Open Electrical Impedance Tomography (OEIT) File Format

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Abstract: Electrical impedance tomography (EIT) creates tomographic images from surface electrical stimulation and measurement. Many research and commercial devices have been made, with correspondingly many data formats, which negatively impacts the ability to share data. To address this issue, we have developed the OEIT data format, an XML-based flexible container format for EIT data. We describe its features and structure.

1 Introduction

Electrical impedance tomography (EIT) is a tomographic imaging technique that makes use of electrical currents injected into a body and of the resulting potential field to calculate the spatial distribution of electrical conductivity/impedivity. Over the last decade, EIT has witnessed a dramatic increase in the number of studies produced and commercial implementations[1], leading to an increase in data formats to store EIT, which negatively impacts the ability to share data. We propose a common file structure and XML data description to encapsulate EIT data in order to promote data sharing.

2 File Structure

The OEIT file makes use of the ZIP format with the following directory structure:

/auxiliary Data from auxiliary devices.
/eit Data related to the EIT stimulation and measurement.
/info Descriptive elements of the EIT device, stimulations, and measurements.
/info/sensitive Data of a sensitive nature that may be stripped if the file is shared.
/log Log files related to data acquisition.
/oem Any user-defined data.
/oeit.xml The XML parsing entry point.

While the directory structure is recommended, the XML contains links to all portions of data. Therefore, the only necessary items are the /oeit.xml file for initial parsing and sections required to complete the XML data description.

3 XML Data Description

The oeit.xml file describes the location of all other relevant pieces of information, making use of XInclude[2]:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<oeit xmlns:xi="http://www.w3.org/2001/XInclude"
    xmlns="http://www.open-eit.org/schema">
  <xi:include href="info/subject.xml"/>
...
```

The recommended location for the data description elements is **/info** with file names and contents as follows:
subject.xml Describes the subject under test.
devices.xml Describes the EIT and other physical devices used during data capture.

electrode_types.xml Describes the physical electrode types used during data capture.
electrodes.xml Describes the logical electrodes used during data capture.
stim_types.xml Describes the types of stimulations used during data capture.
meas_types.xml Describes the types of measurements used during data capture.
frame_types.xml Describes the coupling and temporal arrangements of stimulations and measurements.
streams.xml Describes the internal layout and locations of the data streams in terms of repetitions of frames and describes associated log files.

The XML data description allows a user to describe all fields within a data stream, the stimulations (if any) that produced each field, and the measurement associated with each field (from an example frame_types.xml):

```xml
...<acquisition duration="369.82us" start="0us">
...    <stim type="CurrentInjection">
            <elec ref="e1" multiplier="1"/>
            <elec ref="e2" multiplier="-1"/>
       </stim>
...
       <meas type="Voltage">
            <elec ref="e3" multiplier="1"/>
            <elec ref="e4" multiplier="-1"/>
       </meas>
...</acquisition>
```

This means the user is free to change the arrangements of stimulations and measurements to best suit their purpose, and consumers of the data can reconstruct the events of data acquisition. Since no assumptions are made as to what is included in the data stream, legacy streams may be described by the XML data description. The complete schema definition can be found online at `http://www.open-eit.org/schema`.

4 Conclusions

By making no assumptions about data stream contents, providing mechanisms to describe data streams, and containing one entry point, the OEIT file format provides a flexible mechanism to describe EIT acquisitions in a fashion that can be consumed by other parties without *a priori* knowledge of the data acquisition process.

References

[1] Adler, A, MB Amato, JH Arnold, R Bayford, M Bodenstein, SH Boehm, BH Brown, I Frerichs, O Stenqvist, N Weiler, GK Wolf, "Whither lung EIT: Where are we, where do we want to go and what do we need to get there?", Physiological Measurement (2012), 33:679-694.

[2] http://www.w3.org/TR/xinclude/

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