Audio Toolkit 2.0.7

Audio and MIDI functionality for GNU Octave.

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Distribution

The GNU Octave Audio package is *free* software. Free software is a matter of the users' freedom to run, copy, distribute, study, change and improve the software. This means that everyone is free to use it and free to redistribute it on certain conditions. The GNU Octave Audio package is not, however, in the public domain. It is copyrighted and there are restrictions on its distribution, but the restrictions are designed to ensure that others will have the same freedom to use and redistribute Octave that you have. The precise conditions can be found in the GNU General Public License that comes with the GNU Octave Audio package and that also appears in Appendix A [Copying], page 18.

To download a copy of the GNU Octave Audio package, please visit `https://gnu-octave.github.io/octave-audio/index`.

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1 Installing and loading

The Audio toolkit must be installed and then loaded to be used.

It can be installed in GNU Octave directly from octave-forge, or can be installed in an off-line mode via a downloaded tarball.

The toolkit has a dependency on the RTMIDI library (https://github.com/thestk/rtmidi), so it must be installed in order to successfully install the toolkit.

For Fedora: `yum install rtmidi-devel`

For Ubuntu: `apt install librtmidi-dev`

The toolkit must be then be loaded once per each GNU Octave session in order to use its functionality.

1.1 Windows install

If running in Windows, the package may already be installed, to check run:

```
pkg list audio
```

Otherwise it can be installed by installing the requirements and then using the online or offline install method.

1.2 Online Direct install

With an internet connection available, the Audio package can be installed from octave-forge using the following command within GNU Octave:

```
pkg install -forge audio
```

The latest released version of the toolkit will be downloaded and installed.

1.3 Off-line install

With the Audio toolkit package already downloaded, and in the current directory when running GNU Octave, the package can be installed using the following command within GNU Octave:

```
pkg install audio-2.0.7.tar.gz
```

1.4 Loading

Regardless of the method of installing the Audio toolkit, in order to use its functions, the toolkit must be loaded using the pkg load command:

```
pkg load audio
```

The toolkit must be loaded on each GNU Octave session.

2 Basic Usage Overview

The Audio package must be loaded each time a GNU Octave session is started:

```
pkg load audio
```

An overview of the package can be displayed by running `help audio`

Help for each function can be displayed by `help thefunctionname`

ie:

```
help mididevice
```

2.1 Conversion Functionality

The following functions are available to convert to and from Hz frequency:

hz2erb, erb2hz
: Conversion between hz and equivalent rectangular bandwidths (ERP) frequency scales

hz2mel, mel2hz
: Conversion between hz and equivalent mel frequency scales

hz2bark, bark2hz
: Conversion between hz and equivalent bark frequency scales

2.2 Waveform Generation

The `audioOscillator` function provides a method of creating a waveform generator for sine, square and sawtooth waveforms.

```
% create a sawtooth audio generator
osc = audioOscillator("sawtooth");
% get a frame of data
data = osc();
% plot the data
plot(data);
```

2.3 MIDI Functionality

The Audio toolkit provides 3 main types of MIDI functionality:

Device functions
: These are functions that directly allow opening, sending and receiving MIDI messages.

Controller functions
: Functions that provide a layer on top of the device functions for using MIDI controls.

File functions
: Basic functions that allow read and write of MIDI files.

To read and write to a MIDI device, a MIDI device object must be created, using the name or id of a known MIDI device as provided by the mididevinfo function.

MIDI devices can then be read using the midisend and midireceive functions that use midimsg type to encapsulate the MIDI data.

```
% list the midi devices
devs = mididevinfo

% open a midi device, specifying the first input and output MIDI device
```

```
dev = mididevice("input", devs.input{1}.ID, "output", devs.output{1}.ID)

% receive data and echo it through the output port
while true
  msg = midireceive(dev, 1);
  if !isempty(msg)
    midisend(msg);
  endif
endwhile
```

3 Function Reference

The functions currently available in the Audio toolkit are described below:

3.1 MIDI Device Interface

3.1.1 @octave_midi/hasdata

tf = `hasdata` (*dev*)
Return whether there is data available to read

Inputs

dev - a octave midi device opened using mididevice.

Outputs

tf - true if device has data available to read

See also: mididevice.

3.1.2 mididevice

dev = `mididevice` (*mididev*)
dev = `mididevice` (*mididir*, *mididev*)
dev = `mididevice` (`"input"`, *midiindev*, `"output"`, *midioutdev*)
Create a midi device using the input parameters.

When a single device name or id is provided, attempt to create the midi device using the same name for both input and output.

Otherwise, use the name or device id for the given input or output direction.

Inputs

mididev - name or id of device to load.
mididir - midi direction of `"input"` or `"output"`
midiindev - midi input name or id
midioutdev - midi output name or id

Outputs

dev - octave_midi class for opened device

Properties

Input - Input device name (read only).
Output - Output device name (read only).
InputID - Input device id (read only).
OutputID - Output device id (read only).

Examples

Open midi device with ID of 0.

```
> dev = mididevice(0);
```

```
mididevice connected to
  input: "SparkFun Pro Micro:SparkFun Pro Micro MIDI 1 20:0" (1)
  output: "SparkFun Pro Micro:SparkFun Pro Micro MIDI 1 20:0" (0)
```

Open a named midi device:

```
> dev = mididevice("SparkFun Pro Micro:SparkFun Pro Micro MIDI 1 20:0");

mididevice connected to
  input: "SparkFun Pro Micro:SparkFun Pro Micro MIDI 1 20:0" (1)
  output: "SparkFun Pro Micro:SparkFun Pro Micro MIDI 1 20:0" (0)
```

See also: mididevinfo.

3.1.3 mididevinfo

devlist = mididevinfo ()
mididevinfo ()

Retrieve the midi devices detected within the system.

The list will be stored with variable *devlist* as either a input or output device. If no output variable is provided, the devices will be displayed.

Inputs

None

Outputs

devlist - a structure containing the midi device information

Examples

Display the known devices of the system.

```
> mididevinfo

 MIDI devices available
 ID Direction Interface  Name
  0 output    Alsa       Midi Through:Midi Through Port-0 14:0
  1 output    Alsa       Ensoniq AudioPCI:ES1371 16:0
  2 output    Alsa       SparkFun Pro Micro:SparkFun Pro Micro MIDI 1 20:0
  3 input     Alsa       Midi Through:Midi Through Port-0 14:0
  4 input     Alsa       Ensoniq AudioPCI:ES1371 16:0
  5 input     Alsa       SparkFun Pro Micro:SparkFun Pro Micro MIDI 1 20:0
```

Assign variable *mididevices* with the values from the known devices

```
> mididevices = mididevinfo

 mididevices =
  scalar structure containing the fields:
    input =
    {
      [1,1] =
        scalar structure containing the fields:
          Name = SparkFun Pro Micro:SparkFun Pro Micro MIDI 1 20:0
          Interface = Alsa
          ID =  0
    }
```

```
output =
{
  [1,1] =
    scalar structure containing the fields:
      Name = SparkFun Pro Micro:SparkFun Pro Micro MIDI 1 20:0
      Interface = Alsa
      ID =  1
}
```

See also: mididevice.

3.1.4 midiflush

`midiflush` (*dev*)

Flush the receive buffers on a midi device

Inputs

dev - midi device opened using mididevice

Outputs

None

Examples

Flush a midi device

```
midiflush(dev);
```

See also: mididevice, midireceive.

3.1.5 midimsg

```
msg = midimsg (0)
msg = midimsg (type ....)
msg = midimsg ("note", channel, note, velocity, duration, timestamp)
msg = midimsg ("noteon", channel, note, velocity, timestamp)
msg = midimsg ("noteoff", channel, note, velocity, timestamp)
msg = midimsg ("programchange", channel, prog, timestamp)
msg = midimsg ("controlchange", channel, ccnum, ccval, timestamp)
msg = midimsg ("polykeypressure", channel, note, keypressure,
        timestamp)
msg = midimsg ("channelpressure", channel, chanpressure, timestamp)
msg = midimsg ("localcontrol", channel, localcontrol, timestamp)
msg = midimsg ("pitchbend", channel, pitchchange, timestamp)
msg = midimsg ("polyon", channel, timestamp)
msg = midimsg ("monoon", channel, monochannels, timestamp)
msg = midimsg ("omnion", channel, timestamp)
msg = midimsg ("omnioff", channel, timestamp)
msg = midimsg ("allsoundoff", channel, timestamp)
msg = midimsg ("allnotesoff", channel, timestamp)
msg = midimsg ("resetallcontrollers", channel, timestamp)
msg = midimsg ("start", timestamp)
msg = midimsg ("stop", timestamp)
msg = midimsg ("continue", timestamp)
```

```
msg = midimsg ("systemreset", timestamp)
msg = midimsg ("activesensing", timestamp)
msg = midimsg ("timingclock", timestamp)
msg = midimsg ("systemexclusive", timestamp)
msg = midimsg ("systemexclusive", bytes, timestamp)
msg = midimsg ("eox", timestamp)
msg = midimsg ("data", bytes, timestamp)
msg = midimsg ("songselect", song, timestamp)
msg = midimsg ("songpositionpointer", songposition, timestamp)
msg = midimsg ("tunerequest", timestamp)
msg = midimsg ("miditimecodequarterframe", timeseq, timevalue,
        timestamp)
```

Create a midimsg object

If the input parameter is 0, create an empty midi message object Otherwise the first variable is the type of message to create, followed by the additional parameters for the message.

For each message type, the timestamp value is optional.

Inputs

type - string message type or a midimsgtype.
timestamp - optional seconds time stamp for the event
channel - the channel to use for the message (1..16)
note - the value of the note to play/stop
velocity - the velocity value for a note on/off, with 0 stopping a note from sounding.
duration - seconds between starting and stopping a note when created a 'note' message.
prog - program number when doing a program change message.
ccnum - control change control number.
ccval - control change control value.
keypressure - key pressure value when creating a key pressure message.
chanpressure - channel pressure value when creating a channelpressure message.
pitchchange - pitch change value when creating a pitch bend message.
localcontrol - boolean value when creating a localcontrol message.
monochannels - channels specified for a mono on message.
bytes - array of data in range of 0 to 127 specified as part of a data message or system exclusive message.
song - song selection number for a song selection message.
songposition - song position value for a song position message.
timeseq - timecode sequence number for a miditimecodequarterframe message.
timevalue - timecode value number for a miditimecodequarterframe message.

Outputs

msg - a midimsg object containing the midi data of the message

Properties

timestamp - timestamp of the message, or an array or timestamps if the the message is a compound message.
msgbytes - the raw message bytes that make up the MIDI message.
nummsgbytes - the number of message bytes that make up the MIDI message.
type - string or midimsgtype that represents the message type.
channel - the channel number for message.
note - the note value for message (Only valid for noteon/off and polykeypressure).

velocity - the velocity value for message (Only valid for noteon/off).
keypressure - the keypressure value for message (Only valid for polykeypressure).
channelpressure - the chanpressure value for message (Only valid for channelpressure).
localcontrol - the localcontrol value for message (Only valid for localcontrol messages).
monochannels - channels specified for a mono on message.
program - program number specified for a program change message.
ccnumber - control change number specified for a control change message.
ccvalue - control change value specified for a control change message.
song - song number for a song selection message.
songposition - song position value for a song position message.
pitchchange - pitch change value for a pitch bend message.
timecodesequence - timecode sequence number for a miditimecodequarterframe message.
timecodevalue - timecode value number for a miditimecodequarterframe message.

Examples

Create a note on/off pair with a duration of 1.5 seconds

```
msg = midimsg('note', 1, 60, 100, 1.5)
```

Create a separate note on/off pair with a time between them of 1.5 seconds

```
msg = [midimsg('noteon', 1, 60, 100, 0), midimsg('noteoff', 1, 60, 0, 1.5)]
```

Create a system reset message

```
msg = midimsg('systemreset')
```

See also: midifileread, midisend, midireceive, midimsgtype.

3.1.6 midireceive

midimsg = midireceive (*dev*)
midimsg = midireceive (*dev*, *maxmsg*)

Attempt to receive midi messages from a midi device.

Inputs

dev - a octave midi device opened using mididevice.
maxmsg - Maximum number of messages to retrieve. If not specified, the function will attempt to get all pending.

Outputs

midimsg - a midimsg containing the messages retrieved from the device.
If no messages are available, *midimsg* will be empty.

Examples

Open device 0, and poll and display read messages

```
dev = mididevice(0);
while true
   mx = midireceive(dev);
   if !isempty(mx)
     % display message
     mx
   endif
endwhile
```

See also: mididevice, midisend.

3.1.7 midisend

`midisend (dev, msg)`
`midisend (dev, ...)`
Send a midimsg to a midi device

Inputs

dev - midi device opened using mididevice
msg - a midi message class with messages to send to the midi device
If the msg isn't a midimsg class, the input data is expected to be in same format as the inputs to a midimsg object.

Outputs

None

Examples

Send a note on/off command to a opened midi device *dev*

```
midisend(dev, midimsg("note", 1, 60, 100, 2.0));
```

See also: midimsg, mididevice, midireceive.

3.2 MIDI Controller Interface

3.2.1 midicallback

oldhandle = midicallback (*midicontrolsObj*, *functionHandle*)
oldhandle = midicallback (*midicontrolsObj*, [])
currhandle = midicallback (*midicontrolsObj*)
Get, set or clear the midicontrol object callback.

Inputs

midicontrolObj - control object created using midicontrols.

functionHandle - function handle to set for call back. If it is [], the callback function will be cleared.

NOTE: currently anonymous functions will not work.

NOTE: callbacks should be cleared before losing all references to the midicontrols object.

Outputs

oldhandle The previously set midicallback function handle when setting a new callback.

currhandle The current set midicallback function handle.

Examples

Set a callback on a midicontrols object

```
ctrl = midicontrols(2001)
function dispCallback(ctrl),disp(midiread(ctrl)),endfunction;
midicallback(ctrl, @dispCallback);
```

Clear the callback on a midicontrols object

```
ctrl = midicontrols(2001)
midicallback(ctrl, []);
```

Get the current callback on a midicontrols object

```
ctrl = midicontrols(2001)
cb = midicallback(ctrl);
```

See also: midicontrols, midisync, midiread.

3.2.2 midicontrols

obj = midicontrols ()
obj = midicontrols (*ctrlid*)
obj = midicontrols (*ctrlid*, *initialvalues*)
obj = midicontrols (__, *propertyname*, *propertyvalue*)

Create a midi controls object

Inputs

ctrlid - single control id or array of control ids to monitor, or [] to use any controller.
initialvalues - initial values to use for controls. It should be the same size as *ctrlid*
propertyname, *propertyvalue* - properties to set on the controller. If a device is not specified the value from getpref("midi", "DefaultDevice", 0) will be used.

Known properties are:

mididevice
: name of the mididevice to monitor.

outputmode
: the scaling mode for values: 'rawmidi' will return values between 0 .. 127, 'normalized' will use values between 0 .. 1.

Outputs

obj - returns a midicontrols object

Examples

Create a midicontrols object monitoring control id 2001 on the default midi device

```
ctrl = midicontrols(2001)
```

Create a midicontrols object monitoring control id 2001 on a a non default device

```
ctrl = midicontrols(2001, 'mididevice', 1)
```

See also: midiread, midisync.

3.2.3 midiid

[*ctrlid*, *dev*] = midiid ()

Scan for control messages from midi devices to get the id of the device

Function will display a prompt for the user to move the midi control and return when a control messages is detected or ctrl-C is pressed.

Inputs

None

Outputs

ctrlid - control id made from the controller channel * 1000 + controller number.
dev = name of the midi device the controller was detected on.

Examples

Monitor midi devices for first moving controller

```
[ctrlid, devname] = midiid()
```

See also: mididevinfo, midicontrols.

3.2.4 midiread

val = midiread (*midicontrolsObj*)
Read current values of midi controls

Inputs

midicontrolObj - control object created using midicontrols

Outputs

val single value or array of current values from the midi device.

Examples

Read current value of midicontrols with a ctrlid 2001 on the default midi device.

```
ctrl = midicontrols(2001)
val = midiread(ctrl);
```

Read current value of midicontrols with a ctrlid 2001 on a non default midi device.

```
ctrl = midicontrols(2001, 'mididevice', 1)
val = midiread(ctrl);
```

See also: midicontrols, midisync.

3.2.5 midisync

midisync (*midicontrolsObj*)
midisync (*midicontrolsObj, ctrlvalues*)
Send the values of control object to the control, using *ctrlvalues* values if specified instead

Inputs

midicontrolObj - control object created using midicontrols
ctrlvalues - values to send to the controls instead of initial values

Outputs

None

Examples

Send sync command to a midicontrols with a ctrlid 2001 to set a value of 1

```
ctrl = midicontrols(2001)
midisync(ctrl, 1);
```

See also: midicontrols.

3.3 MIDI File I/O

3.3.1 ismidifile

ismidi = ismidifile (*filename*)
Check if *filename* is a midi file.

The function only checks whether it is an existing file and the file starts with a valid 'MThd' header.

Non existing files, or files that do not meet the header criteria will return false.

Inputs

filename - filename of file to check.

Outputs

ismidi - true if it is a midi file, false otherwise

See also: midifileread, midifilewrite.

3.3.2 midifileinfo

info = midifileinfo (*filename*)
Read MIDI file and display information about the tracks and data

Inputs

filename - filename of file to open.

Outputs

info - structure of the midi file data with the following fields:

filename	the name of the file
header	The header block information
track	An array of tracks read from the file
other	An array of non-track midi blocks read from the file

See also: midifileread.

3.3.3 midifileread

msg = midifileread (*filename*, [propertyname, propertyvalue ...])
Read MIDI file into a midimsg

Inputs

filename - filename of file to open.
propertyname, *properyvalue* - optional propertyname/value pairs.

Known property values are:

includemetaevents
A True/False value to include MetaEvents in the out message list.

Outputs

msg - a midimsg struct containing the messages read from the file

See also: midifileinfo, midimsg.

3.3.4 midifilewrite

`midifilewrite (`*`filename`*`, `*`msgs`*`)`
`midifilewrite (`*`filename`*`, `*`msgs`*`, `*`optionname`*`, `*`optionvalue`*`)`
Write a midifile

Inputs

filename - filename of file to open.
msg - a midimsg struct or a cell array of midimsg containing data to write to file
optionname, *optionvalue* - option value/name pairs

Known options are:

format MIDI file format number. (0 (default), 1, 2)

Where format is 0, if a cell array is passed to midifilewrite, the midimsg values will be concatenated together before saving.

Were format is not 0, the cell array is treated as tracks of misimsg.

Outputs

None

See also: midifileread, midimsg.

3.4 Enumerations

3.4.1 midimsgtype

`midimsgtype`
A midimsg type enumeration for values of the midimsg type.

Enumeration values are:

Data	Stop	SongPositionPointer
PolyOn	PolyKeyPressure	NoteOff
EOX	ActiveSensing	SongSelect
MonoOn	ChannelPressure	ControlChange
TimingClock	SystemReset	AllSoundOff
OmniOn	PitchBend	ProgramChange
Start	TuneRequest	ResetAllControllers
OmniOff	Undefined	SystemExclusive
Continue	MIDITimeCodeQuarterFrame	LocalControl
AllNotesOff	MetaEvent	

The enumeration value can be used instead of a string in midimsg creation.

Examples

Use both a string and a midimsgtype for the type parameter of a midimsg.

```
# both statements are equivalent
```

```
msg = midimsg('NoteOn', 1, 60, 100);
msg = midimsg(midimsgtype.NoteOn, 1, 60, 100);
```

See also: midimsg.

3.5 Waveform Generation

3.5.1 audioOscillator

`audioOscillator`
Generate sine, sawtool and square waveforms

Methods

obj = audioOscillator ()
obj = audioOscillator (*signalTypeValue*)
obj = audioOscillator (*signalTypeValue*, *frequencyValue*)
obj = audioOscillator (__, *propertyname*, *propertyvalue*)
Create a audioOscillator object

Inputs

signalTypeValue - signal type of "sine" (default), "square", "sawtooth".
frequencyValue - hz frequency value of waveform (default 100).
propertyname, *propertyvalue* - properties to set on the object.

Known properties are:

SignalType
: signal type of "sine" (default), "square" or "sawtooth". (readonly)

Frequency
: frequency of the waveform (default 100)

Amplitude
: amplitude of the signal (default 1)

SampleRate
: sample rate of the signal (default 44100)

PhaseOffset
: phase offset of signal 0 (default) - 1 (readonly)

DutyCycle
: dutycycle of the signal 0 - 1 (default 0.5) when signal is a square wave.

SamplePerFrame
: Samples per frame as returned from () (default 512)

MaxSamplePerFrame
: Max samples per frame (default 192000)

DCOffset
: DC Offset of signal (default 0)

Width
: Width of sawtooth (default 1)

OutputDataType
: Output data type of 'single' or 'double' (default 'double')

Outputs

obj - signalGenerator object

Examples

Create a 100 hz sine wave and plot first 512 samples

```
sinosc = audioOscillator
data = sinosc();
plot(data);
```

Create a 2 hz square wave with duty cycle of 0.5

```
sqosc = audioOscillator('square', 'DutyCycle', 0.50,  'Frequency', 2);
```

`data = obj()`
Generate a frame of waveform data from the generator function

Inputs

obj - signalGenerator object

Outputs

data - waveform data

`release(obj)`
Release resources of generator

Inputs

obj - signalGenerator object

Outputs

None

3.6 Measurements

3.6.1 bark2hz

`hz = bark2hz (bark)`
Convert equivalent Bark Frequency to Hz.

Inputs

bark - input frequency in bark.

Outputs

hz - Output frequency in Hz.

References

Traunmüller, Hartmut. *Analytical Expressions for the Tonotopic Sensory Scale. Journal of the Acoustical Society of America. Vol. 88, Issue 1, 1990*

See also: hz2bark.

3.6.2 erb2hz

`hz = erb2hz (erb)`
Convert equivalent rectangular bandwidth (ERB) to Hz.

Inputs

erb - input frequency in erb.

Outputs

hz - Output frequency in Hz.

References

Glasberg and Moore. *Derivation of Auditory Filter Shapes from Notched-Noise Data. Hearing Research. Vol. 47, 1990*

See also: hz2erb.

3.6.3 hz2bark

`bark = hz2bark (hz)`
Convert hz to equivalent bark frequency

Inputs

hz - input frequency in Hz.

Outputs

bark - Output frequency as a bark value

Examples

Convert 4000 Hz to erb

```
erb = hz2erb(4000)
```

References

Traunmüller, Hartmut. *Analytical Expressions for the Tonotopic Sensory Scale. Journal of the Acoustical Society of America. Vol. 88, Issue 1, 1990*

See also: bark2hz.

3.6.4 hz2erb

`erb = hz2erb (hz)`
Convert hz to equivalent rectangular bandwidth (ERB)

Inputs

hz - input frequency in Hz.

Outputs

erb - Output frequency as a erb value

Examples

Convert 4000 Hz to erb

```
erb = hz2erb(4000)
```

Convert a range of Hz to erb

```
erb = hz2erb(4000:100:5000)
```

References

Glasberg and Moore. *Derivation of Auditory Filter Shapes from Notched-Noise Data. Hearing Research. Vol. 47, 1990*

See also: erb2hz.

3.6.5 hz2mel

mel = hz2mel (*hz*)
Convert hz to equivalent mel frequency.

Inputs

hz - input frequency in Hz.

Outputs

mel - Output frequency as a mel value

Examples

Convert 4000 Hz to mel

```
mel = hz2mel(4000)
```

Convert a range of Hz to mel

```
mel = hz2erb(4000:100:5000)
```

References

O'Shaghnessy, Douglas. *Speech Communication: Human and Machine. Reading, MA: Addison-Wesley Publishing Company, 1987*

See also: mel2hz.

3.6.6 mel2hz

hz = mel2hz (*mel*)
Convert equivalent mel frequency to Hz.

Inputs

mel - input frequency in mel.

Outputs

hz - Output frequency in Hz.

References

O'Shaghnessy, Douglas. *Speech Communication: Human and Machine. Reading, MA: Addison-Wesley Publishing Company, 1987*

See also: hz2mel.

Appendix A GNU General Public License

Version 3, 29 June 2007

Preamble

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