

Developing multitrack audio effect plugins for music production research

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19 November 2015

\$ whoami

Research at the Centre for Digital Music (C4DM)

60+ academics, post-docs, PhD students

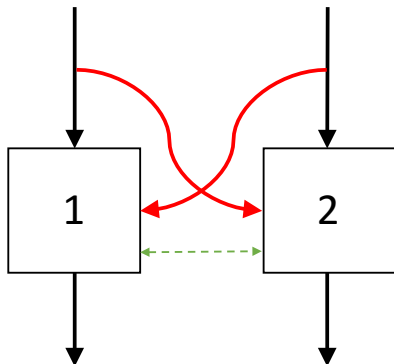
Area: audio engineering, intelligent music production

Why a (JUICE) plugin?

- ▶ Rapid prototyping
 - Idea
 - Algorithm
 - Stand-alone software
 - Hardware
- ▶ Compatibility with existing audio production tools
- ▶ Focus on processing
 - Platform independence
 - Audio input and output taken care of (real time!)
 - Easy GUI
- ▶ JUICE *'encourages good coding practice', 'made my life a lot easier' is 'very well thought through', 'well integrated', and just 'Great!'*

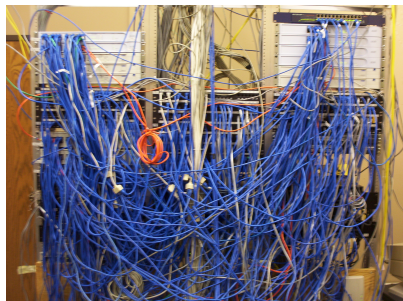
Why multitrack?

- ▶ Cross-adaptive functionality
- ▶ Avoid sidechaining clutter
- ▶ Modelling of larger system
- ▶ Simple setup
- ▶ Spatial applications



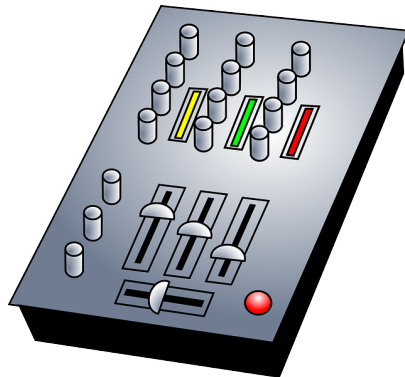
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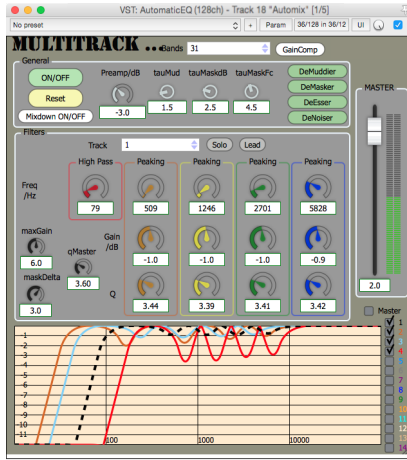
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Researchers, developers, artists, ...

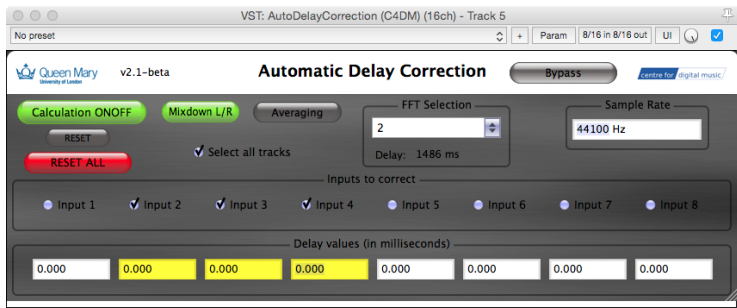
Example: Automatic faders



Example: Automatic EQ



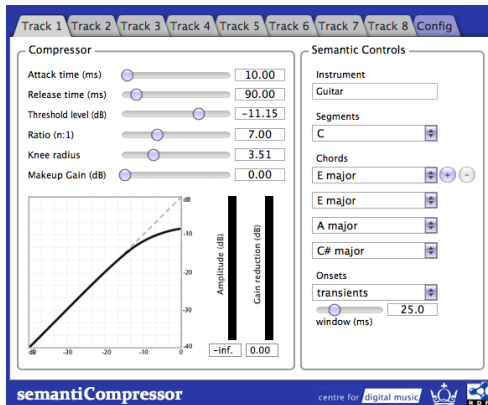
Example: Audio alignment



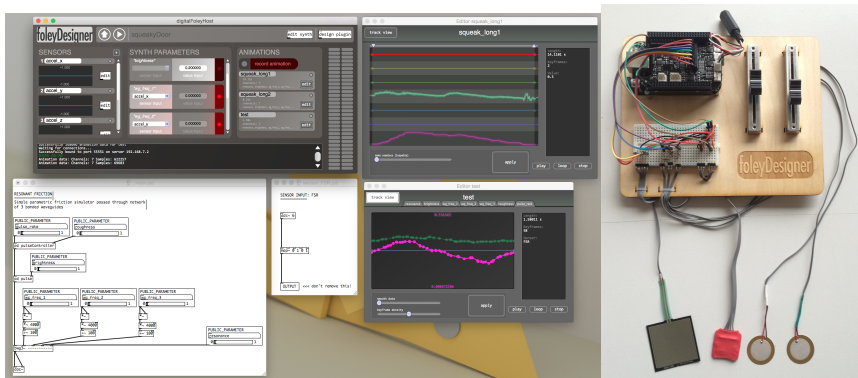
Example: Listening test



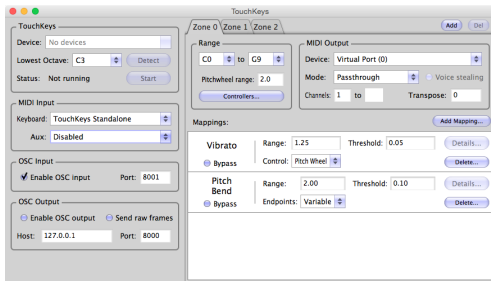
Example: Semantic compressor



Others || Full applications



Others || TouchKeys



Others || Non-multitrack (≤ 2) plugins

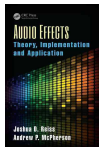


SAFE plugins (semanticaudio.co.uk)

4:30pm today: *'The SAFE JUCE module: A System for Managing Music Production Metadata'* by Sean Enderby



iNtelligent Audio Switch Box



Audio Effects (Reiss & McPherson)

QMUL Digital Audio Effects course

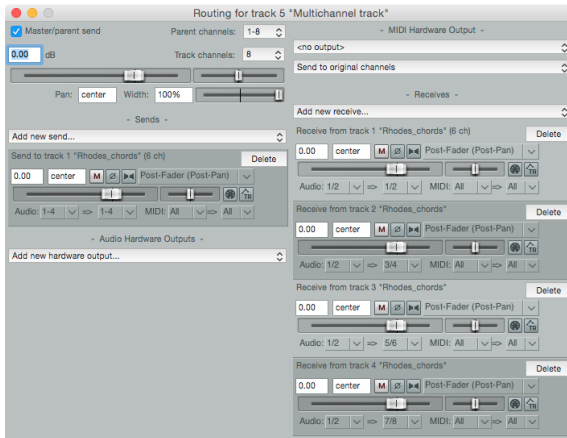
...

DAW multitrack plugin support

Few DAWs support multitrack VSTs/AUs

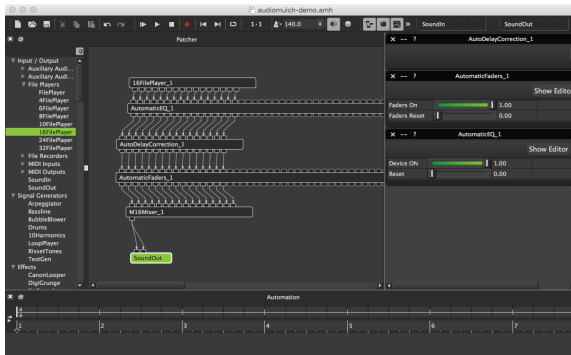
DAW multitrack plugin support

Cockos Reaper



DAW multitrack plugin support

AudioMulch



Avid Pro Tools

AAX not accessible to us lowly researchers



"You must be willing to make your product available for commercial sale to end-users. We don't offer our developer materials or services for academic use, experimentation, or 'just to check them out.' "

(<https://www.avid.com/US/partners/audio-plugin-dev-program>)

Complexity

- ▶ HeapBlock
- ▶ OwnedArray
- ▶ `for (int trk = 0; trk < numTracks; ++trk)`

CPU

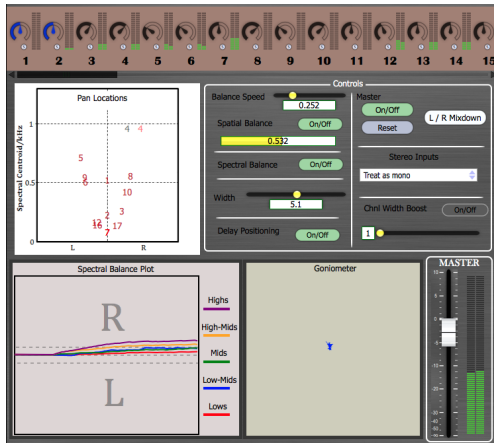
- ▶ Scaling factor
- ▶ Inter-dependencies, cross-adaptiveness, ...
- ▶ $\mathcal{O}(?)$
- ▶ Efficiency more critical

CPU

```
1 int MultitrackEffectAudioProcessor::GetNumValidTracks(AudioSampleBuffer& buffer) {  
2     int numActiveTracks;  
3  
4     for (int trk=0; trk<_numTracks ; ++trk) {  
5         if (buffer.getMagnitude(trk,0,_numSamples)) {  
6             numActiveTracks = trk+1;  
7         }  
8     }  
9  
10    return numActiveTracks;  
11 }  
12
```

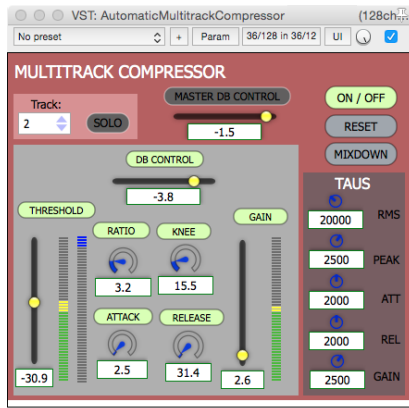
Interfaces

Large, complex



Interfaces

Pagination



Concluding remarks

- ▶ Multitrack audio plugins provide unique opportunities and challenges
 - Cross-adaptive audio streams, complex architectures
 - Compatibility, complexity
- ▶ Academic focus $\neq$ industry focus
 - Prototyping, data collection
 - Computational efficiency, slick interfaces
- ▶ JUCE supports multitrack plugins and enables quick development

Use cases for multitrack plugins are limited, but support could stimulate development

References I

- S. Mansbridge, S. Finn, and J. D. Reiss, "Implementation and evaluation of autonomous multi-track fader control," in *132nd Convention of the Audio Engineering Society*, April 2012.
- E. Perez-Gonzalez and J. D. Reiss, "Automatic gain and fader control for live mixing," *IEEE Workshop on applications of signal processing to audio and acoustics*, October 2009.
- E. Perez-Gonzalez and J. D. Reiss, "Automatic equalization of multi-channel audio using cross-adaptive methods," *127th Convention of the Audio Engineering Society*, October 2009.
- S. Hafezi and J. D. Reiss, "Autonomous multitrack equalisation based on masking reduction," *to appear in Journal of the Audio Engineering Society*, 2015.
- A. Clifford and J. D. Reiss, "Calculating time delays of multiple active sources in live sound," in *129th Convention of the Audio Engineering Society*, 2010.
- A. Clifford and J. D. Reiss, "Reducing comb filtering on different musical instruments using time delay estimation," *Journal of the Art of Record Production*, vol. Issue 5, July 2011.
- N. Jillings, A. Clifford, and J. D. Reiss, "Performance optimization of gcc-phat for delay and polarity correction under real world conditions," in *134th Convention of the Audio Engineering Society*, 2013.
- Z. Ma, B. De Man, P. D. Pestana, D. A. A. Black, and J. D. Reiss, "Intelligent multitrack dynamic range compression," *Journal of the Audio Engineering Society*, vol. 63, pp. 412–426, June 2015.
- T. Wilmering, G. Fazekas, and M. B. Sandler, "High-level semantic metadata for the control of multitrack adaptive digital audio effects," in *Audio Engineering Society Convention 133*, 10 2012.
- A. McPherson, "TouchKeys: Capacitive multi-touch sensing on a physical keyboard," in *Proc. NIME*, 2012.

References II

R. Stables, S. Enderby, B. De Man, G. Fazekas, and J. D. Reiss, "SAFE: A system for the extraction and retrieval of semantic audio descriptors," in *15th International Society for Music Information Retrieval Conference (ISMIR 2014)*, October 2014.

J. D. Reiss and A. McPherson, *Audio Effects: Theory, Implementation and Application*. CRC Press, 2015.

S. Mansbridge, S. Finn, and J. D. Reiss, "An autonomous system for multi-track stereo pan positioning," in *133rd Convention of the Audio Engineering Society*, October 2012.

E. Perez-Gonzalez and J. D. Reiss, "Automatic mixing: Live downmixing stereo panner," in *10th International Conference on Digital Audio Effects (DAFx-10)*, 2007.

E. Perez Gonzalez and J. D. Reiss, "A real-time semiautonomous audio panning system for music mixing," *EURASIP Journal on Advances in Signal Processing*, 2010.

Q&A

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See also: 4:30pm today: *'The SAFE JUCE module: A System for Managing Music Production Metadata'* by Sean Enderby