HDF5-based data format for EIT data

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Abstract: Many devices, both research and commercial, have been made for EIT and bioimpedance applications. We propose a new, flexible data format which can allow data interchange, based on the HDF5 data standard.

1 Introduction

EIT and bioimpedance applications are growing. For research applications, there is an increasing complexity of configurations in which complex configurations and multi data streams are used. We have previously proposed an openEIT data format[1], which received little traction because of the difficulties of using XML as a data container. For a new data format, our requirements are:

- Simplicity: writing data in < 50 code lines.
- Self-documenting: core data element is the "frame".
- Streaming: suitable for large and online data sets.
- Extensibility: easy to add additional data and elements.

Here, we propose a data format based on HDF5 [4], a hierarchical format designed for numerical data.

2 Format

The format (Version 2023.4) is illustrated in Fig 1; updated versions will be documented at [3]. Data sets are stored as frames of data, where each is a sequence of measurements, which are repeated over time. For complex data, Meas.V.Real and Meas.V.Imag data sets are stored. Multiple data sets can be stored in one file, and e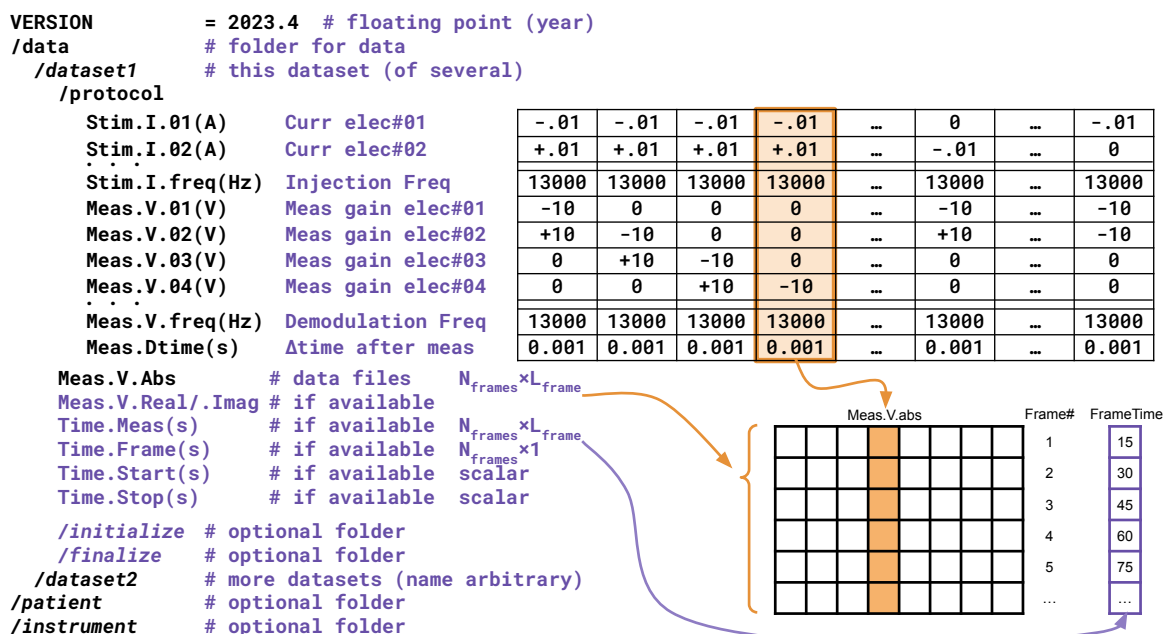ach measurement configuration is documented in a /data/{Data set name}/protocol field. Electrodes can be numbered or named. In the protocol, the field Stim.I.01(A) indicates the excitation current into electrode 01 in Amps; the 4th element shows $10\,\text{mA}=0.01\,\text{A}$ is injected during the 4th measurement in each frame. Excitation (stimulation) information is stored into fields that start with Stim and specify the kind of excitation after a dot. Similary, measurement information are stored into fields that start with Meas. Measurements normally correspond to stimulations, but this is not required e.g. for biopotential measurements, where Meas.V.freq(Hz)=0. Measurement data are stored as a matrix $N_{\text{frames}} \times L_{\text{frame}}$, with an extension indicating the type (.Abs, .Real, .Imag). Times (if known) can be stored as shown. Optional / vendor-specific information (e.g. /instrument, or /data/initialize) can be stored. Additional recordings with their own protocols are stored with different /data/{Data set name}.

3 Discussion

We describe an HDF5-based data format for EIT data. It documented with code examples at [3]. The data format is supported in EIDORS [2] and will be part of the next software release.

References

[1] C Jones *et al*, p.20, Conf EIT 2014
[2] A Adler, WRB Lionheart, Physiol Meas 27:S25–42, 2006
[3] A Adler *et al*, sf.net/p/eidors3d/code/HEAD/tree/trunk/dev/HDF5_tools/ "HDF5 tools", 2023
[4] The HDF Group, 1997–2023, hdfgroup.org/HDF5

Figure 1: Structure of the proposed HDF5 file (Version 2023.4). All data sets must contain a protocol defining the configuration for each measurement in a frame. Frame data is a single file (e.g. Meas.V.abs). Times for measurements or frames are provided if available. Items in *italics* have example names (can be named differently).