## McGILL'S ACTIVE ACOUSTICS ENHANCEMENT SYSTEM

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#### VIRTUAL ACOUSTICS TECHNOLOGY LAB

1. CAPTURING IR MATERIAL

2. SYNTHESIZING ROOM FEATURES

3. SOUNDFIELD RENDERING

#### CAPTURING IR MATERIAL

- Multiple locations of Source and Receiver
- Receiver and Source arrays
  - Example: Grace Cathedral

MICROPHONE AND SOURCE POSITIONS IN THE GRACE CATHEDRAL OF SAN FRANCISCO

> 100 m long 49 m wide 53 m high



## EXAMPLE OF THE SOURCE SET UP



#### MICROPHONE ARRAY



#### **DECAY CURVE OF 8 CHANNEL ARRAY**

Three distinct decay curves picked up by the microphone array



#### SYNTHESIZING ROOM FEATURES

- Temporal segmentation
- Creation of characteristic IR's
  - Diffusion and decorrelation
  - Density of early reflections
  - Immersiveness
  - Movement of reverberation

### IMPULSE RESPONSE SEGMENTS ALLOW TEMPORAL STRUCTURING OF ENHANCEMENT

Separate unique acoustic features



- Early reflections
- Mid reverberation
- Late reverberation

Temporal segmentation and multiple low-latency convolution processing allow us to control the buildup of room energy

#### ENERGY PLOT OF DIFFERENT RECEIVERS

• The plots of the microphone array shows a more uniformed decay curve



#### ENERGY PLOT OF DIFFERENT RECEIVER POSITIONS

• The plots of the different microphone position shows a more diverse decay curves



### SOUNDFIELD RENDERING IN ROOM

- Low-latency Multichannel Convolution
- Studio post-production
- Live sound enhancement
- Recording and performing in virtual acoustics
- The Virtual Haydn

#### VIRTUAL ACOUSTIC TECHNOLOGY IN MULTIMEDIA ROOM

- 3 Weiss Powerhouse DSP engine
  - Each computing 8 channel of 96Khz 24bit convolution reverb
  - Latency = 7ms
- 16 dodecahedron omnidirectional speakers in three different height layers at 2m, 3m, 4m

 $(16 \times 12 = 192 \text{ drivers})$ 

- Multimedia Room 24.8m x 18.3m x 15.2m
- RT20 = 1.6 sec

#### VAT grid in the MMR



#### Speaker arrangement



#### VAT system layout



#### **OMNIDIRECTIONAL VS BOX SPEAKERS**



In a typical box speaker, even when flat on-axis, the total acoustic power radiated into the room drops typically 10 dB (10x) or more between low and high frequencies

#### PERCEIVED 'DRAGGING' OF THE ROOM



#### SYNTHESIS OF MOVING REVERBERATION USING ACTIVE ACOUSTIC SYSTEM – PRELIMINARY REPORT

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138<sup>th</sup> AES Convention Paper 9326, Warsaw, May 7-10, 2015

## MULTIMEDIA ROOM WITH VAT



#### MULTIMEDIA ROOM WITH VAT



#### LISTENING TEST

 15 second excerpt of anechoic choral recording played back through two coincident back to back JBL 308
Speakers placed 10 ft away from listener

 The participant was asked to rate their impression of either movement or envelopment on -5 to +5 scale compared to the reference condition.

#### DECAY CURVE OF VAT CONDITIONS FOR PERCEPTUAL TESTING



<b>Ref Condition</b>	T20 (500Hz)	1.6 sec
Condition 1	T20 (500Hz)	5.8 Sec
Condition 2	T20 (500Hz)	5.8 Sec
Condition 3	T20 (500Hz)	5.5 Sec

## SYNTHESIS OF 3 REVERBERANT CONDITIONS FROM GRACE CATHEDRAL

- Three different acoustical conditions randomly chosen for the test
  - Condition 1 Cross pair of fig-8 microphones at increased distances from the source with increasing height (2m, 3m, 4m)
  - Condition 2 Cross Pair of fig-8 microphones at two different source position S1 and S2 in different receiver positions at same height
  - Condition 3 Microphone array captured at single source and receiver position

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#### CONCLUSIONS

- In order to capture the moving reverberation of a large acoustic space, multiple microphone positions and source positions must be used.
- Synthesis must achieve distinct reverberation characteristics, in a given rendering system, in the actual application.

#### On the web: www.thevirtualhaydn.com

The Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT), the Schulich School of Music of McGill University and Naxos invite you to a two-day celebration of the upcoming release of:

#### THE VIRTUAL HAYDN: COMPLETE WORKS FOR SOLO KEYBOARD A BOX SET OF FOUR BLU-RAY DISCS

Early Music meets High-Tech: experience a collection of recordings featuring seven historical keyboards and nine virtual rooms. Tom Beghin performs Haydn's works for solo keyboard with the imagination and creativity expected of the most accomplished 18th-century keyboardist. Seven period instruments have been newly constructed to match those that Haydn and his contemporaries would have used. The sound characteristics of nine rooms in which Haydn's music would have been performed are reproduced in the recording laboratory using surround-sound recording techniques and virtual acoustics.

The brainchild of McGill Professors Tom Beghin (performer & historian), Martha de Francisco (Tonmeister & producer), and Wieslaw Woszczyk (sound engineer & virtual acoustics architect), The Virtual Haydn is being released world-wide by Naxos, world-leading classical music label and distributor, as its first ever Blu-ray production.

#### Join us in celebrating the results of this pathbreaking project!

Friday, September 25<sup>th</sup> 2009 4:15pm Tanna Schulich Hall

Lecture by Tom Beghin THE VIRTUAL HAYDN: PERSPECTIVES FOR SCHOLARSHIP AND PERFORMANCE

Saturday, September 26<sup>th</sup> 2009

4:00pm Tanna Schulich Hall

Documentary Film: World Premiere of PLAYING THE ROOM: THE MAKING OF "THE VIRTUAL HAYDN"

Directed by Robert J. Litz and Jeremy Tusz Q&A with Martha de Francisco and Wieslaw Woszczyk



Friday, September 25<sup>th</sup> & Saturday, September 26<sup>th</sup> 2009 7:30pm Multimedia Room

> Concert by Tom Beghin

THE VIRTUAL HAYDN: FOUR KEYBOARDS, THREE ROOMS

Experience live performances an the clavichard, fortepiano, and harpsichord in the virtual acoustics of Eszterháza Castle (Fertiðl), Lobkowitz Palace (Vienna), and Château Ramezay (Montreal)

> Admission: free

CIR Centre for Interdisciplinary Research MMT in Music Media and Technology

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cGill 🛛 Schulich School of Music Coole de musique Schuli



Look for Paul Wells' article about this project in MacLean's magazine on September 24th!

Seating is limited. Please reserve online in advance: <u>www.cirmmt.mcgill.ca/activities/live-cirmmt/reservations</u> Admission is free for all events. New Music Building, McGill University, 527 Sherbrooke St. West, Montreal

#### 1st music Blu-ray from Naxos 4 disc box set



the Virtual HAYDN complete works for solo keyboard



Tom Beghin on 7 historical keyboards in 9 virtual rooms



#### 4 DISC BOX SET

15 hours of high-resolution audio in 5.0 surround and 2.0 stereo 3 hours of high-definition video, including *Playing the Room*, a documentary film with subtitles in Dutch, French, German, and Japanese

#### **IMMERSIVE PRESENCE LAB**





#### Live concert

# Choral Rehearsal

80

30

3

100

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Sol 1

## **Choral Rehearsal**

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# Demonstration by Jonathan Hong



# Thank you for your attention