Muse Developer Resources

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OSC Paths - MuseIO v3.4.0

Note that these paths should be considered "beta" as Muse-IO is under rapid development, the paths could change with a new release.

Changes since 3.2.0:

- Renamed /muse/dsp/bandpowers to /muse/dsp/elements
- Changed all double outputs to floats. This only occurred in the dsp paths.

EEG Paths

/muse/eeg

This is the EEG data converted to microvolts. Depending on the preset specified, this can be 4 or 6 channels.

Four channel (10bits): ffff

- Position 1: Left Ear(TP9), Range: 0.0 - 1682.0 in microvolts
- Position 2: Left Forehead(FP1), Range: 0.0 - 1682.0 in microvolts
- Position 3: Right Forehead(FP2), Range: 0.0 - 1682.0 in microvolts
- Position 4: Right Ear(TP10), Range: 0.0 - 1682.0 in microvolts

If the --osc_timestamp option is used, there are 2 extra fields appended to these messages:

- integer: Number of seconds since 1970 when this event occurred
- integer: Number of microseconds within that second

If you use the --no-scale command-line option, you get the proprietary raw data. We do not recommend you use this as it may change at any time. Keep

in mind that the gain will be slightly different for every Muse, as the value of the resistors that determine it can change by up to 1%. So the gain could be anywhere from about 1923 to 2001. So the uV/bit for the ADC will vary from Muse to Muse.

Four channel (10 bit resolution): ffff

- Position 1: Left Ear, Range: 0.0-1023.0, measure of voltage of EEG reading. To get microvolts: uV=(x/1023)*3.3V*(1/A)*1000000; x= this value; A=gain of AFE(Analog Front End)=1961. Max microvolts: 1682, Min microvolts: 0
- Position 2: Left Forehead, Range: 0-1023
- Position 3: Right Forehead, Range: 0-1023
- Position 4: Right Ear, Range: 0-1023

/muse/eeg/quantization: iiii

When using the consumer presets, the EEG data is compressed. If there is too much variation in the signal, then the signal must be rounded off (estimated) when it is sent. To decrease the size of the data, the EEG value is divided by a number before it is sent. This is the number it is divided by.

Four channel:

- Position 1: Left ear quantization amount. Possible values: 1,2,4,8,16,32,64,128. This is the amount that the EEG value has been divided by. To get the real (estimated) EEG value, multiply by this number.
- Position 2: Left forehead quantization amount. Possible values: 1,2,4,8,16,32,64,128.
- Position 3: Right forehead quantization amount. Possible values: 1,2,4,8,16,32,64,128.
- Position 4: Right ear quantization amount. Possible values: 1,2,4,8,16,32,64,128.

/muse/eeg/dropped_samples : i

- Position 1: Number of EEG samples (all channels = 1 sample) dropped from bluetooth connection issues, 16bit, Range: 0-65535. Position of this message in the message stream indicates where the dropped samples occurred.

Accelerometer Paths

/muse/acc : fff

The relative positions specified(forward/back, up/down) are if you are wearing Muse properly on your head.
These values are in milli-G's where 1 G is the force of gravity, this is also known as "weight per unit mass" or "acceleration vector".
For an explanation of G-forces, see: http://en.wikipedia.org/wiki/G-force

Some relevant points:

- The g-force acting on a stationary object resting on the Earth's surface is 1 g (upwards) and results from the resisting reaction of the Earth's surface bearing upwards equal to an acceleration of 1 g, and is equal and opposite to gravity. The number 1 is approximate, depending on location.
- The g-force acting on an object under acceleration can be much greater than 1 g.

Data:

- Position 1: forward and backward position, Range: -2000.0 milli-g to +1996.1 milli-g
- Position 2: up and down position, Range: -2000.0 mill-g to +1996.1 milli-g
- Position 3: left and right position, Range: -2000.0 milli-g to +1996.1 milli-g

If you use the --no-scale command-line option, you get the proprietary raw data. We do not recommend you use this as it may change at any time.

The positions specified are if you are wearing Muse properly on your head.

- Position 1: forward and backward position, Range: -512 to 511
- Position 2: up and down position, Range: -512 to 511
- Position 3: left and right position, Range: -512 to 511

/muse/acc/dropped_samples : i

- Position 1: Number of accelerometer samples(all channels = 1 sample) dropped from bluetooth connection issues, 16bit, Range: 0-65535. Position of this message in the message stream indicates where the dropped samples occurred.

Battery Paths

/muse/batt : iiii

- Position 1 = State of Charge, Divide this by 100 to get percentage of charge remaining, (e.g. 5367 is 53.67%) Range: 16 bit, 0-10000.
- Position 2 = Millivolts measured by Fuel Gauge, Range: 16bit, 3000-4200 mV.
- Position 3 = Millivolts measured by ADC, Range: 16bits, 3200-4200 mV. Values below 3350 are not reliable(they will flat line and stop falling) and you can consider the battery close to dead at that point(about 5 mins left).
- Position 4 = Temperature in degrees Celcius, signed integer, 1°C Resolution, range is -40 to +125 °C.

DRL/Ref Path

The Driven-Right-Leg (DRL) circuit has been used for about 50 years to reduce common-mode noise in biopotential amplifiers in applications that range from stationary equipment powered from the wall to battery-powered ambulatory monitors, and for systems that use gelled, dry, textile, and capacitive electrodes. The Driven Right Leg circuit is used to eliminate common-mode noise by actively cancelling it.

The reference signal is the one all other EEG values are derived from and is maintained around 1.65V. The DRL is driving the reference through the skin and adjusts the output based on noise fed back from the reference. If the headband is off the head the reference signal is not driven and the difference between the two values is significant, if on the head the difference is small.

/muse/drlref : ff

- Position 1 = DRL, 0-3300 in microvolts
- Position 2 = Reference, 0-3300 in microvolts

Config Path

/muse/config

The config data is emitted every 1 seconds, encoded in JSON format as key-value pairs. This maps to the Muse protocol buffer file format.

Global Configuration

`mac_addr: string, e.g. "012345678912"`
The MAC address of the Muse in use.

`serial_number: string, e.g. "1070-YRTD-2A4D"`
The serial number of the Muse in use.

`preset: string, e.g. "ab"`
The current preset.

Network protocol

`compression_enabled: bool, e.g. 0`
Set to 1 if compression is on. If compression is on, then quantization messages will be emitted.

EEG Data

`filters_enabled: bool, e.g. 0`
Set to 1 if the 50Hz or 60Hz filter is enabled.

`notch_frequency_hz: int, e.g. 60`
Which frequency is being filtered, either 50Hz or 60Hz.

`eeg_sample_frequency_hz: int, e.g. 12000`
The base sampling frequency before downsampling and filtering.

`eeg_output_frequency_hz: int, e.g. 500`
The speed of EEG data being sent from Muse in Hz.

`eeg_channel_count: int, e.g. 4`
How many channels are being sampled.

`eeg_samples_bitwidth: int, e.g. 0`
Number of bits per sample.

`eeg_channel_layout: string, e.g. "TP9 FP1 FP2 TP10"`
Layout of the channels emitted, using the 10-20 system.

`eeg_downsample: int, e.g. 24`
Number of input samples per output sample. The ***eeg_output_frequency*** is equal to ***eeg_sample_frequency / eeg_downsample***.

afe_gain: float, e.g. 1961
Analog front end gain.

DRLREF Data

drlref_data_enabled: bool

drlref_conversion_factor: float

drlref_sample_frequency_hz: int

Accelerometer Data

acc_data_enabled: bool, e.g. 1
Set to 1 if accelerometer data is enabled.

acc_units: string, can be "raw" or "gforce"
The units of the accelerometer data.

acc_sample_frequency_hz: int, e.g. 30
Number of acc samples emitted per second.

Battery Data

battery_data_enabled: bool, e.g. 1
Set to 1 if battery data is enabled. If enabled, it is emitted every 10 seconds.

battery_percent_remaining: int, e.g. 91
Percentage of battery remaining.

battery_millivolts: int, e.g. 4094
Number of millivolts remaining in the battery.

Error Data

error_data_enabled: bool, e.g. 1
Whether headset errors will be transmitted or not.

Version Path

/muse/version

This is the version string for the Muse, emitted every 10 seconds, encoded in JSON format. The first string is the MAC address for the connected Muse, and the second string is the version string. See this page for information about the version string.

Example values:

```
mac_addr: 000666641732
hardware_version: 7.0
firmware_type: consumer
firmware_bootloader_version: 7.0.7
firmware_headset_version: 7.0.7
build_number: 8
protocol_version: 2
```

Annotation Paths

/muse/annotation sssss "blink" "" "" "" ""

- Position 1: event data
- Position 2: format, can be: "plain_string", "json", "osc"
- Position 3: event type
- Position 4: event id
- Position 5: parent id

See the Muse protocol buffer file for more info.
All values after the first one can be blank. However, they should all be there even if they are blank.

DSP Paths

/muse/dsp/elements/low_freqs ffff

1-8Hz, log band power (dB)

/muse/dsp/elements/delta ffff

1-4Hz, log band power (dB)

/muse/dsp/elements/theta ffff

5-8Hz, log band power (dB)

/muse/dsp/elements/alpha ffff

9-13Hz, log band power (dB)

/muse/dsp/elements/beta ffff

13-30Hz, log band power (dB)

/muse/dsp/elements/gamma ffff

30-50Hz, log band power (dB)

/muse/dsp/status_indicator ffff

Status indicator for each channel (think of the Muse status indicator that looks like a horseshoe).
1 = good, 2 = ok, >=3 bad

/muse/dsp/is_good iiii

Strict data quality indicator for each channel, 0= bad, 1 = good.

/muse/dsp/blink i

A boolean value, 1 represents a blink was detected.

/muse/dsp/jaw_clench i

A boolean value, 1 represents a jaw clench was detected.

/muse/dsp/touching_forehead i

A boolean value, 1 represents that Muse is on the head correctly.

/muse/dsp/bandpower
/raw_fft0 fffffffffffffffffffffffffffffffffffffffffffffffff

129 decimal values with a range of roughly -4.0 to 2.0. This represents FFT for the first channel, show the absolute power on a log scale(dB) of each frequency from 0hz-110Hz, divided into 129 bins.

/muse/dsp/bandpower
/raw_fft1 fffffffffffffffffffffffffffffffffffffffffffffffff

129 decimal values with a range of roughly -4.0 to 2.0. This represents FFT for the second channel, show the absolute power on a log scale(dB) of each frequency from 0hz-110Hz, divided into 129 bins.

/muse/dsp/bandpower
/raw_fft2 fffffffffffffffffffffffffffffffffffffffffffffffff

129 decimal values with a range of roughly -4.0 to 2.0. This represents FFT for the third channel, show the absolute power on a log scale(dB) of each frequency from 0hz-110Hz, divided into 129 bins.

/muse/dsp/bandpower
/raw_fft3 fffffffffffffffffffffffffffffffffffffffffffffffff

129 decimal values with a range of roughly -4.0 to 2.0. This represents FFT for the fourth channel, show the absolute power on a log scale(dB) of each frequency from 0hz-110Hz, divided into 129 bins.

Comments

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