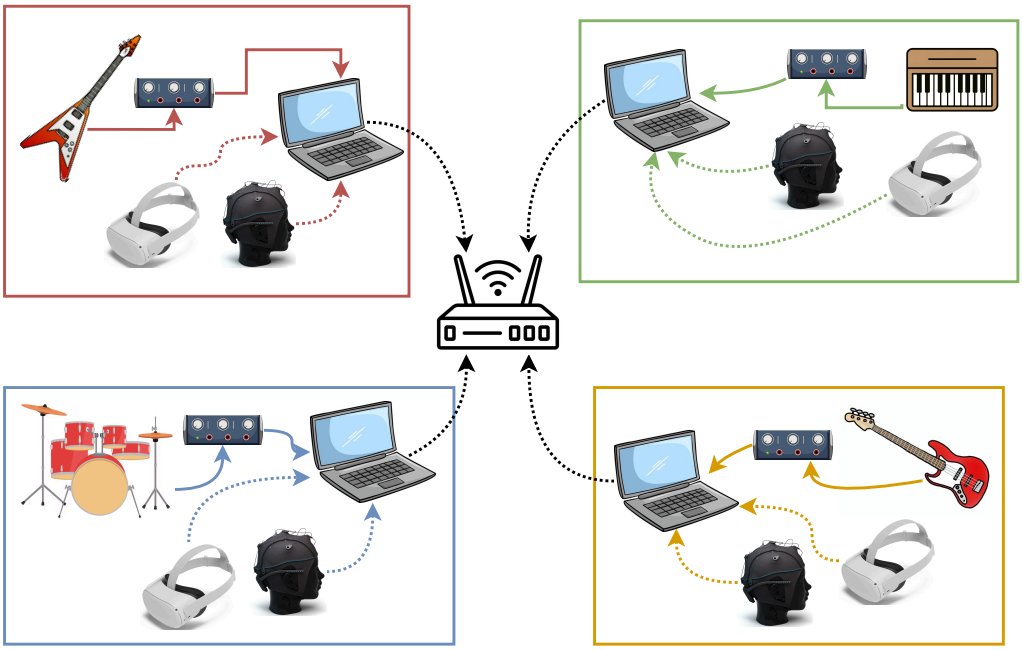


Figure 1: System architecture. Solid lines denote wired connections. Dotted lines indicate wireless connections.

1 Introduction

1.1 MCVCP140.dll error

If you encounter the error that states MSVCP140.dll was not found, install it from the below links.

- `https://aka.ms/vs/16/release/vc_redist.x86.exe`
- `https://aka.ms/vs/16/release/vc_redist.x64.exe`

This document highlights the usage of the Recording Suite created for the data acquisition for MUSMET. The software is created to obtain data streams of four musical instruments (guitar, bass, drums, keyboard), along with the data from Brain Computer Interfaces (BCIs), and Head Mounted Displays (HMDs) attached to each musician.

1.2 System Architecture

Figure 1 shows the System architecture. Each bounded box will represent all devices associated with a single musician. As illustrated in the Figure 1, the four musical instruments and attached devices are follows:

- Red Box - Guitarist
  - Electric guitar is connected to an audio interface, which is connected to the computer. *All connections are WIRED.*
  - The HMD worn by the guitarist is connected wirelessly *via WI-Fi*.
  - The BCI worn by the guitarist is connected to the laptop wirelessly *via Bluetooth*.
- Green Box - Keyboardist
  - Keyboard is connected to an audio interface, which is connected to the computer. *All connections are WIRED.*
  - The HMD worn by the keyboardist is connected wirelessly *via WI-Fi*.
  - The BCI worn by the keyboardist is connected to the laptop wirelessly *via Bluetooth*.
- Blue Box - Drummer
  - Drum-kit is connected to an audio interface, which is connected to the computer. *All connections are WIRED.*
  - The HMD worn by the drummer is connected wirelessly *via WI-Fi*.
  - The BCI worn by the drummer is connected to the laptop wirelessly *via Bluetooth*.
- Oranhge Box - Bass Guitarist
  - Bass guitar is connected to an audio interface, which is connected to the computer. *All connections are WIRED.*
  - The HMD worn by the bassist is connected wirelessly *via WI-Fi*.
  - The BCI worn by the bassist is connected to the laptop wirelessly *via Bluetooth*.

1.3 Data Types

As introduced above, each musician is equipped with their own instrument, along with a BCI and HMD. Each device will transmit a different type of data as shown below.

- Musical Instrument: is connected to an audio interface. The audio data is recorded, both as a *.wav* file locally, and as a 32-bit floating point data stream with a 48kHz sampling rate.
- Head Mounted Display (HMD) is connected using Wi-Fi. The HMD will transmit messages using the Open Sound Control (OSC) protocol. The OSC messages contain the position and orientation details of the HMD. The data is saved as an array of OSC messages, along with another array of timestamps corresponding tpo each message.
- Brain Computer Interface (BCI): is connected to the computer using Bluetooth, and it will transmit data from the attached electrodes. The BCI has a total of 8 such electrodes, and the user can configure the data to be recorded in one of two methods:
  - **All data in a single stream:** *If this configuration is selected, all the data from the BCI will be saved as a single array. Each data point will be a nested array containing the readings of all sensors. Another accompanying array will be saved with timestamps corresponding to each data point.*
  - **Data in individual streams:** *If this configuration is selected, each sensor will be transmitted and saved as an individual array. An accompanying array of timestamps will also be saved.*

1.4 Network

As illustrated in Figure 1, the computers associated with each musician must be connected to a local network. It is advised to configure a small router to create a local network, and not to use an existing enterprise network.

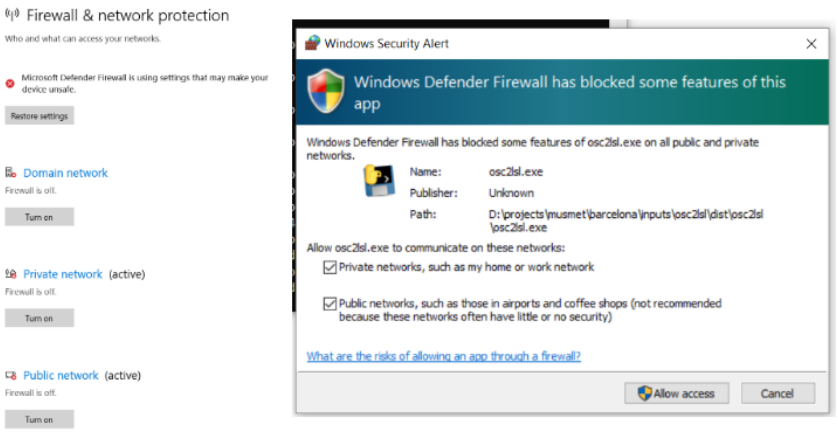
It is advised to use the network only to connect the recording laptops - as connecting other devices into the network may potentially use more bandwidth and may increase latency.

2 Device and Interface Setup

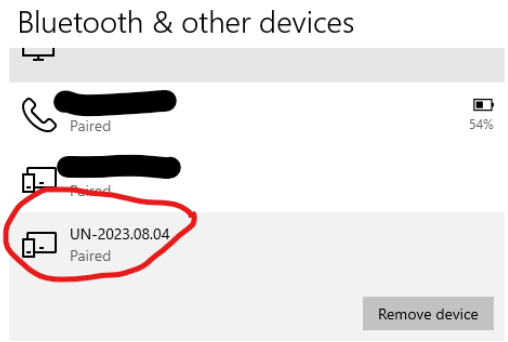
Note that all programs work exclusively on Windows.

2.1 Network Setup

1. Make sure all the computers have their firewalls turned off. When you run each program for the first time, you will be prompted to allow the program access. Allow the programs to communicate on all networks.



2. Connect the musical instrument to the audio interface, and the audio interface to the computer. Make sure all the drivers for the audio interface are installed, and the instrument gain is at an adequate level.
3. Connect the BCI to the computer via Bluetooth.

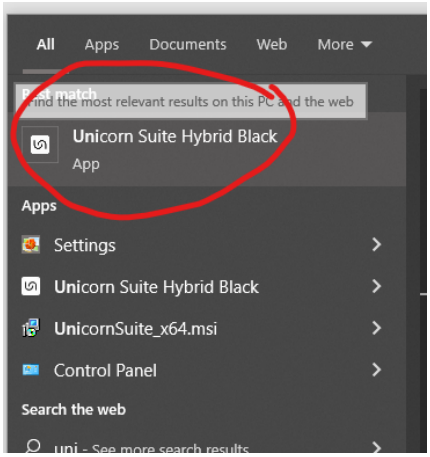


4. Connect the HMD to the network.

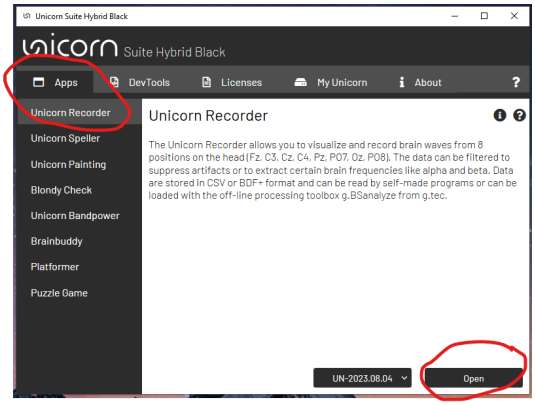
2.2 Connecting gTec Unicorn Brain Computer Interface (BCI)

First we must make sure sure that the BCI is connected and transmitting data. You can download the gTec Unicorn Suite Hybrid Black

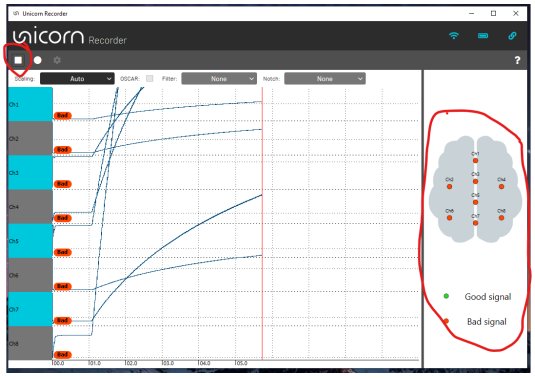
1. As illustrated in the earlier section, connect the BCI via Bluetooth.
2. Run ***Unicorn Suite Hybrid Black*** from the ***Start Menu***.



3. Select ***Apps*** -> ***Unicorn Reader*** -> ***Open***



4. When you Press ***Play/Stop*** you will see the signals. The panel on the right will specify if the BCI nodes are connected properly and transmitting a good signal.



3 Recording Multiple streams of Data

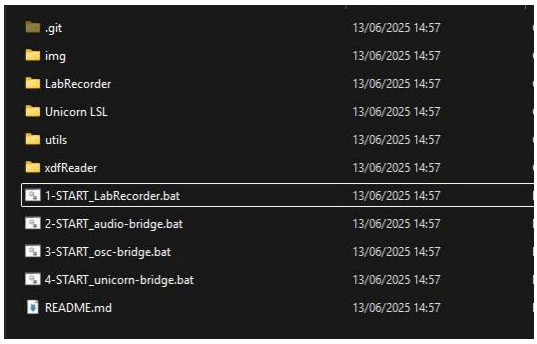
The open source framework LabStreamingLayer[1] is used to store the data with accompanying timestamps. The open source tool *LabRecorder is used for the actual recording*. There are 3 other applications that act as bridges to convert raw data to the desired format.

- **Audio Bridge** will convert the audio into LSL streams.
- **OSC Bridge** will convert HMD signals into LSL streams.
- **Unicorn Bridge** will convert the BCI signals into LSL streams.

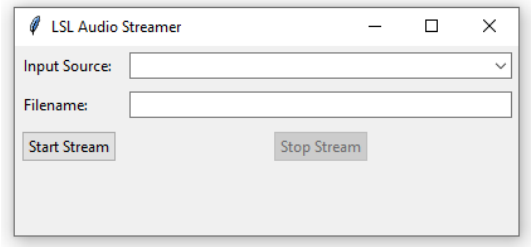
3.1 Audio Bridge

The audio bridge will convert the audio into LSL streams to be saved and synchronized.

1. Select **2-START_audio-bridge.bat**



2. Select the corresponding input from the Audio Interface.



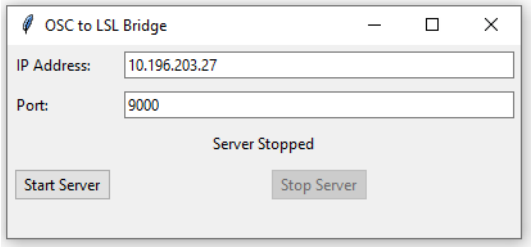
3. Enter a filename for the audio to be saved. The files are saved in the **/audio** folder on the working directory.
4. **Start Stream** button starts streaming the audio and recording locally.
5. **Stop Stream** button will end the LSL stream, and save the audio as a .wav file.

[1] https://labstreaminglayer.org/

3.2 OSC Bridge

1. Select **3-START_osc-bridge.bat**

2. The window will show the IP address of the device, along with the port to create the OSC server.

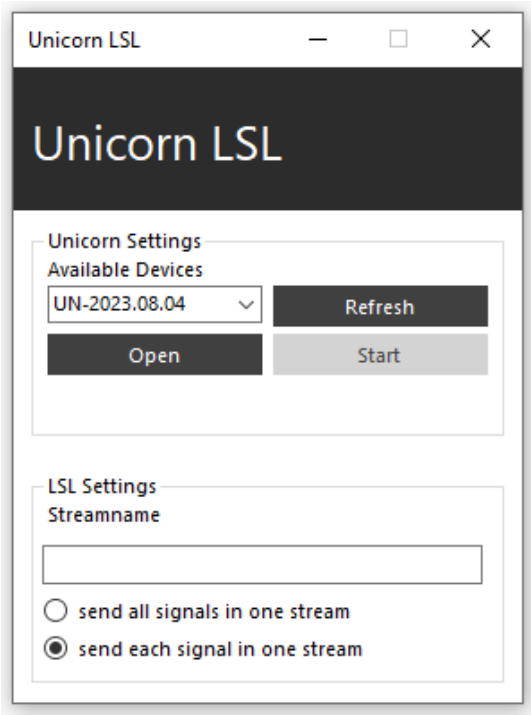


3. The window will show the IP address of the device, along with the port to create the OSC server.
4. The terminal window that will open will show each OSC message as it arrives.
5. **Start Stream** button starts the OSC server and streaming.
6. **Stop Stream** button will end streaming and the server.

3.3 Uniocorn Bridge

1. Select **4-START_unicorn-bridge.bat**

2. Select the Unicorn device connected via bluetooth.

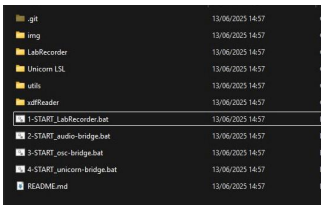


3. There are two methods of streaming data, as elaborated in Section 1.3.
    - *Send all signals in one stream*: all the data from the BCI will be saved as a single array.
    - *Send each signal in one stream*: each sensor will be transmitted and saved as an individual array
4. Enter a name for the LSL stream. You may leave this field blank, and the program will automatically insert the ID of the connected device here.
5. Press Open to initiate connection with the BCI.
6. **Start Stream** button will start streaming.
7. **Stop Stream** button will end the stream.

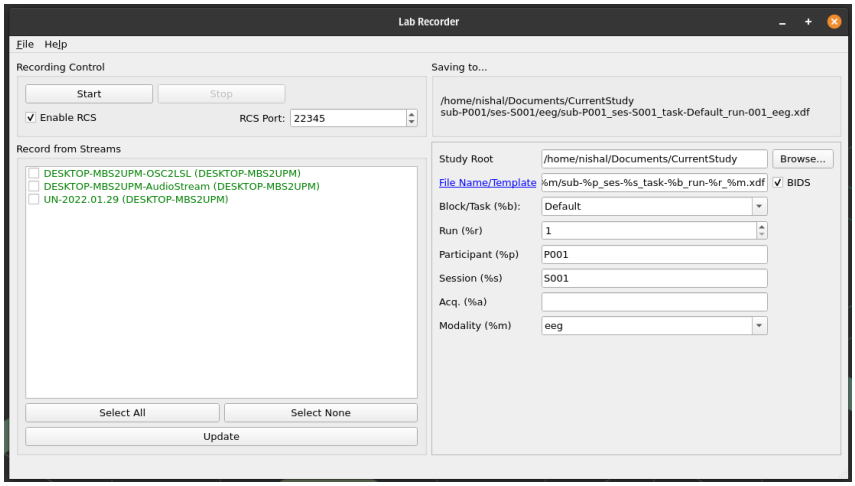
3.4 LabRecorder

You can use a computer in the same network to record the data.

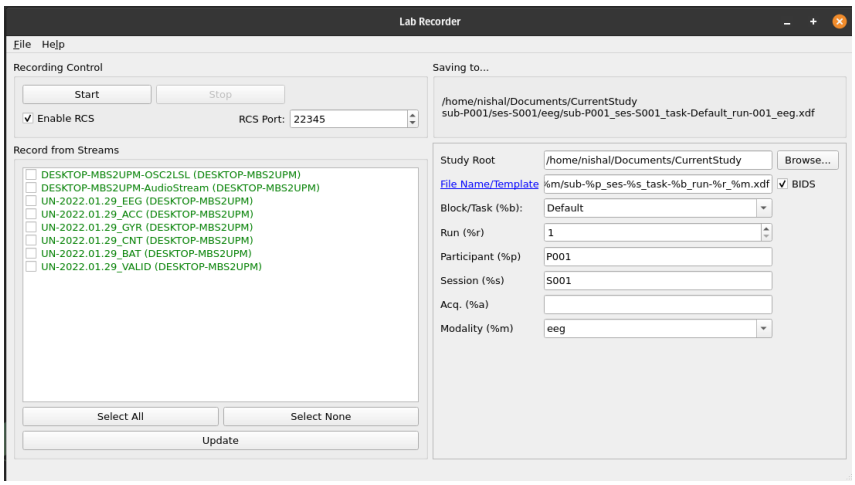
1. Select **4-START_LabRecorder.bat**



2. If the option *Send all signals in one stream* was selected for the BCI, the following screen will be displayed. Each stream is labeled with its domain name as a prefix. The Unicorn BCI is shown as a single stream, along with the OSC stream, and the audio stream.

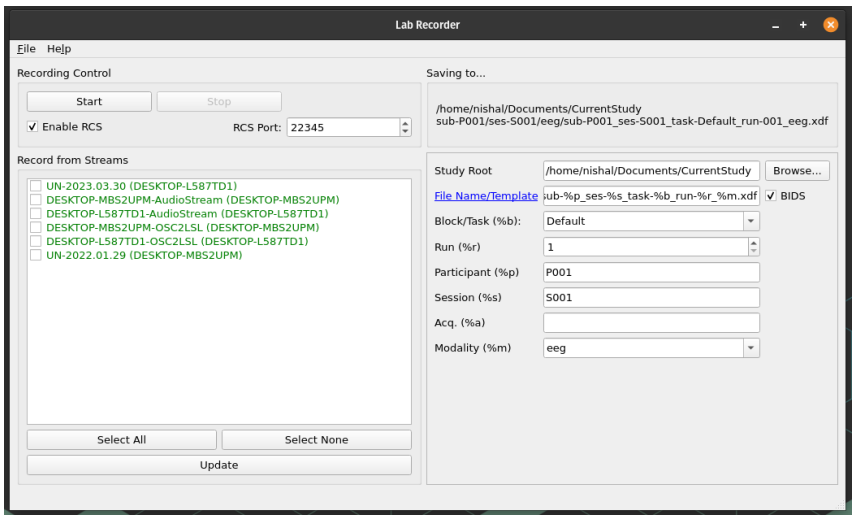


3. If the option *Send each signal in one stream* was selected for the BCI, the streams will be populated as below. Along with the Audio and OSC streams, you should see six BCI streams (EEG, ACC, GYR, CNT, BAT, VALID).

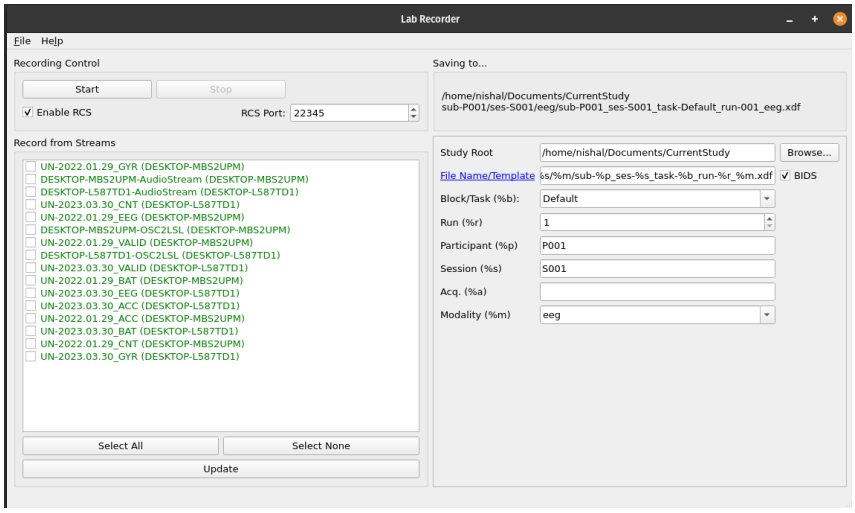


4. The field **Study Root** is the location where the xdf file with all the time-stamped streams will be saved.
5. The filenames are generated using the BIDS framework[2]. You can choose to use this framework, or uncheck the BIDS checkbox. *This setting only affects the filename and you are free to use either option.*
6. Press Update until you see all the streams from all the devices in the network.

    - Below if a screenshot of two computers with the BCIs being transmitted in a single stream. You can see two audio streams, two OSC streams, and two BCI streams. Each stream name has a prefix of the computer hostname for identification.



    - Below if a screenshot of two computers with the BCIs being transmitted in a multiple streams. You can see two audio streams, two OSC streams, and 12 BCI streams. Each stream name has a prefix of the computer hostname for identification.



[2] https://bids.neuroimaging.io/

7. Press **Start/Stop** to start or stop the recording.

3.5 Converting .xdf to .xml

All the data is timestamped and recorded into the .xdf extention. You may use the *xdfReader/xdf.exe* program to convert the .xdf file to .xml, which can be read by most commercial applications.

Simply select the corresponding .xdf file, and press Convert. The .xml file with the recorded data will be saved in the same directory as the original .xdf file.