Ambiente de Teste para Filtros Adaptativos

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Chapter 1

Main Page

Projeto Final de Graduação

Para compilar:

```
         [   pf/  ]$ cd build
      [  pf/build/  ]$ ./config.sh
      [  pf/build/  ]$ cd release
[  pf/build/release/  ]$ make
```

O executável será colocado no diretório `build/release`.

Para gerar um executável do *Debug Build*, basta substituir o `cd release` por `cd debug`. O novo diretório do executável será `build/debug`.

Manual em PDF `aqui`.

Chapter 2

Todo List

Class Signal

Implement "stream" signals, to provide real-time processing.

Member Signal::DFTDriver::DFTDriver ()

make the table be inside a std::vector, instead of a built-in array, so that we can use the solution provided here. An alternative is documented here.

this static member should be initialized only once, even though multiple instances of the DFTDriver might be created (that is, static members shouldn't be initialized in the constructor). (perhaps we could have a private bool telling wether it's been already initialized)

Chapter 3

Hierarchical Index

3.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Signal::DFTDriver 11

std::exception

    std::runtime_error

        FileError 16

Signal 19

Chapter 4

Class Index

4.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Signal::DFTDriver
A class for providing discrete Fourier transform capabilities 11
FileError
A runtime exception while trying to process a file 16
Signal
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Chapter 5

File Index

5.1 File List

Here is a list of all files with brief descriptions:

main.cpp 29
Signal.cpp 32
Signal.h 33

Chapter 6

Class Documentation

6.1 Signal::DFTDriver Class Reference

A class for providing discrete Fourier transform capabilities.

```
#include <Signal.h>
```

Public Types

- enum dir_t { DIRECT, INVERSE }

Public Member Functions

- DFTDriver ()

  Constructor for an object that computes DFTs.
- void operator() (container_t &re, container_t &im, dir_t direction=DIRECT)

  Used to perform the actual computation of the DFT.

Static Public Attributes

- static const unsigned tblbits = 14

  Number of bits for the index of the table of sines and cosines.
- static const size_t tblsize = 16384

  Number of entries in the tables of sines and cosines.

Private Member Functions

- double Wre (unsigned k)

  Easy access to the table of cosines.
- double Wim (unsigned k)

  Easy access to the table of sines.

Static Private Member Functions

- template<typename T >
  static T br (T x, int bits)

  Bit-reverse.

Private Attributes

- unsigned bits

  Number of bits for the current FFT computation.

Static Private Attributes

- static double sintbl [tblsize]

  Table of sines.
- static double costbl [tblsize]

  Table of cosines.

6.1.1 Detailed Description

A class for providing discrete Fourier transform capabilities.

This class implements the radix-2 FFT algorithm used in the Signal::filter() method.

Usage:

```
Signal::DFTDriver dft;
Signal::container_t real, imag;
// initialize the real and imaginary parts of a complex time-domain
// signal
dft(real, imag); // performs in-place FFT
// now, work with the real and imaginary parts of the
// frequency-domain version of the signal
dft(real, imag, Signal::DFTDriver::INVERSE); // inverse in-place fft
// now, we can work again with the time-domain complex signal
```

Definition at line 259 of file Signal.h.

6.1.2 Member Enumeration Documentation

6.1.2.1 enum Signal::DFTDriver::dir_t

This is a type for specifying whether we should perform a direct or inverse FFT.

Enumerator

DIRECT Perform direct FFT.

INVERSE Perform inverse FFT.

Definition at line 404 of file Signal.h.

6.1.3 Constructor & Destructor Documentation

6.1.3.1 Signal::DFTDriver::DFTDriver ( ) `[inline]`

Constructor for an object that computes DFTs.

Computes and initializes the table of sines and cosines. After this initialization, the entries of the table shouldn't be modified.

Todo make the table be inside a std::vector, instead of a built-in array, so that we can use the solution provided `here`. An alternative is documented `here`.

Todo this static member should be initialized only once, even though multiple instances of the DFTDriver might be created (that is, static members shouldn't be initialized in the constructor). (perhaps we could have a private bool telling wether it's been already initialized)

See Also

sintbl
costbl

Definition at line 430 of file Signal.h.

References costbl, sintbl, and tblsize.

6.1.4 Member Function Documentation

6.1.4.1 template<typename T > static T Signal::DFTDriver::br (T *x*, int *bits*) `[inline]`, `[static]`, `[private]`

Bit-reverse.

Returns the bit-reversed version of the parameter *x*. Assumes *x* is *bits*-bit wide, and ignore any bits with more significance than that.

This function assumes that the number of bits in one `char` is 8, and that bitshifting is zero-padded, and not circular.

Template Parameters

T	The type of the parameter *x*. It **must** be an unsigned integer type.

Parameters

`in`	*x*	The *bits*-bit unsigned integer to be bit-reversed.
`in`	*bits*	The number of bits of the integer *x*.

Returns

the unsigned integer *x*, bit-reversed.

Definition at line 285 of file Signal.h.

Referenced by operator()().

6.1.4.2 void Signal::DFTDriver::operator() (container_t & *re*, container_t & *im*, dir_t *direction* = DIRECT)

Used to perform the actual computation of the DFT.

Implements the radix-2 time-decimation FFT algorithm. The computation happens in-place, which means that the *re* and *im* parameters are substituted by their new versions.

Of course, the *re* and *im* vectors must be of the same size. This size must be a power of two not greater than tblsize.

Exceptions

std::runtime_error	if any of the above conditions aren't met.

Parameters

`in,out`	*re*	Real part of the compelx signal on which the FFT will act.

in,out	*im*	Imaginary part.
in	*direction*	Wether this is a direct or inverse DFT.

Definition at line 428 of file Signal.cpp.

References bits, br(), DIRECT, INVERSE, tblsize, Wim(), and Wre().

6.1.4.3 double Signal::DFTDriver::Wim (unsigned *k*) `[inline], [private]`

Easy access to the table of sines.

Parameters

in	*k*	Same as in Wre.

Returns

$\sin\left(\tau \cdot \mathtt{k}/2^{\mathtt{bits}}\right)$

See Also

sintbl
Wre

Definition at line 378 of file Signal.h.

References bits, sintbl, and tblbits.

Referenced by operator()().

6.1.4.4 double Signal::DFTDriver::Wre (unsigned *k*) `[inline], [private]`

Easy access to the table of cosines.

This function is aware of the number of bits of the current FFT, and makes it easy to get the cosine of $\tau \cdot \mathtt{k}/2^{\mathtt{bits}}$, using the pre-computed table of cosines.

Parameters

in	*k*	An integer in the range $\left[0, 2^{\mathtt{bits}}\right[$.

Returns

$\cos\left(\tau \cdot \mathtt{k}/2^{\mathtt{bits}}\right)$, where τ is shorthand for 2π.

See Also

costbl
Wim

Definition at line 366 of file Signal.h.

References bits, costbl, and tblbits.

Referenced by operator()().

6.1.5 Member Data Documentation

6.1.5.1 unsigned Signal::DFTDriver::bits `[private]`

Number of bits for the current FFT computation.

Always assume this is uninitialized, and all methods that use it should initialize it themselves.

Definition at line 266 of file Signal.h.

Referenced by operator()(), Wim(), and Wre().

6.1.5.2 double Signal::DFTDriver::costbl `[static]`, `[private]`

Table of cosines.

See Also

sintbl

Definition at line 456 of file Signal.h.

Referenced by DFTDriver(), and Wre().

6.1.5.3 double Signal::DFTDriver::sintbl `[static]`, `[private]`

Table of sines.

Holds the sines of $\tau \cdot k / \texttt{tblsize}$, for k in the range $[0, \texttt{tblsize}[$. Here, τ is shorthand for 2π.

See Also

costbl

Definition at line 450 of file Signal.h.

Referenced by DFTDriver(), and Wim().

6.1.5.4 const unsigned Signal::DFTDriver::tblbits = 14 `[static]`

Number of bits for the index of the table of sines and cosines.

We won't be able to perform an N-bit dft if $N > \texttt{tblbits}$, so this should be big. Also, this **must** be equal to $\log_2(\texttt{tblsize})$, but there's nothing in the source code that enforces it.

See Also

tblsize

Definition at line 391 of file Signal.h.

Referenced by Wim(), and Wre().

6.1.5.5 const size_t Signal::DFTDriver::tblsize = 16384 `[static]`

Number of entries in the tables of sines and cosines.

This **must** be equal to $2^{\texttt{tblbits}}$, but there's nothing in the source code that enforces it.

See Also

tblbits

Definition at line 400 of file Signal.h.

Referenced by DFTDriver(), Signal::filter(), and operator()().

The documentation for this class was generated from the following files:

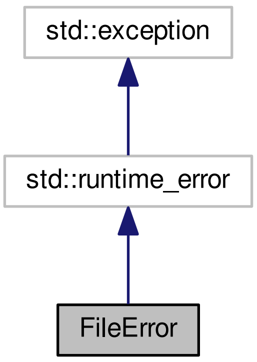
- Signal.h (v0.1-1-g41ddbc8)
- main.cpp (v0.1-1-g41ddbc8)
- Signal.cpp (v0.1-1-g41ddbc8)

6.2 FileError Class Reference

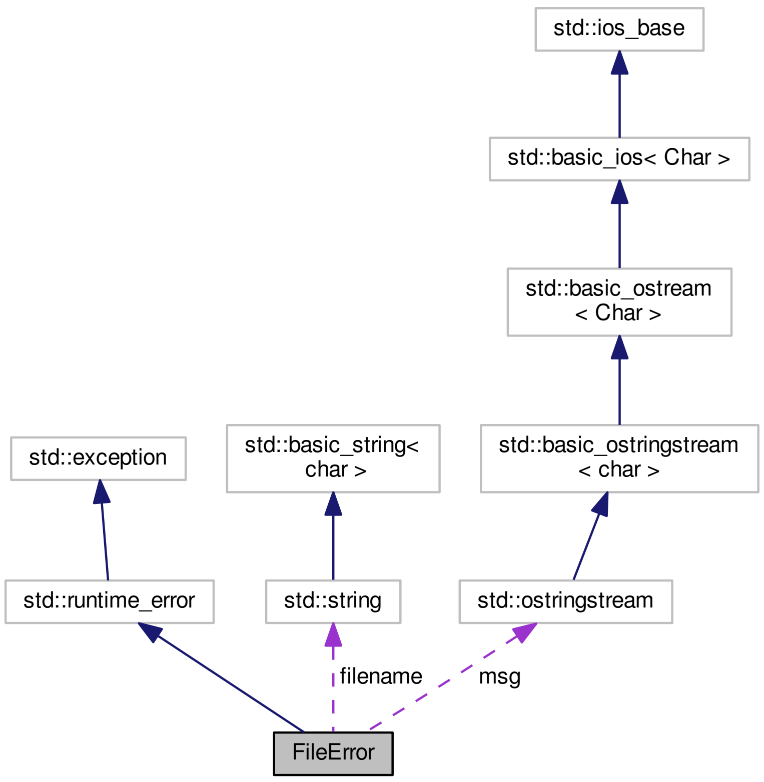
A runtime exception while trying to process a file.

```
#include <Signal.h>
```

Inheritance diagram for FileError:



Collaboration diagram for FileError:



Public Member Functions

- FileError (const std::string &fn)

  Constructs the exception object from the filename.
- ∼FileError () throw ()

  Destructor that does nothing.
- virtual const char ∗ what () const throw ()

  Gives a description for the error.

Private Attributes

- const std::string filename

  The name of the file that caused the error.

Static Private Attributes

- static std::ostringstream msg

  The message that will be displayed if we don't catch the exception.

6.2.1 Detailed Description

A runtime exception while trying to process a file.

Thrown when we cannot read a file, for some reason.
Usage:

```
if (error ocurred) throw FileError("badfile.wav");
```

Or:

```
std::string filename;
std::cin >> filename;
// ...
if (error ocurred) throw FileError(filename);
```

Definition at line 63 of file Signal.h.

6.2.2 Constructor & Destructor Documentation

6.2.2.1 FileError::FileError (const std::string & *fn*) `[inline]`

Constructs the exception object from the filename.

Parameters

`in`	*fn*	A `std::string` that holds the filename.

Definition at line 81 of file Signal.h.

6.2.2.2 FileError::∼FileError ( ) throw) `[inline]`

Destructor that does nothing.

Needed to prevent the `looser throw specifier` error because, `std::runtime_error::∼runtime_error()` is declared as `throw()`

Definition at line 89 of file Signal.h.

6.2.3 Member Function Documentation

6.2.3.1 virtual const char∗ FileError::what ( ) const throw) `[inline]`, `[virtual]`

Gives a description for the error.

Updates the msg static member with the error message, and returns it as a C string.

Definition at line 96 of file Signal.h.

References filename, and msg.

6.2.4 Member Data Documentation

6.2.4.1 const std::string FileError::filename `[private]`

The name of the file that caused the error.

Definition at line 74 of file Signal.h.

Referenced by what().

6.2.4.2 std::ostringstream FileError::msg [static], [private]

The message that will be displayed if we don't catch the exception.

Must be static, so that we can modify it inside the `what() const` function, and read it after the temporary object has been destroyed.

Definition at line 71 of file Signal.h.

Referenced by what().

The documentation for this class was generated from the following files:

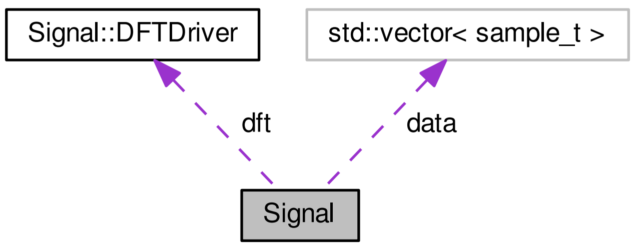
- Signal.h (v0.1-1-g41ddbc8)
- main.cpp (v0.1-1-g41ddbc8)

6.3 Signal Class Reference

A time- or frequency-domain signal.

`#include <Signal.h>`

Collaboration diagram for Signal:



Classes

- class DFTDriver

  A class for providing discrete Fourier transform capabilities.

Public Types

- enum delay_t { MS, SAMPLE }

  This is a type for specifying whether a time interval is given in milliseconds or in samples.
- typedef float sample_t

  The type for holding each signal sample.
- typedef unsigned long index_t

  The type for holding each signal sample index.
- typedef std::vector< sample_t > container_t

  The type for holding the whole vector of signal samples.

Public Member Functions

- Signal ()

  Constructs an empty signal.
- Signal (const std::string &filename)

  Constructs a signal from an audio file.
- Signal (const Signal &other)

  Copy-constructor. Constructs a signal as a copy of another.
- ∼Signal ()

  Frees memory used.
- const sample_t ∗ array () const

  Returns a pointer to the first sample.
- index_t samples () const

  Number of samples.
- int samplerate () const

  Sample rate in samples per second.
- sample_t & operator[] (index_t index)

  Returns a sample.
- const sample_t & operator[] (index_t index) const

  Returns a "read-only" sample.
- void set_size (index_t n)

  Changes the number of samples.
- void set_samplerate (int sr)

  Re-samples the signal.
- void delay (delay_t t, unsigned long d)

  Delays the signal in time.
- void gain (double g)

  Applies gain g to the signal.
- sample_t l_inf_norm ()

  Gets the ℓ^∞-norm of the signal.
- void normalize ()

  Normalize the signal according to its ℓ^∞-norm.
- Signal & operator+= (Signal other)

  Adds the other signal to the caller.
- void filter (Signal imp_resp)

  Convolves the sinal with an impulse response.
- void play (bool sleep=true)

  Makes PortAudio playback the audio signal.

Public Attributes

- index_t counter

  general-purpose variable for external use.

Static Public Attributes

- static DFTDriver dft

  Single instance of the DFTDriver class.

Private Attributes

- container_t data

  Holds the signal samples.
- int srate

  Signal sample rate in Hertz.

6.3.1 Detailed Description

A time- or frequency-domain signal.

Holds data and provides routines for dealing with time-domain and frequency-domain signals. Currently, all Signals are an array of single-precision floating-point samples. Signals are aware of their sample rates.

Todo Implement "stream" signals, to provide real-time processing.

Definition at line 114 of file Signal.h.

6.3.2 Member Typedef Documentation

6.3.2.1 typedef std::vector<sample_t> Signal::container_t

The type for holding the whole vector of signal samples.

Definition at line 125 of file Signal.h.

6.3.2.2 typedef unsigned long Signal::index_t

The type for holding each signal sample index.

Definition at line 122 of file Signal.h.

6.3.2.3 typedef float Signal::sample_t

The type for holding each signal sample.

Definition at line 119 of file Signal.h.

6.3.3 Member Enumeration Documentation

6.3.3.1 enum Signal::delay_t

This is a type for specifying whether a time interval is given in milliseconds or in samples.

Enumerator

MS	Time interval given in milliseconds.
SAMPLE	Time interval given in samples.

Definition at line 129 of file Signal.h.

6.3.4 Constructor & Destructor Documentation

6.3.4.1 Signal::Signal ( ) `[inline]`

Constructs an empty signal.

Initializes the signal with no meta-data and no samples. The user needs to specify the sample rate and create samples before using the signal.

Definition at line 139 of file Signal.h.

6.3.4.2 Signal::Signal (const std::string & *filename*)

Constructs a signal from an audio file.

Constructs a signal getting the signal data from an audio file. This is done using the `libsndfile` library. The filetypes supported are listed `here`. WAV is supported, but MP3 is not.

If the given file is stereo, or otherwise multi-channel, just the first channel will be read. (On stereo audio files, this is the left channel.)

The sample rate is extracted from the file's meta-data info.

Parameters

in	*filename*	Audio file name.

Exceptions

FileError	if file openening/reading fails.

Definition at line 45 of file Signal.cpp.

References data, samples(), set_size(), and srate.

6.3.4.3 Signal::Signal (const Signal & *other*) `[inline]`

Copy-constructor. Constructs a signal as a copy of another.

Constructs a signal as a copy of another one. If this signal is not empty, we destroy it.

Parameters

in	*other*	The signal to be copied from.

Definition at line 151 of file Signal.h.

6.3.4.4 Signal::∼Signal ( ) `[inline]`

Frees memory used.

Free the pointer to the array of samples.

Definition at line 158 of file Signal.h.

6.3.5 Member Function Documentation

6.3.5.1 const sample_t* Signal::array ( ) const `[inline]`

Returns a pointer to the first sample.

Sometimes needed for performance reasons. Shouldn't be used to modify the samples.

Returns

a pointer to the first element of a contiguous region of memory that holds the samples.

Definition at line 168 of file Signal.h.

References data.

6.3.5.2 void Signal::delay (delay_t *t*, unsigned long *d*)

Delays the signal in time.

Adds zeroed samples at the beginning of the signal.

If we try do delay a signal by milliseconds, but the signal has no associated sample rate, a warning is emitted, and nothing is done. No exception is thrown.

Parameters

`in`	*t*	A delay type element.
`in`	*d*	The time interval to be delayed, given in the units specified by `t`.

Definition at line 88 of file Signal.cpp.

References data, MS, samples(), set_size(), and srate.

Referenced by main().

6.3.5.3 void Signal::filter (Signal *imp_resp*)

Convolves the sinal with an impulse response.

Convolves the signal with the given finite impulse response (FIR).

The algorthm used is the "overlap-and-add", and we use the FFT implemented in the DFTDriver class to compute each step. We try to do it using the least possible number of DFTs.

Parameters

`in`	*imp_resp*	The filter impulse response to be convolved with.

See Also

DFTDriver::operator()

Definition at line 115 of file Signal.cpp.

References data, dft, Signal::DFTDriver::INVERSE, samples(), set_samplerate(), set_size(), srate, and Signal::DF-TDriver::tblsize.

Referenced by main().

6.3.5.4 void Signal::gain (double *g*)

Applies gain *g* to the signal.

This can be useful, for example, to make sure that the signal is within the $[-1,1]$ range.

Parameters

`in`	*g*	The signal gain to be applied.

Definition at line 394 of file Signal.cpp.

References data.

Referenced by normalize().

6.3.5.5 Signal::sample_t Signal::l_inf_norm ( )

Gets the ℓ^∞-norm of the signal.

Take the signal's infinity-norm, which is the maximum absolute value of all the samples of the signal.

Returns

the ℓ^∞-norm of the signal.

Definition at line 406 of file Signal.cpp.

References data.

Referenced by normalize().

6.3.5.6 void Signal::normalize ( ) `[inline]`

Normalize the signal according to its ℓ^∞-norm.

Divide the signal by a constant so that the maximum absolute value of its samples is 1.

Definition at line 231 of file Signal.h.

References gain(), and l_inf_norm().

Referenced by main().

6.3.5.7 Signal & Signal::operator+= (Signal *other*)

Adds the *other* signal to the caller.

First, we re-sample *other* into a new temporary signal. Then we increase the caller's size if needed, and finally add the signals sample-by-sample.

Parameters

`in`	*other*	The signal to be added to the caller.

Returns

a reference to this signal, already added to the `other`.

Definition at line 379 of file Signal.cpp.

References data, samples(), set_samplerate(), set_size(), and srate.

6.3.5.8 sample_t& Signal::operator[] (index_t *index*) `[inline]`

Returns a sample.

Gets a sample of the signal. For performance reasons, this method does not check that the given index is valid.

Parameters

`in`	*index*	The index of the desired sample. Signal indexes are zero-based.

Returns

a reference to the sample.

Definition at line 195 of file Signal.h.

References data.

6.3.5.9 const sample_t& Signal::operator[] (index_t *index*) const `[inline]`

Returns a "read-only" sample.

Just like the "read-write" version, but returns a const reference to a sample.

Parameters

`in`	*index*	The index of the desired sample. Signal indexes are zero-based.

Returns

a const reference to the sample.

Definition at line 207 of file Signal.h.

References data.

6.3.5.10 void Signal::play (bool *sleep* = `true`)

Makes PortAudio playback the audio signal.

Creates a PortAudio stream for audio playback of the signal content. If *sleep* is `true`, we wait for the playback to end before returning. (If it's false, the function returns, while playback goes on in the background.)

Parameters

`in`	*sleep*	If set to true, the method will only return when the playback ends (that is, when the end of the signal is reached). Otherwise, it returns imediatly, and the playback goes on in the background.

Exceptions

std::runtime_error	if any of the PortAudio steps fail (check the source code)

See Also

callback

Definition at line 298 of file Signal.cpp.

References callback(), counter, samples(), and srate.

Referenced by playsig().

6.3.5.11 int Signal::samplerate ( ) const `[inline]`

Sample rate in samples per second.

Returns

the number of samples per second that should be used when playing back the signal.

Definition at line 181 of file Signal.h.

References srate.

6.3.5.12 index_t Signal::samples ( ) const [inline]

Number of samples.

Returns

the number of elements inside the vector of samples.

Definition at line 174 of file Signal.h.

References data.

Referenced by delay(), filter(), operator+=(), play(), set_samplerate(), and Signal().

6.3.5.13 void Signal::set_samplerate (int *sr*)

Re-samples the signal.

Changes the sample rate of the signal. The way it is done, this is equivalent to reconstructing the time-domain signal by linear interpolation, and then re-sampling the continuous-time reconstructed signal at the new sample rate.

Parameters

`in`	*sr*	The new sample rate in Hertz.

See Also

srate

Definition at line 356 of file Signal.cpp.

References data, samples(), and srate.

Referenced by filter(), and operator+=().

6.3.5.14 void Signal::set_size (index_t *n*) [inline]

Changes the number of samples.

Changes the signal length. Allocates more space if we are growing the signal, and deletes the last samples if we are shrinking it. Also initializes any new samples to zero.

Parameters

`in`	*n*	The desired signal length.

See Also

container_t::resize()

Definition at line 219 of file Signal.h.

References data.

Referenced by delay(), filter(), main(), operator+=(), and Signal().

6.3.6 Member Data Documentation

6.3.6.1 index_t Signal::counter

general-purpose variable for external use.

Definition at line 183 of file Signal.h.

Referenced by play().

6.3.6.2 container_t Signal::data [private]

Holds the signal samples.

Definition at line 463 of file Signal.h.

Referenced by array(), delay(), filter(), gain(), l_inf_norm(), operator+=(), operator[](), samples(), set_samplerate(), set_size(), and Signal().

6.3.6.3 Signal::DFTDriver Signal::dft [static]

Single instance of the DFTDriver class.

Definition at line 460 of file Signal.h.

Referenced by filter().

6.3.6.4 int Signal::srate [private]

Signal sample rate in Hertz.

Definition at line 464 of file Signal.h.

Referenced by delay(), filter(), operator+=(), play(), samplerate(), set_samplerate(), and Signal().

The documentation for this class was generated from the following files:

- Signal.h (v0.1-1-g41ddbc8)
- main.cpp (v0.1-1-g41ddbc8)
- Signal.cpp (v0.1-1-g41ddbc8)

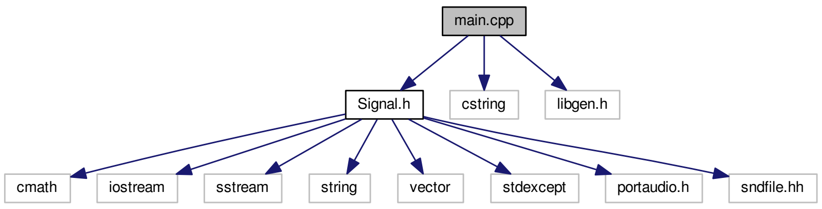
Chapter 7

File Documentation

7.1 main.cpp File Reference

```
#include "Signal.h"
#include <cstring>
#include <libgen.h>
```

Include dependency graph for main.cpp:



Macros

- #define ATFA_DIR

    Macro for getting the path to the project directory from cmake.

Functions

- void portaudio_init (bool list_devices=false)

    Initialize PortAudio.
- void portaudio_end ()

    Close PortAudio.
- void playsig (Signal s)

    Playback signal.
- int main (int argc, char ∗argv[])

    `main()` *function.*

Variables

- char static_filename [] = __FILE__

- char static_dirname [] = __FILE__
- char static_projdirname [] = __FILE__

7.1.1 Detailed Description

Holds the `main()` function and other routines.

Author

Pedro Angelo Medeiros Fonini

Definition in file main.cpp.

7.1.2 Macro Definition Documentation

7.1.2.1 #define ATFA_DIR

Value:

```
(static_cast<const char *>( \
        std::strcpy(static_dirname, dirname(static_filename)), \
        std::strcpy(static_filename, __FILE__), \
        std::strcpy(static_projdirname, dirname(static_dirname)),
      \
        static_projdirname \
    ))
```

Macro for getting the path to the project directory from cmake.

Should be passed from `CMakeLists.txt`, but if it's not, we try to deduce it from the `__FILE__` macro

Definition at line 35 of file main.cpp.

Referenced by main().

7.1.3 Function Documentation

7.1.3.1 int main (int *argc*, char ∗ *argv[]*)

`main()` function.

No command-line parameters.

This function:

1. Prints version info
2. Creates two Signals, `sound_me` and `sound_other` from two input files.
3. Delays the second.
4. Creates an impulse response.
5. Filters `sound_me` according to the impulse response and adds it to the second, delayed.
6. Initializes a PortAudio session, plays the resulting sound, and closes PortAudio.

Parameters

`in`	*argc*	argument count (unused)
`in`	*argv*	argument values (unused)

Returns

0 if no errors

Definition at line 144 of file main.cpp.

References ATFA_DIR, Signal::delay(), Signal::filter(), Signal::MS, Signal::normalize(), playsig(), and Signal::set_-size().

7.1.3.2 void playsig (Signal *s*)

Playback signal.

Wrapper function for `Signal::play` that handles PortAudio.

Definition at line 119 of file main.cpp.

References Signal::play(), portaudio_end(), and portaudio_init().

Referenced by main().

7.1.3.3 void portaudio_end ( )

Close PortAudio.

Ends a PortAudio session.

Exceptions

std::runtime_error	if PortAudio closing fails.

See Also

`portaudio_init()`

Definition at line 106 of file main.cpp.

Referenced by playsig().

7.1.3.4 void portaudio_init (bool *list_devices* = `false`)

Initialize PortAudio.

Initializes a PortAudio session. Also prints out a list of available devices that PortAudio sees., if requested.

Parameters

`in`	*list_devices*	Whether or not to print the device list.

Exceptions

std::runtime_error	if PortAudio initialization fails.

See Also

`portaudio_end()`

Definition at line 64 of file main.cpp.

Referenced by playsig().

7.1.4 Variable Documentation

7.1.4.1 char static_dirname[ ] = __FILE__

Definition at line 27 of file main.cpp.

7.1.4.2 char static_filename[ ] = __FILE__

Definition at line 26 of file main.cpp.

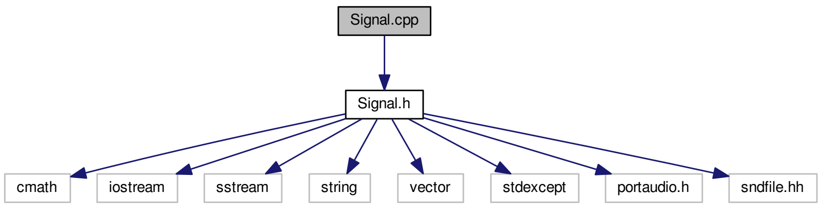
7.1.4.3 char static_projdirname[ ] = __FILE__

Definition at line 28 of file main.cpp.

7.2 README.md File Reference

7.3 Signal.cpp File Reference

`#include "Signal.h"`
Include dependency graph for Signal.cpp:



Functions

- static int callback (const void ∗in_buf, void ∗out_buf, unsigned long frames_per_buf, const PaStreamCallback-TimeInfo ∗time_info, PaStreamCallbackFlags status_flags, void ∗user_data)

  PortAudio callback function.

7.3.1 Detailed Description

Holds the implementation of the `Signal` class.

Author

Pedro Angelo Medeiros Fonini

Definition in file Signal.cpp.

7.3.2 Function Documentation

7.3.2.1 static int callback (const void ∗ *in_buf,* void ∗ *out_buf,* unsigned long *frames_per_buf,* const PaStreamCallbackTimeInfo ∗ *time_info,* PaStreamCallbackFlags *status_flags,* void ∗ *user_data*) `[static]`

PortAudio callback function.

The PortAudio library implements the stream playback using *callback* functions. These functions get called at interrupt time whenever PortAudio needs a new buffer of samples to pass to the hardware. Callback functions should not take long to return; in particular, they should **not** throw or catch exceptions, or do I/O.

This callback function just reads a given `Signal` and passes its samples to PortAudio.

Parameters

`in`	*in_buf*	Pointer to a buffer of samples retrieved from an input audio device. This parameter is unused because we're not reading from any device.
`out`	*out_buf*	Pointer to a buffer where the callback function will store samples to be given to an output audio device.
`in`	*frames_per_buf*	Number of samples we will store in the buffer. This is actually the number of *frames*, which in turn is equal to number of samples because we're working with mono-channel signals.
`in`	*time_info*	PortAudio time information. (unused)
`in`	*status_flags*	PortAudio status flags. (unused)
`in,out`	*user_data*	Pointer to an arbitrary data-holder passed to the stream open function. We use this to get the signal samples, and to keep track of where in the signal we are (using the `Signal::counter` auxiliary member).

See Also

Signal::play

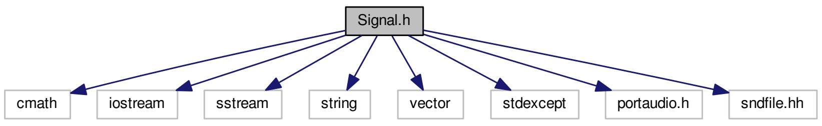
Definition at line 258 of file Signal.cpp.

Referenced by Signal::play().

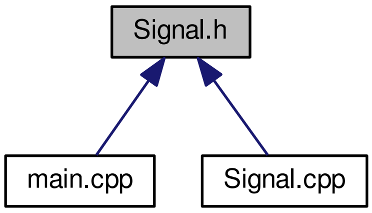
7.4 Signal.h File Reference

```
#include <cmath>
#include <iostream>
#include <sstream>
#include <string>
#include <vector>
#include <stdexcept>
#include <portaudio.h>
#include <sndfile.hh>
```

Include dependency graph for Signal.h:



This graph shows which files directly or indirectly include this file:



Classes

- class FileError

  A runtime exception while trying to process a file.
- class Signal

  A time- or frequency-domain signal.
- class Signal::DFTDriver

  A class for providing discrete Fourier transform capabilities.

Functions

- Signal operator+ (Signal lhs, const Signal &rhs)

  Adds two signals.

Variables

- static const void ∗const NULL

  Null pointer.

7.4.1 Detailed Description

Holds the interface to the `Signal` class.

Author

Pedro Angelo Medeiros Fonini

Definition in file Signal.h.

7.4.2 Function Documentation

7.4.2.1 Signal operator+ (Signal *lhs,* const Signal & *rhs*) [inline]

Adds two signals.

See Also

Signal::operator+=

Definition at line 472 of file Signal.h.

7.4.3 Variable Documentation

7.4.3.1 const void∗ const NULL [static]

Initial value:

```
= ((void *)0)


static const double TAU = 6.283185307179586477
```

Null pointer.

Replaces the standard null pointer in case it's not defined.

Definition at line 38 of file Signal.h.

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