The CUBEMixer a Performance-, Mixing- and Masteringtool

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Abstract

With the CUBEMixer we created a real time multi-purpose mixing- and masteringtool for multichannel speakersystems or binaural rendering in the 3D-Audio domain. The mixing-system with integrated room-simulation possibilities is written in the graphical programming language Pure-Data. I was orginally designed to be used for performances as spatialisation-system and 3D-Audio mastering application and can also be used with additional virtual acoutics in a concert-room. It has several master sections for rendering inputchannels in either 3D-audio with ambisonics or as a bus-subsystem for other spatializations strategies. It can be controlled with either a PD-native GUI over OSC oder MIDI and has a dynamic parameter handling system for storing an loading settings, parameter on files.

This paper describes the possibilities of the CUBEMixer with his plugin- and extensions-system and how the mixer is expansable for many other purposes. The CUBEMixer can be easily extended for special compositions and performances or used as a library for PD.

Keywords

Spatialisation, Binaural, Mixer, Virtual Room Acoustics

1 Introduction

The CUBEmixer[8] thinks of sound as a spatial, sculptural phenomenon and is a softwaretool which can render Sound in an 3D-audioenvironment. The control data should be independend from the current playback/rendering situation. The main target is the use as an higher order ambisonics system. The 3D-spatialising data, azimuth, elevation and distance can also be interpreted in different domains, eihter with own master sections, or special ambisonics decoders to render the mix for example in 5.1 surround or even plain stereo.

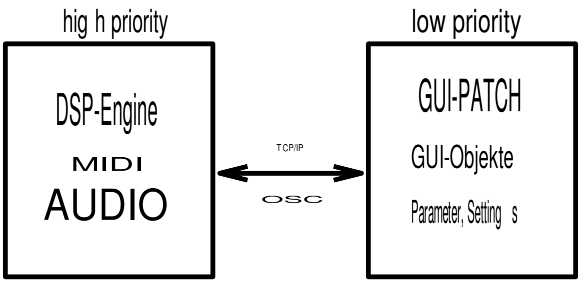
The CUBEmixer is programmed with the graphical computermusic language Pure-Data [6] with few special external objects libraries [4] and can be extended with plugins, extensions and any other PD-Patch which respects the namespaces.

The basics of the software has ben developped since 1999 out from different projects for sound-installtion, performances in big concert halls with multichannel audiosystems. It was also used in mastering projects to produce ambisonics audiofiles and within a lot of research and experiments done at IEM. The software original intented to drive the CUBE [12], a concert hall with 82 speaker over 54 channels at IEM. It was later generalized and adapted for the use in different audio environments. It is distributed under GPL. The goal is to find a common performance standard for audio mixed in the 3D-domain.

2 Architecture of the system

The software is split into a DSP-Patch and a GUI-Patch to be run on seperate PD-instances, so the latency dangerous GUI-control is seperated from the low latency DSP-Patch. Also it is possible to remote-control the audioworkstation with the DSP-Patch over TCP/IP. The connection between them is done with OSC[1][10] and should be run over a TCP/IP Link, but also an UDP-connection is sufficient.

[1]Open Sound Control Protocol



Zeichnung 1: running GUI and DSP in an own PD-Instance

The mixer is split into configurable number of input sections assgineable to individual input signals, with different optional encoders and a master section with extensions like the different decoder and subwoofer-system, effects, 3D-reverbs, soundfile-player/recorder and other tools. At the time of writing an ambisonics decoder for a 24.1 channel Speaker system in an Hemisphere doing 4th order ambisonics [1,2,3], a binaural rendering stage using the an ambisonics decoder with HRTF-Filters [5], a busmixer and 64x64-matrix for routings to output signals eg. DACs, a subwoofer mastersection, "room in room simulation", and 3D-reverberation. In the ambisonics domain, the 25 ambisonics signals can be used as a storage format for spatialized soundfiles.

Additionally all paramters can be stored and loaded from files, where the parameter naming follows the OSC style. Testsignal generators and soundfile -player, -recoder complete the Version 2 of the CUBEmixer.

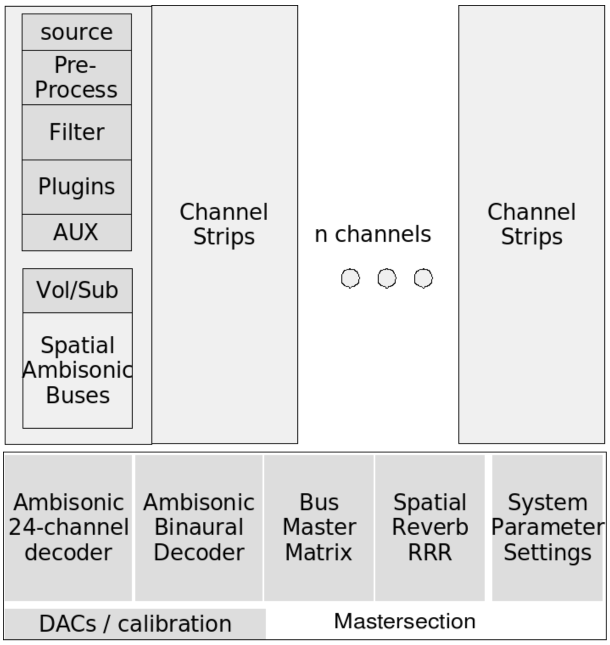


figure 2: mixer organisation

2.2 Input Section

Inputs are channels which can be assigned to ADCs of the soundcard or other sources in the system generated by effects, soundfile players, AUX-routings and free definable signals from extensions.

Each input can be routed to AUX-Sums and to a ambisonics encoder or the to a bus matrix.

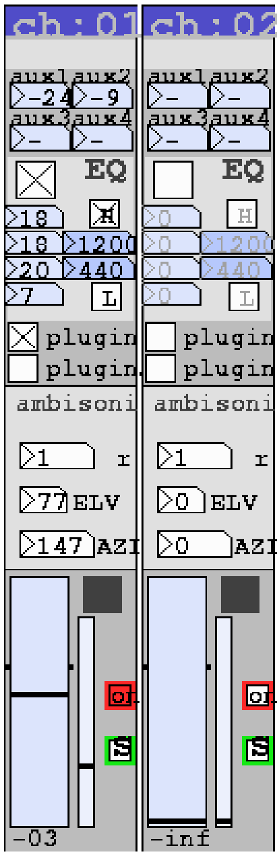


Abbildung 1: input channel overview GUI

Also plugins can be configured, not only to modify signals as also control other parameter of the systems eg. to link channel effects.

The spatial control data is an abstract set of the angles elevation, azimuth and the distance r. This is used in the ambisonics encoder to spatialize audio and control the width of the signal, imidation distance. The volume section allows an additional output to the subwoofer master section.

2.3 Extensions

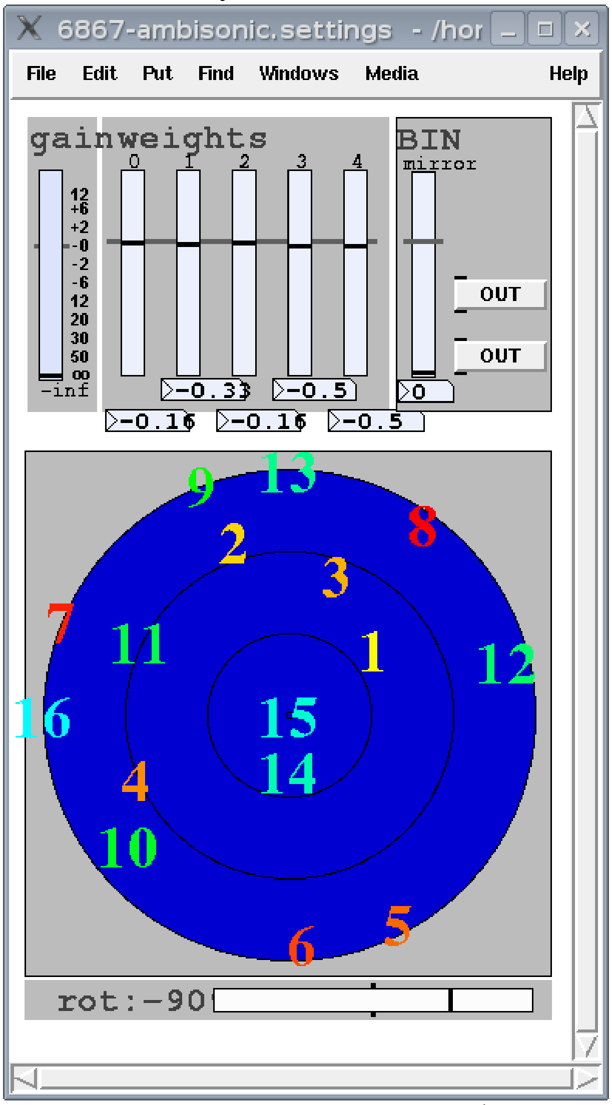
Extensions are modules in the master section which provide sinks and sources for the input channels. The ambisonic decoders are extensions, like the busmaster, reverbs, soundfile player, etc. Special computemusic pieces can be also included.

2.4 Controller

Since OSC with the dynamic naming mechanism is used as base for controls, the pattern matching system of OSC is used for filtering parameter groups and store them in seperate files or control a whole bunch of parameter parallel. Generative complex movement algorithms can be implemented as patches, with their own parameter room.

The OSC control data can be mapped to MIDI connections, so MIDI-sequencers can store control data and play them back. Also the system is designed to be driven by MIDI-Controller like Fader-Boxes or other sensoric systems.

3 ambisonics system



In this version ambisonics is used in 4th order for horizontal and vertical spatialization as a maximum. The encoder can be used to feed a weightable order resolution of the 25-channel ambisonics signal to control the width of the source. This is used to code the distance of the signal toward the center.

The ambisonics-decoder renders the ambisonics signal to the actual speaker settings, in our case 24 speaker hemisphere, having an own decoding matrix parameter set. For each speaker setup an own parameter set for the decoder has to be calculated. The speakers can be calibrated in volume and propagation time correction, so the offset in the distances of the speaker to the center can be equalized. Of course a well arranged speaker sets sounds better than an odd one, but also not perfect speaker distributions can be handled efficient.

As an special feature, the ambisonics rendered signal can be stored and playbacked later without the use of inputs, enabling the playback of additional complex sound environments in parallel.

4 3D reverberation system

Since CUBEMixer can render audio signals in the 3D-domain, first reflections and late reverb can also be spatialized. With this feature the reverb sounds more natural and transparent. Especially the spatialization of the late reverb allows the construction of virtual acoustic rooms with different dimensions in different directions, e.g. staying in the coners of a room or simulate a room besides the main room.

5 Binauraul rendering

The ambisonics signals can also be rendered on an binaural ambisonics-decoder. Therefore a 4th order ambisonics decoder is used, applying HRTF-functions on virtual speaker. This is used also to set up complex spatialization-productions with headphones for preproduction before moving to the concert hall.

Important for the good performance of the binaural rendering is a room simulation, wich is a multichannel reverb-system. Plugins can produce first reflections wich are also spatialized using a virtual room model.

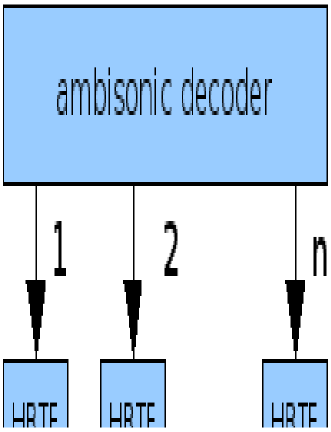
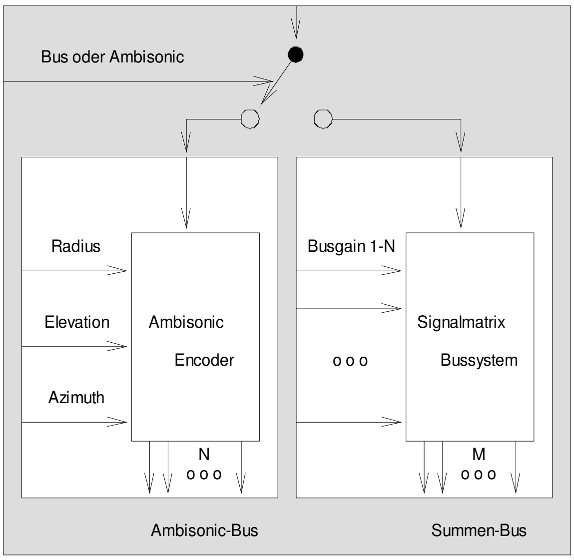


figure 2: Ambisonic Bibaural Renderer

6 Room in Room Simulation

With the usage of microphones in the performance room, preferable to be mounted on the walls, a "room in room reverberation" (RRR) can be build. The RRR module renders the reflections and reverb in the same room. So virtual acoustical rooms, on top of the physical room acoustic can be constructed for performances and rehearsals.



7 Tools, Control and Storage

The control of the CUBEMixer is done with OSC, which can be mapped to/from MIDI and can be adapted to a lot of environments for rendering 3D-audio and virtual acoustics.

8 Conclusion

The CUBEmixer has proofed to be general tool rendering 3D-Audio in different situations and is also ready to be extended with other render domains like vector-panning, etc. It can be run in dedicated computemusik workstation as a distribution system in sound-installation and concert halls and on laptops for binaural productions.

The CUBEmixer is an open source project licenced under GPL and can be downloaded from sourceforge or checked out from svn from the IEM opensource projects site at http://iem.sourceforge.net/

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