From Basic Academic Research To High-tech Start-up

A case study from the Audio Engineering research group in the Centre for Digital Music
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It starts with a PhD proposal

Blind Mixing for Live Audio

5 month research proposal

Enrique Perez Gonzalez
First research result… Wow!
We’re on to something...

There’s no reason why a band recording using reasonably conventional instrumentation shouldn’t be EQ’d and balanced automatically by advanced DAW software.

Musicians who’d rather get on with making music than get too deep into engineering
Abstract

An intelligent mixing system, which integrates both stage sound and front of house sound, and the interconnectivity between them is developed. A mathematical model of the stage sound is derived which describes the perceived loudness of each instrument to each musician. Practical limitations on the stage sound are enforced, for example maximum monitor level before feedback, and maximum and minimum loudness for each performer. The desired mix of each performer can then be input to the model, and the necessary gains which best satisfy all requirements can be found.

The interconnectivity between the stage sound and front of house sound is investigated, enabling the contribution of the stage sound to the front sound to be incorporated into established automatic mixing tools.

MSc Project Report

Investigation in Dynamic Range Compression

Name: Michael Maxberg
Student No.: 099600527
Supervisor: Dr. J. D. Reiss
Date: 25 August 2009

A high quality sub-band approach to musical transient modification

Authors: [Names and Affiliations]

ABSTRACT

This paper presents a multi-band method to detect and model transients in audio. The method is based on the Time-Frequency implementation of the Cohen's class of the multitaper method [1]. Although the effect is commonly used on single microphone sources it is also intended to apply the ability to identify transient parts of an audio signal with soft sources where transient parts are complex noise.

Research Proposal - Hardware Development of Intelligent Audio Consoles (IAC) — DRAFT v0.2

Research Student: Yonghao Wang
Supervisors: Joanne Reiss (First)

1. Abstract

The aim of this research is to develop a system framework for intelligent audio consoles (IAC). The architectural design of the proposed hardware framework should have the capability, scalability and usability for high resolution and multi-channel intelligent audio processing as well as providing a novel user experience for audio sound engineer.

2. Background

Modern recording studios are normally equipped with digital audio workstations (DAWs), which are high performance computers with audio processing software. However, the audio console hardware is still the essential device of audio production in many situations. The operability of an audio console is irreplaceable even with the availability of software virtual consoles [1].

Like many other engineering areas, the audio console has mostly moved from the analogue to digital domain. The earlier types of digital console were mimics of their analogue counterparts. With the development of high speed digital signal processors and microprocessor technology, modern digital audio consoles continuously add new features and expand their territory [2].

Researchers at the Centre for Digital Music at Queen Mary University have proposed a set of novel algorithms to automate some engineering processes during various stages of recording, mixing, and playback [3][4]. The characteristics of the proposed algorithms are often multiple-channel dependent and involve computation both in time and frequency domain, using advanced signal processing techniques, as well as optimization, control theory, and artificial intelligence.

In order to integrate those algorithms into a digital audio console, the proposed IAC hardware architecture should have the capacity to deal with high-resolution multiple channel signals. A modular design will be considered in order to address the requirements of flexibility and scalability. The system is considered to be divided into control plane and data plane, in which the control plane shall calculate the control parameters based on the algorithm, and the data plane shall process the high speed real time audio streams using the parameters updated by control plane. This design is borrowed from network processor architecture design for data communication applications due to the fact of similar nature of the tasks [4].

A multi-core processor system will be proposed, which comprises a general purpose microprocessor core as control panel, and one or multiple DSP cores as the data

Figure 1: General Framework

Automatic Target Mixing

Daniele Berlino
February 4, 2009

General framework

Solving the optimization problem. A geometric approach

Suppose that the parameter of the mix are the gains applied to each track and that we are computing the parameter estimated from main and target, each track:

P(a_{i1}, a_{i2}) = a_{i1} P_{m} + a_{i2} P_{t} \quad \forall a \in \mathbb{R}

This optimization task can be solved geometrically using least squares.
First proof of concept

MUSICIANS will soon be able to deliver a click-free performance without employing an acoustic engineer - and audiences won't know the difference.

"A lot of what sound engineers do is rule-based," says Enrique Perez-Gonzalez, an electronic engineer at Queen Mary University of London's Centre for Digital Music. So he and Josh Reiss, also at the CD, have created a piece of software, called Automatic Mixing, to take care of basic sound engineering functions such as mixing and switching channels.

The software ensures sound doesn't distort by using an automatic gain tool to adjust signal levels from different instruments or microphones. It can also boost the bass or treble from an instrument or vocal track by increasing the strength of signals from specific frequency bands.

Sounds from an instrument can cancel each other out if they are picked up by more than one microphone, so the software inverts the signals from offending sound sources to stop that happening. Other features include introducing slight delays to align the instruments' signals, spreading the sounds signals, and generating a stereo effect and an anti-feedback function. However, the software is not intended to replace sound engineers. Instead, it should allow them to concentrate on more creative tasks, says Reiss; it will be launched at the Audio Engineering Society Convention in London in May.

"The software should allow sound engineers to concentrate on more creative tasks," he says.

The CD's ESI audio analyser will make its European debut at AES Convention in London in the platform to show its recently released ultra-high bandwidth analyser option for the APx385 family of audio analysers for the first time in Europe.

The WS12 High Bandwidth option extends the APx's FFT (Fast Fourier Transform) capability all the way to 1MHz, with 24-bit resolution and 2.38kHz bin width, making APx suitable for looking at out-of-band noise in Class D amplifiers, sigma-delta converters and other modern audio devices. "As compared to the previous state of the art, an FFT of this length and resolution is like trading a pair of reading glasses for the Hubble telescope," says Bruce Hofer, chairman and co-founder of Audio Precision. "It's a real technical achievement for the company."

Automation mixing and more from Queen Mary's C4DM

The Centre for Digital Music (C4DM) is a multidisciplinary research group in the field of Music & Audio Technology at Queen Mary, University of London that works with industry leaders in forging new business models for the music industry, will be showing the latest technologies at its interactive stand at AES.

Featured technology includes the Automatic Mixing Tools, which can generate an automatic sound mix of an unknown set of multichannel signals. This out-of-a-kind technology can work with either live sound or post-production.

Software programme R-Keeps changes the tempo of a sequence (such as a demo in Ableton Live) so that it synchronises with a drummer. This means that loops and pre-recorded parts will stay in time without forcing the drummer to play to a click track.

Also on show is Audio Browser, which creates a virtual environment to help users to navigate easily around an audio library.

Finally, the Rhythm Transformation Software can be used to mix together two pieces of music so that they are synchronised not only at the level of musical notes but also in terms of finer rhythmic structure.
THE COMMERCIALISATION STAGE
Disruptive innovation
We can change the way people produce music!
The elevator pitch

- The modern digital camera
  - Auto-focus
  - Red-eye removal
  - Image stabilizer
  - Face,
  - Scene detection
  - Motion detection
  - ...

- The modern digital audio console
  - No intelligent features
  - Requires a professional
  - Quality suffers
Companies interested...

- “We were reading the article in New Scientist about your projects on Automixing and are interested in learning a little more, or even seeing if there’s a way we may be able to find some commercial applications” – Director of New Products at one of the world’s biggest mixing console manufacturers
But...

- Enrique graduates... 😊 and 😞
- Now Product Manager at Solid State Logic

Solid State Logic

SOUND | | VISION

- Project students move on.
- Company interest heats up
- Queen Mary Innovation supports the R&D
- I get a grant to commercialise research

Enter Stuart, Alice, Sina, Zheng...
FOUNDING THE COMPANY & INVESTMENT
Enter Tandem Launch Technologies

- Venture Fund
- Unique business model
Proof of concept → Prototype

- We build new demonstrators
- C++ code, VST plugins, videos, patents ...
- Much closer to ‘Industry Ready’
Proof of concept ➔ Prototype + Continual Conversation = Investment!

- $400K investment from Tandem Launch 😊
- “We have a slight hiccup”

Solution: Two start-up companies
  - Automatic Music Production Systems Ltd. (UK company)
  - 8352593 Canada Inc. (Canadian company)

Second stage investment ➔
The challenge, the contradictions

**Academia**
- High risk research with unknown outcomes
- Want new ideas & knowledge
- Ends with proof of concept
- Share the knowledge
  - Publish
- Spend the money

**Industry**
- Real world problems with assured solutions
- Want market validation
- Starts with prototype
- Protect the IP
  - Patent
- Generate revenue
Lessons and dilemmas

<table>
<thead>
<tr>
<th>Dilemma</th>
<th>Approach</th>
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<tbody>
<tr>
<td>Do I start a company?</td>
<td>Yes! Sort of...</td>
</tr>
<tr>
<td>Who are the cofounders?</td>
<td>University, student, incubator</td>
</tr>
<tr>
<td>Cofounder positions?</td>
<td>Nail this down but leave space to adapt</td>
</tr>
<tr>
<td>Who makes the decisions?</td>
<td>Be explicit!</td>
</tr>
<tr>
<td>Who and how to hire?</td>
<td>Put in the effort!</td>
</tr>
<tr>
<td>Who to invest and how to</td>
<td>Need options, don’t give away too much too</td>
</tr>
<tr>
<td>raise capital?</td>
<td>soon.</td>
</tr>
<tr>
<td>Founder vs CEO</td>
<td>Expect a battle.</td>
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An alternative route to commercialisation

- Dissemination generates interest
- Assets are the team, the knowledge
- Value is in the research
- Unique selling point is in the research breakthrough
  - Protect? Ok.
  - Publicise? Yes!

- No single route to commercialisation
- Enjoy the journey!
Thanks!

And thanks to Enrique Perez Gonzalez, Stuart Mansbridge, Alice Clifford, Sina Hafezi, Zheng Ma, Brecht De Man, Dimitrios Giannoulis, Michael Massberg, Jacob Maddams…

Questions?

- Company website(s)
  - mixgeni.us, mixgenius.com, mixgenius.co.uk...

- Research website
  - c4dm.eecs.qmul.ac.uk/audioengineering.html

- Youtube channel
  - www.youtube.com/user/IntelligentSoundEng

- Publications
  - www.eecs.qmul.ac.uk/~josh/publications.htm