
VISR Code documentation

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ABOUT**1.1 About VISR****1.2 About this document**

This is the code reference document for the VISR (Versatile Interactive Scene Renderer) software framework. It describes the software architecture and modules, and provides the API documentation for the C++ and Python interfaces. In addition, it details the software development process, including obtaining and compiling the source code.

DEVELOPMENT AND CONTRIBUTION

2.1 Source Code

Depending on the operating system you have, the following startup guides will be useful for creating a successful build and/or using VISR for your own development. In a new terminal window, run the following:

```
git clone gitlab@gitlab.eps.surrey.ac.uk:s3a/VISR.git
```

2.1.1 osx

The choice of IDE for MacOS X is Xcode. You can see the full guide on developing with visr here at the MacOS Setup Guide.

2.1.2 linux

To develop and contribute using VISR with a Linux-based IDE, have a look at the Linux Setup Guide.

2.1.3 windows

To develop and contribute using VISR with Windows and Visual Studio, have a look at the Windows Setup Guide.

2.1.4 Raspberry Pi

2.2 VISR Git Workflow

This page documents the version control workflow followed by the VISR community when dealing with the development of VISR. If you want to contribute, and/or already have code or bug fixes you would like to see in the official repo, please follow these guidelines to make the life of the devs easier, minimize time needed for review, and ensure speedy and efficient incorporation of your improvements into VISR.

2.2.1 VISR Git Workflow

The git workflow for openFrameworks is based on this article detailing a very good branching model. Read the article first, it's quite complete and nicely presented, no need to replicate everything here.

<https://nvie.com/posts/a-successful-git-branching-model/>

2.2.2 Continuous Integration

All contributions that are merged together in the remote are tested before they are pushed. This is to ensure what you contribute works and is tested on all operating systems. Sometimes, before you push, you might forget to compile or test your code (we all make these mistakes sometimes), so the cvssp-servers at Surrey University will run certain jobs to ensure that your code compiles and is built correctly.

Every time a merge request from your feature/name-of-your-feature to the remote/origin/develop occurs, a pipeline is triggered testing what you have done before it is merged. You should receive an email if it does not.

On a successful pipeline, other work is done to automatically update VISR's WebAPI. Make sure you comment what you have written!

2.3 Setting up a build environment

2.3.1 Standard build setup

2.3.2 Git

- On Linux git can be installed through the distribution's package manager. On Ubuntu, Raspbian, and Debian-based distribution, the command is `sudo apt install git`.
- On Mac OS X 10.9 and above, the git command line tool is installed on its first invocation (source: ['GIT SCM book <'](#)
- On Windows, we suggest the [Git for Windows](#) binaries.

Alternatively you can choose from a number of GUIs, for example [SourceTree <https://www.sourcetreeapp.com/>](#) or [GitKraken](#), or the support in modern IDEs as Microsoft Visual Studio or Apple XCode.

2.3.3 CMake

VISR uses [CMake](#) as a portable build tool. The minimum required version is CMake 3.1.

CMake can be used as a command line tool but also provides a GUI (cmake-gui) for configuring builds.

- On Linux, install through the distribution's package manager. On Debian-based systems, the packages are named `cmake` for the command line tools and `cmake-qt-gui` for the graphical user interface.
- On Windows and Mac OS X, download
- If you plan to use the machine for CI (continuous integration tasks), make sure you add it to the system path (Windows: Select "Add CMake to the system PATH for all users")

2.3.4 Documentation

The VISR documentation is mainly written as ReStructured text documents (using ['Sphinx <>'](#) to create web pages and PDF documents), whereas the code documentation pulled into these documents is generated through [Doxygen](#).

In order to create the user and API documentation, the following software tools must be installed:

- Doxygen: On Windows and Mac OS X, we recommend downloading binary packages from the [Doxygen download page](#) and installing them. On Linux, installing via the distribution-specific package manager (e.g., `"sudo apt install doxygen"`). Note that the XML output generation needed for subsequent build stages is quite buggy in older Doxygen releases, it might therefore be advisable to upgrade to a recent Doxygen release or to build from source (especially on Linux, where the version provided by the package manager could be rather dated).

- LaTeX: Both the Doxygen documentation and the PDF generation of Sphinx require a LaTeX system to be installed. We recommend the following LaTeX distributions:

- **Linux:** The system-provided LaTeX (installed, e.g., through “`sudo apt install texlive-full`” “`sudo apt install texlive`”

- * Mac OS X: ‘**MacTeX** <<http://www.tug.org/mactex/>’_

- * Windows: ‘**MikTeX** <<http://www.miktex.org/>’_

Note that - unless you install a “full” distribution - LaTeX packages might be missing and would need to be installed as needed. So look out for error messages when running the documentation generation for the first time, and use the distribution’s package manager to install the missing packages as needed.

After installing LaTeX and running the CMake configuration stage with the option `BUILD_DOCUMENTATION` enabled

- Windows: Set the CMake variable “`MIKTEX_BINARY_PATH`” to the directory containing the MikTeX binaries, e.g., “`C:/Program Files/MiKTeX 2.9/miktex/bin/x64`”

- Mac OS X: Set `PDFLATEX_COMPILER` to the result of the shell command which `pdflatex`’. On a recent MacTeX installation, this yields ```/Library/TeX/texbin/pdflatex/`

- Sphinx: Sphinx is typically bundled with the Python distribution you are using and should therefore be installed through the package management system of this distribution.

- **Linux:** use the package manager of the Linux distribution, e.g., `sudo apt install python3-sphinx`.

- * Anaconda (recommended distribution on Windows and Mac OS X): use `conda install sphinx`.

Alternatively, the generic Python package manager `pip` can be used.

- **Breathe:** Breathe is needed by sphinx to render source code generation for languages other than Python. As Breathe is

- Linux: use the package manager of the Linux distribution, e.g., `sudo apt install python3-breathe`.

- Anaconda (recommended distribution on Windows and Mac OS X): use `conda install -c conda-forge breathe`. Note that breathe is not contained in the standard package repository but the additional repository `conda-forge`.

- `sphinxcontrib-bibtex`: Extension to create bibliographies using BibTeX files. Installed in the same way as breathe, that, is using `conda` where available, or the `pip` package manager. Again, it is not included in the standard conda package repository, therefore it has to be installed through

```
conda install -c conda-forge sphinxcontrib-bibtex
```

- `sphinx.ext.autodoc`: Extract documentation from the docstrings contained in Python code and Python bindings.
- `sphinx.ext.napoleon`: Enables a simpler syntax for Python docstrings to be extracted via `autodoc`.

2.3.5 Installer package generation

Installation packages are created using `CPack`, which is integrated into the CMake build software. On Linux and Mac OS X, no external build software is needed.

Windows

Download and install the NSIS installer system ([‘https://sourceforge.net/projects/nsis/’](https://sourceforge.net/projects/nsis/)). It will be automatically recognized if you create the installer packages.

2.3.6 Setup as Gitlab runner

To provide a

LIBRARIES

3.1 VISR API

3.1.1 Architecture

3.1.2 API reference

Class Component

class Component

Base class for processing components. Components may contain ports to exchange data (either audio signal or parameter) with other components or with the exterior. A component may have a parent, that is, a composite component it is contained in. If the parent is null it is a top-level component. Components also have a name, which must be unique within a containing composite component.

Subclassed by *visr::AtomicComponent*, *visr::CompositeComponent*

Public Functions

Component (SignalFlowContext **const** &context, char **const** *componentName, *CompositeComponent* *parent)

Constructor, constructs a component.

Parameters

- context: Configuration object containing basic execution parameters (such as sampling frequency and period (block length))
- componentName: The name of the component. If this component is contained in a higher-level parent component, the name must be unique within that parent component
- parent: Pointer to the containing composite component, if there is one. Otherwise, that is, if the present component is at the top level, pass `nullptr`.

Component (SignalFlowContext **const** &context, std::string **const** &componentName, *CompositeComponent* *parent)

Constructor. Convenience function, accepts a standard string instead of a C character pointer.

Parameters

- context: Configuration object containing basic execution parameters (such as sampling frequency and period (block length))
- componentName: The name of the component. If this component is contained in a higher-level parent component, the name must be unique within that parent component.
- parent: Pointer to the containing composite component, if there is one. Otherwise, that is, if the present component is at the top level, pass `nullptr`.

Component (*Component* const&)

Deleted copy constructor to avoid copy construction of this and derived classes.

Component (*Component*&&)

Deleted move constructor to avoid moving of this and derived classes.

Component &**operator=** (*Component* const&)

Deleted assignment operator to prohibit (copy) assignment of this and derived classes.

Component &**operator=** (*Component*&&)

Deleted assignment operator to prohibit move assignment of this and derived classes.

~Component ()

Destructor (virtual)

std::string **const** &**name** () **const**

Return the 'local', non-hierarchical name.

std::string **fullName** () **const**

Return the full, hierarchical name of the component.

void **status** (StatusMessage::Kind *status*, char **const** **message*)

Signal informational messages or the error conditions. Depending on the value of the *status* parameter, this might result in a message conveyed to the user or abortion of the audio processing.

Parameters

- *status*: The class of the status message
- *message*: An informational message string.

template <typename... *MessageArgs*>

void **status** (StatusMessage::Kind *status*, MessageArgs... *args*)

Signal informational messages or the error conditions where the message string is constructed from an arbitrary sequence of arguments. Depending on the value of the *status* parameter, this might result in a message conveyed to the user or abortion of the audio processing.

Template Parameters

- *MessageArgs*: List of argument types to be printed. Normally they are automatically determined by the compiler, so there is no need to specify them.

Parameters

- *status*: The class of the status message
- *args*: Comma-separated list of parameters with unspecified types. The main requirement is that all types support an "<<" operator.

bool **isComposite** () **const**

Query whether this component is atomic (i.e., a piece of code implementing a rendering functionality) or a composite consisting of an interconnection of atomic (or further composite) components.

AudioPortBase &**audioPort** (char **const** **portName*)

AudioPortBase **const** &**audioPort** (char **const** **portName*) **const**

AudioPortBase &**audioPort** (std::string **const** &*portName*)

AudioPortBase **const** &**audioPort** (std::string **const** &*portName*) **const**

ParameterPortBase &**parameterPort** (char **const** **portName*)

ParameterPortBase **const** &**parameterPort** (char **const** **portName*) **const**

ParameterPortBase &**parameterPort** (std::string **const** &*portName*)

ParameterPortBase **const** ¶meterPort (std::string const &portName) **const**

SamplingFrequencyType **samplingFrequency** () **const**

Return the sampling frequency of the containing signal flow.

std::size_t **period** () **const**

Return the period of the containing signal processing graph, i.e., the number of samples processed in each invocation of the process function of the derived audio components. This methods can be called at any point of the lifetime of the derived component, i.e., for instance in the constructor.

bool **isTopLevel** () **const**

Query whether the component is at the top level of a signal flow.

Note Not needed for user API

impl::ComponentImplementation &**implementation** ()

Provide a pointer to an external implementation object. The type of this implementation object is opaque, i.e., not visible from the public VISR API.

Note This method is not supposed to be called in user code. It is public because it is used by the VISR runtime system.

impl::ComponentImplementation **const** &**implementation** () **const**

Provide a pointer to an external implementation object, constant version. The type of this implementation object is opaque, i.e., not visible from the public VISR API.

Note This method is not supposed to be called in user code. It is public because it is used by the VISR runtime system.

Public Static Functions

std::string **const** &nameSeparator ()

Separator used to form hierarchical names.

Protected Functions

Component (impl::ComponentImplementation *impl)

Constructor that receives the internal implementation object. This overload has to be called by the other constructors (including those of subclasses) to make sure that the implementation object is instantiated. The motivation for this constructor is to provide different implementation objects for different subclasses.

Class AtomicComponent

class AtomicComponent : **public** visr::Component

Base class for atomic components. These components are at the lowest level in the hierarchy and implement runtime functionality as C++ code. Abstract base class, derived classes must override the virtual method *process()*.

Subclassed by visr::apps::audio_network_streamer::AudioNetworkEncoder,
visr::impl::test::TestAtom, visr::python::visr::AtomicComponentWrapper, visr::rcl::Add,
visr::rcl::BiquadIirFilter, visr::rcl::CAPGainCalculator, visr::rcl::ChannelObjectRoutingCalculator,
visr::rcl::CrossfadingFirFilterMatrix, visr::rcl::DelayMatrix, visr::rcl::DelayVector,
visr::rcl::DiffusionGainCalculator, visr::rcl::FirFilterMatrix, visr::rcl::GainMatrix,
visr::rcl::GainVector, visr::rcl::HoaAllRadGainCalculator, visr::rcl::InterpolatingFirFilterMatrix,
visr::rcl::ListenerCompensation, visr::rcl::NullSource, visr::rcl::ObjectGainEqCalculator,
visr::rcl::PanningCalculator, visr::rcl::PositionDecoder, visr::rcl::ScalarOscDecoder,
visr::rcl::SceneDecoder, visr::rcl::SceneEncoder, visr::rcl::SignalRouting, visr::rcl::SparseGainMatrix,

```
visr::rcl::TimeFrequencyInverseTransform,          visr::rcl::TimeFrequencyTransform,
visr::rcl::UdpReceiver,          visr::rcl::UdpSender,          visr::reverboject::LateReverbFilterCalculator,
visr::reverboject::ReverbParameterCalculator, visr::rrl::SignalRoutingInternal< SampleType >
```

Public Functions

AtomicComponent (SignalFlowContext **const** &context, char **const** *name, *CompositeComponent* *parent = nullptr)

Constructor.

Parameters

- context: a signal flow context structure containing general parameters, e.g., sampling rate and block size of computation.
- name: Null-terminated character string containing the name. Name must be unique within the containing composite component (if there is one).
- parent: A composite component to contain this atom, If it is a null pointer (the default), then this component is at the top level.

AtomicComponent (*AtomicComponent* **const**&)

Deleted copy constructor to avoid copying.

AtomicComponent (*AtomicComponent*&&)

Deleted move constructor to avoid move construction.

~AtomicComponent ()

Destructor (virtual). Atomic components are destined to be instantiated and managed polymorphically, thus requiring virtual destructors.

virtual void process () = 0

Pure virtual *process()* function. The overriding methods of base classes are called in regular intervals, each processing a fixed number (`context.period()`) number of samples.

Class CompositeComponent

class CompositeComponent : **public** visr::Component

Base class for processing components that are composed of other components (atomic and composite). In this way, processing components can be structured hierarchically. Composite components store the contained sub-components, external audio and parameter ports, and connections between the ports.

Subclassed by visr::apps::audio_network_streamer::SignalFlow, visr::apps::feedthrough::Feedthrough, visr::apps::scene_decoder::SignalFlow, visr::audiointerfaces::test::Feedthrough, visr::mex::feedthrough::SignalFlow, visr::python::visr::CompositeComponentWrapper, visr::pythoncomponents::Wrapper, visr::reverboject::ReverbObjectRenderer, visr::signalflows::BaselineRenderer, visr::signalflows::BunchRenderer, visr::signalflows::CoreRenderer, visr::signalflows::DelayVector, visr::signalflows::GainMatrix, visr::signalflows::TimeFrequencyFeedthrough, visr::signalflowspython::VisrRenderer

Unnamed Group

using ChannelRange = visr::ChannelRange

Making the types for defining audio connections known inside CompositeComponent and derived classes These are convenience aliases to make the syntax in derived signal flows more concise.

Note : This also means that we include the ChannelList/ChannelRange definition in this header, as these classes become part the *CompositeComponent* interface.

using ChannelList = visr::ChannelList

Public Functions

CompositeComponent (SignalFlowContext **const** &*context*, char **const** **name*, *CompositeComponent* **parent* = nullptr)

Constructor.

Parameters

- *context*: Reference to a signal flow context object providing basic runtime parameters as period length or sampling frequency.
- *name*: “the name of the component. Used to address the component inside other components and for status reporting.
- *parent*: Reference (pointer) to a parent component if the present object is part of a containing signal flow. If `nullptr` is passed, this component is the top level.

~CompositeComponent ()

Destructor.

std::size_t **numberOfComponents** () **const**

The number of contained components (not including the composite itself). This method considers only atomic and composite components at the next level, i.e., not recursively.

impl::CompositeComponentImplementation &**implementation** ()

Return a reference to the internal data structures holding ports and contained components. From the user point of view, these data structure is opaque and unknown.

impl::CompositeComponentImplementation **const** &**implementation** () **const**

Return a reference to the internal data structures holding ports and contained components, const version. From the user point of view, these data structure is opaque and unknown.

void **parameterConnection** (char **const** **sendComponent*, char **const** **sendPort*, char **const** **receiveComponent*, char **const** **receivePort*)

Register a connection between parameter ports (both real ports of contained components or external placeholder ports).

Parameters

- *sendComponent*: The name of the component holding the send port (local name, not the fully qualified name). When specifying an external port of a composite component, use an empty string or “this”.
- *sendPort*: The local (not fully qualified) name of the send port.
- *receiveComponent*: The name of the component holding the receive port (local name, not the fully qualified name). When specifying an external port of a composite component, use an empty string or “this”.
- *receivePort*: The local (not fully qualified) name of the receive port.

Exceptions

- `std::invalid_argument`: if a specified component or port does not exist.

void **parameterConnection** (ParameterPortBase &*sender*, ParameterPortBase &*receiver*)

Register a connection between parameter ports (both real ports of contained components or external placeholder ports).

Parameters

- *sender*: Reference to the sendig port (retrieved, for example using `Component::parameterPort ()`)
- *receiver*: Reference to the sendig port (retrieved, for example using `Component::parameterPort ()`)

```
void audioConnection (char const *sendComponent, char const *sendPort, ChannelList  
                      const &sendIndices, char const *receiveComponent, char const  
                      *receivePort, ChannelList const &receiveIndices)
```

Register an audio connection between a sending and a receiving audio port. This overload uses C strings to denote both the names of the components holding the ports and the output ports itself. Lists of channel indices are to be specified for the sending and the receiving port. The sizes of these lists must be identical, and the contained indices must not exceed the width of the send and receive port, respectively. Empty lists for both the send and receive indices are permitted and result in no connection.

See *ChannelList* for the syntax to specify the channel index lists.

Parameters

- `sendComponent`: Name of the component holding the sending audio port. If the send port is an external input of this component, use "" or "this"
- `sendPort`: The name of the sending port.
- `sendIndices`: A list of channel indices denoting the send channels of the sending side.
- `receiveComponent`: Name of the component holding the receiving audio port. If the receive port is an external output of the present component, use "" or "this"
- `receivePort`: The name of the receiving port.
- `receiveIndices`: A list of channel indices denoting the receive channels within the receiver port.

Exceptions

- `std::invalid_argument`: if a specified component or port does not exist.

```
void audioConnection (AudioPortBase &sendPort, ChannelList const &sendIndices, Audio-  
                      PortBase &receivePort, ChannelList const &receiveIndices)
```

Register an audio connection between a sending and a receiving audio port. This overload uses audio ports (either directly referencing external in- and output of this components or retrieving ports of contained components using the *Component::audioPort()* method). Lists of channel indices are to be specified for the sending and the receiving port. The sizes of these lists must be identical, and the contained indices must not exceed the width of the send and receive port, respectively. Empty lists for both the send and receive indices are permitted and result in no connection.

See *ChannelList* for the syntax to specify the channel index lists.

Parameters

- `sendPort`: The send port object.
- `sendIndices`: A list of channel indices denoting the send channels of the sending side.
- `receivePort`: The receive port object.
- `receiveIndices`: A list of channel indices denoting the receive channels within the receiver port.

```
void audioConnection (AudioPortBase &sendPort, AudioPortBase &receivePort)
```

Register an audio connection between all channels of a sending and a receiving audio port. This overload uses audio ports (either directly referencing external in- and output of this components or retrieving ports of contained components using the *Component::audioPort()* method). It establishes one-to-one connections between the channels of the sender and the receiver.

Parameters

- `sendPort`: The send port object.
- `receivePort`: The receive port object.

Exceptions

- `std::invalid_argument`: if the port widths do not match.

Class AudioPortBase

class AudioPortBase

Base class for audio ports. Audio ports can form part of the external interface of components and denote start and end points of audio signal connections. An audio port is characterised by a sample type (fundamental integral and floating-point data type as well as complex floating-point types), the width, that is, the number of elementary audio signals represented by this port.

Subclassed by *visr::AudioInputBase*, *visr::AudioOutputBase*

Protected Functions

void ***basePointer** ()

Return the data pointer to fir first (technically zeroth) channel. The type of this pointer is char and needs to be casted in derived, typed port classes.

void **const *basePointer** () **const**

Return the data pointer to fir first (technically zeroth) channel, constant version. The type of this pointer is char and needs to be casted in derived, typed port classes.

Private Members

impl::AudioPortBaseImplementation ***mImpl**

Pointer to the private, opaque implementation object.

Class AudioInputBase

class AudioInputBase : public visr::AudioPortBase

Base class for audio input ports. This base class is not intended to be used by API users. This class itself cannot be instantiated, because it is not associated with a specific sample type. Only derived classes may actually be instantiated.

Subclassed by *visr::AudioInputT< SampleType >*, *visr::AudioInputT< DataType >*

Template class AudioInputT

template <typename *DataType*>

class AudioInputT : public *visr::AudioInputBase*

Class template for concrete audio inputs holding samples of a specific type.

Template Parameters

- *DataType*: The sample type used by this audio port type.

Alias class AudioInput

Non-template of the *visr::AudioInputT* port template specialised for the default sample type.

using visr::AudioInput = typedef AudioInputT<SampleType>

Alias for audio input ports using the default datatype (typically float)

3.2 Builtin component library (rcl)

3.3 Runtime library

3.3.1 Purpose

3.3.2 Main classes

class AudioSignalFlow

Base class for signal flows, i.e., graphs of connected audio components which perform an audio signal processing operation. This base class provides the infrastructure for setting up the graphs and for transferring the input and output samples. For the audio processing, this class provides a callback interface that must be called in regular intervals (i.e., for a fixed number of samples consumed and generated, respectively).

Subclassed by `visr::mex::gain_matrix::SignalFlow`, `visr::mex::gain_matrix::SignalFlow`, `visr::mex::late_reverb_filter_calculator::SignalFlow`

3.3.3 Checking functions

3.3.4 Internal classes and functions

3.4 Object model library

3.4.1 Purpose

3.4.2 API reference

namespace objectmodel

The documentation for the namespace `objectmodel`. Detailed description follows here.

Typedefs

```
using visr::objectmodel::ObjectId = typedef unsigned int
```

```
using visr::objectmodel::GroupId = typedef unsigned int
```

```
using visr::objectmodel::LevelType = typedef float
```

Type use for level (gain, volume) settings, linear scale

```
using visr::objectmodel::ObjectTypeIntegerRepresentation = typedef std::uint8_t
```

Enums

enum ObjectTypeId

A numeric id to uniquely describe object types.

Values:

PointSource = 0

Simple point-like source (monopole)

PlaneWave = 1

Straight plane-wave source type

DiffuseSource = 2

Totally diffuse source type

PointSourceWithDiffuseness = 3

Point-source-like audio object with an additional “diffuseness” attribute controlling the fraction of the source that is reproduced diffusely.

ExtendedSource = 4

Source type with controllable extent, i.e. width and height.

PointSourceWithReverb = 5

Point source with reverberation

PointSourceExtent = 6

Point source with explicit spatial extent.

HoaSource = 7

Higher Order Ambisonics object, sound field representation based on spherical harmonics

ChannelObject = 8

Source type representing a single or multiple channels routed to a set of loudspeaker channels.

Functions

`std::string const &objectTypeToString (ObjectTypeId type)`

Convert an object type id into its string representation

Parameters

- type:

Exceptions

- `std::logic_error`: Happens only in case of an internal inconsistency, i.e., if the type is not found in the lookup table.

`ObjectTypeId stringToObjectType (std::string const &typeString)`

Return The object id of the type corresponding to the string representation

Parameters

- typeString:

Exceptions

- `std::invalid_argument`: If typeStr does not correspond to an existing object type.

Variables

InstantiateObjectFactory **const cInstantiationHelper**

Object which is used to initialise the object factory.

struct InstantiateObjectFactory

A helper class with whole purpose is to register the different object types in the factory.

class Object

`#include <object.hpp>` Subclassed by `visr::objectmodel::ChannelObject`,
`visr::objectmodel::DiffuseSource`, `visr::objectmodel::HoaSource`, `visr::objectmodel::PlaneWave`,
`visr::objectmodel::PointSource`

class ObjectParser

`#include <object_parser.hpp>`

Subclassed by `visr::objectmodel::ChannelObjectParser`, `visr::objectmodel::DiffuseSourceParser`,
`visr::objectmodel::HoaSourceParser`, `visr::objectmodel::PlaneWaveParser`,
`visr::objectmodel::PointSourceParser`

```
class ObjectVector
    #include <object_vector.hpp> A class representing a set of audio objects of potentially different types.
    Subclassed by visr::pml::ObjectVector

class PointSource : public visr::objectmodel::Object
    #include <point_source.hpp> Subclassed by visr::objectmodel::PointSourceWithDiffuseness,
    visr::objectmodel::PointSourceWithReverb

class PointSourceParser : public visr::objectmodel::ObjectParser
    #include <point_source_parser.hpp> Subclassed by visr::objectmodel::PointSourceWithDiffusenessParser,
    visr::objectmodel::PointSourceWithReverbParser

class PointSourceWithDiffuseness : public visr::objectmodel::PointSource
    #include <point_source_with_diffuseness.hpp> Subclassed by visr::objectmodel::PointSourceExtent

class PointSourceWithDiffusenessParser : public visr::objectmodel::PointSourceParser
    #include <point_source_with_diffuseness_parser.hpp> Subclassed by
    visr::objectmodel::PointSourceExtentParser

class PointSourceWithReverb : public visr::objectmodel::PointSource
    #include <point_source_with_reverb.hpp> Audio object representing a monopole point source with
    corresponding object-based reverberation. Derived from PointSource.

namespace python
```

Functions

```
void exportChannelObject (pybind11::module &m)
void exportDiffuseSource (pybind11::module &m)
void exportHoaSource (pybind11::module &m)
void exportObject (pybind11::module &m)
void exportObjectType (pybind11::module &m)
void exportObjectVector (py::module &m)
void exportObjectVector (pybind11::module &m)
void exportPointSource (pybind11::module &m)
void exportPointSourceExtent (pybind11::module &m)
void exportPointSourceWithDiffuseness (pybind11::module &m)
void exportPointSourceWithReverb (pybind11::module &m)
void exportPlaneWave (pybind11::module &m)
```

namespace test

Functions

```
BOOST_AUTO_TEST_CASE (ParsePointSource)
BOOST_AUTO_TEST_CASE (ParsePlaneWave)
BOOST_AUTO_TEST_CASE (UpdateSceneSameIdSameType)
```

BOOST_AUTO_TEST_CASE (UpdateSceneSameIdDifferentType)

BOOST_AUTO_TEST_CASE (ParseMultiChannelObject)

BOOST_AUTO_TEST_CASE (ParseObjectEq)

BOOST_AUTO_TEST_CASE (ReencodeObjectEq)

BOOST_AUTO_TEST_CASE (ParseChannelObject)

BOOST_AUTO_TEST_CASE (WriteChannelObject)

BOOST_AUTO_TEST_CASE (InstantiatePointSources)

BOOST_AUTO_TEST_CASE (ObjectVectorAssign)

BOOST_AUTO_TEST_CASE (ParsePointSourceWithReverb)

BOOST_AUTO_TEST_CASE (SerialisePointSourceWithReverb)

BOOST_AUTO_TEST_CASE (InstantiateRenderer)

3.5 Elementary functions Library

3.5.1 Purpose

The **efl** library provides a common interface for arithmetic functions commonly used in DSP. These are mainly vector and matrix arithmetic functions. These

3.5.2 Numeric container classes

3.5.3 Arithmetic functions

```
template <typename T>
ErrorCode visr::efl::vectorCopy (T const *const source, T *const dest, std::size_t numEle-
                                ments, std::size_t alignment)
```