Myungin Lee

Cohesive Multimodal XR Experience Design

Portfolio

XR / HCI / Immersive Media /
Deep Learning / Signal Processing

Linked **in**

Google Scholar

GitHub

WEBSITE
www.myunginlee.com

Cover Image: Generative Visual using Gestural Interactive XR

Myungin Lee [이명인 : Myeong–in Lee]

"A researcher designing multi-modal XR experience

based on HCI, signal processing, and machine learning"

LISTS   * Projects on the review are not listed

Selected Projects   (https://www.myunginlee.com/projects)

Sensorium (2022-2024)
The Voice of the World Ocean

Coexistence with the SARS-CoV-2 Virus (2022)
Interactive Audiovisual Installation

AlloThresher (2024)
Multimodal Granulator

AlloLib Playground & Selected Series (2020-2022)
Interactive Audiovisual Development Platform

Entangled (2021)
Multi-user interactive system in virtual 3D spaces
using the machine learning-based gestural recognition of smartphones

Inspiration (2018)
Deep neural network-based music source conducting system

Blind Reverberation Time Estimation (2015-2017)
Machine learning-based room acoustic information from sound sources received by microphones

Selected Students' Work

FractalBrain (2024)
A Neuro-interactive Virtual Reality Experience using EEG for Mindfulness

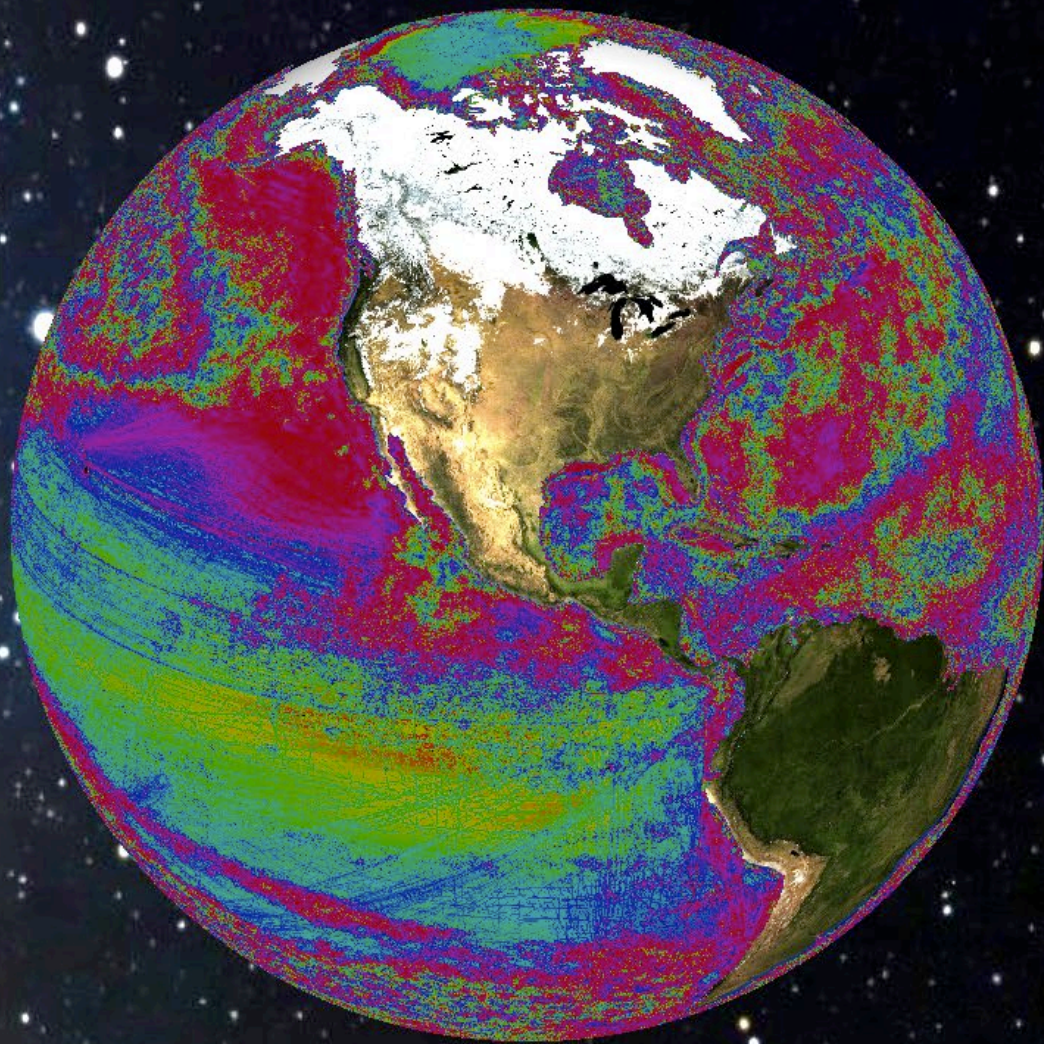**[UMD] Immersive Media Design**
CMSC499A, IMDM327, IMDM290, IMDM101

[UCSB] AlloLib Audiovisual Concerts (2022)
MAT 276IA, MUS 109IA, MUS 209IA

Sensorium (2024)

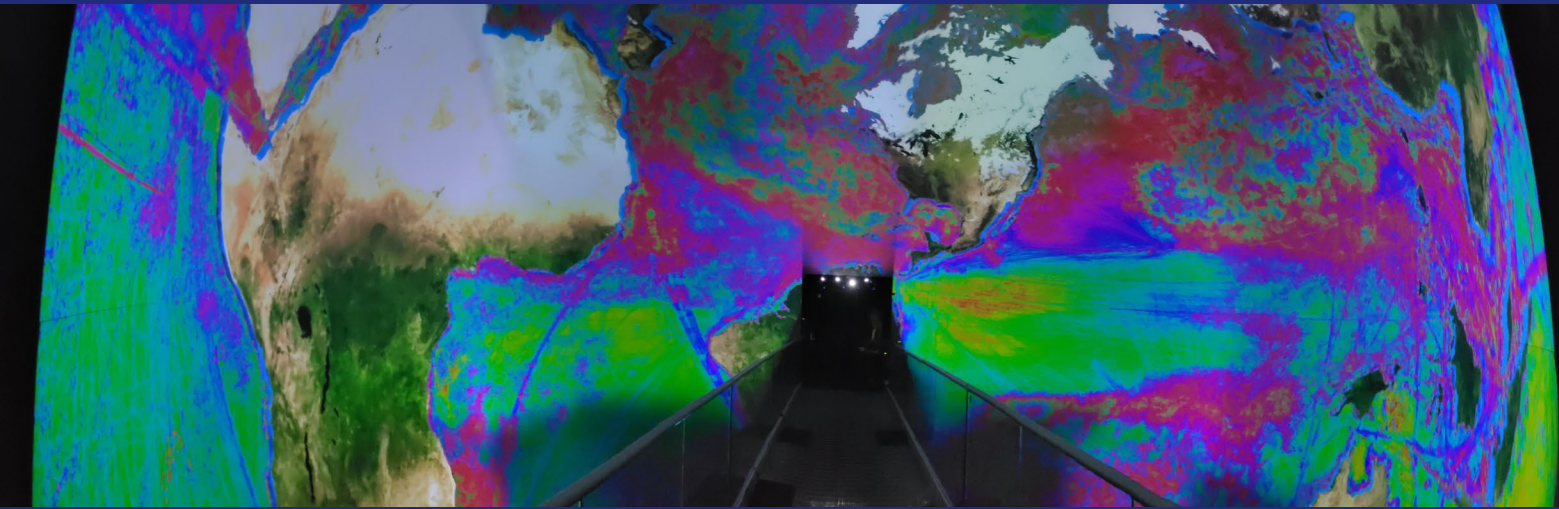| Getty's Pacific Standard Time (PST) 2024 ART: Art & Science Collide

The Voice of the World Ocean

Sensorium (2024)

| Getty's Pacific Standard Time (PST) 2024 ART: Art & Science Collide

The Voice of the World Ocean


Role in the Project:
Collaboration with NASA and groups of Ocean scientists
Core development of the large data processing, visualization, sonification, interaction, and installation.

Sketches for Sensorium showcases core elements of the late environmental artist Newton Harrison's (1932- 2022) long-term project, Sensorium for the World Ocean. It will premiere at the AlloSphere as a satellite to the UC Irvine Beall Center for Art and Technology's forthcoming exhibition, Future Tense: Art, Complexity, and Uncertainty (Press Release), produced in partnership with the 2024 Getty PST Art: Art and Science Collide initiative. The installation will incorporate immersive audio and visual scientific climate and ocean health data provided by the Ocean Health Index of the Halpern Lab at the Bren School of Environmental Science & Management, as well as ocean climate data from NASA scientists who are working with researchers at the University of Maryland College Park under the direction of Dr. Myungin Lee, PhD '23.

Sketches for Sensorium is a project of the Center for the Study of the Force Majeure in collaboration with Virtual Planet Technologies, Almost Human Media, the AlloSphere Research Group at the University of California Santa Barbara, and the Immersive Media Design Lab in the Department of Computer Science at the University of Maryland College Park. It will premiere with an original spatialized composition and an interactive data world, following Newton's wish to impart a sense of hope to audiences. This experience also includes a spatial audio composition for the 54.1 channel sound system of the AlloSphere composed by Dr. JoAnn Kuchera-Morin. The spatialized sound includes audio samples of the ocean, sounds of the ships' engines, as well as synthesized sound created by Kuchera-Morin. Newton Harrison was a prolific artist, and also a poet, performer and master storyteller. I encourage anyone interested to read some of his many writings (mostly composed with his wife and lifetime collaborator, Helen Mayer Harrison). A good place to begin would be their book, In the Time of the Force Majeure. Harrison, Joshua. To begin to learn about Newton & Helen Harrison work. 2024
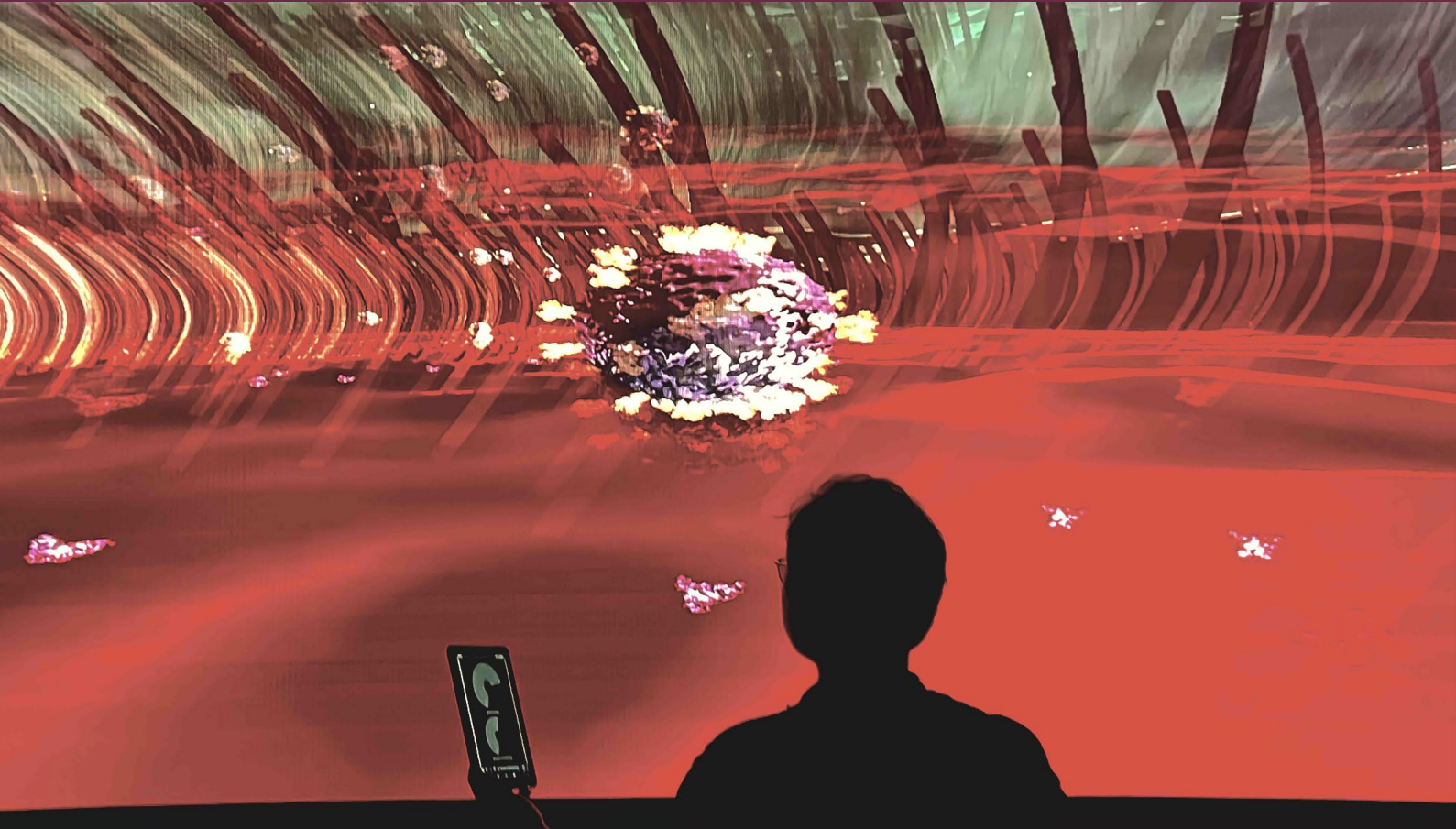
Exhibition
* AlloSphere, September- November, 2024 (1,400 people attended)
* 2025: Closing symposium event in coordination with the AD&A Museum
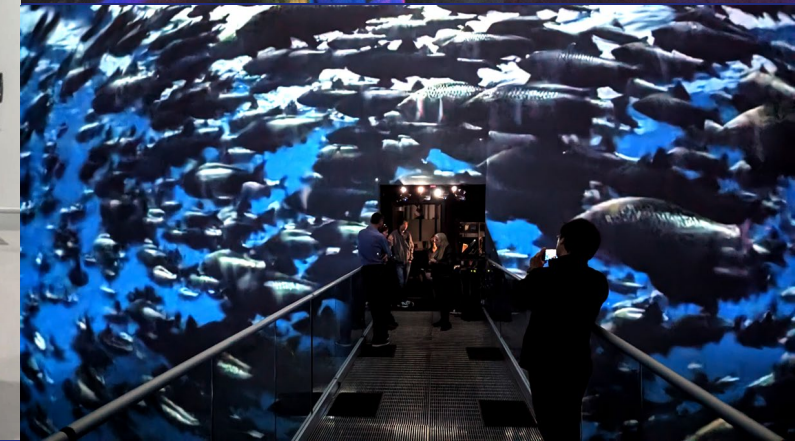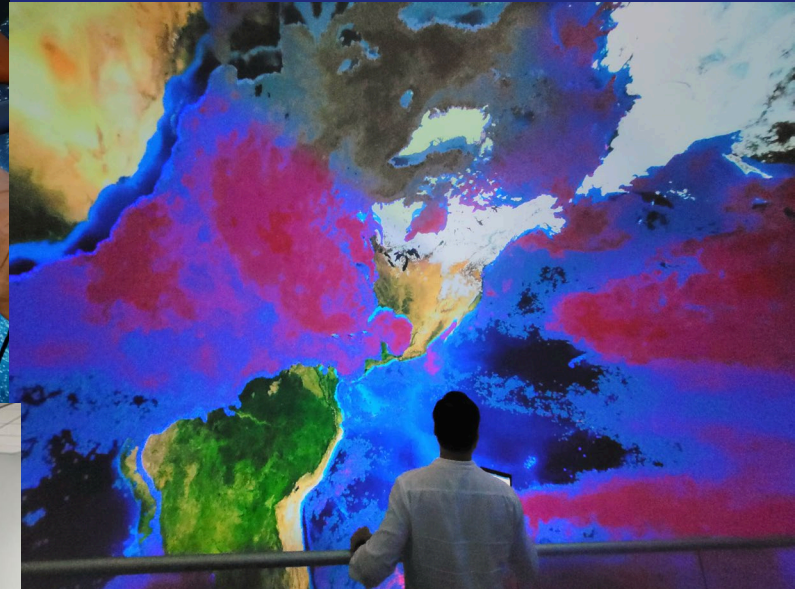
Parasitic signals: Multimodal Sonata for Real-time Interactive Simulation of the SARS-CoV-2 Virus (2022-2023)

Role in the Project (1st author):
Collaboration with bio scientists and artists.
Core research and development of the simulation model, data processing, visualization, sonification, interaction, installation, and performance

This project aims to transform the nano-scale of a striking biological phenomenon, the relationship between SARS-CoV-2 coronavirus and human molecules, into an interactive audiovisual simulation. In this work, the interaction data between the spike protein of SARS-CoV-2 and human cellular proteins is measured by Atomic Force Microscopy, which can touch and image a single molecule. We are creating an interactive audiovisual installation and performance from a set of interaction data. The audience is invited to an immersive space where they can control the biomolecules' behavior so that they can intuitively recognize the biological characteristics.
This project is not only a demonstration of scientific data but also tries to look at the interspecies relationship in parasitism. This project particularly deals with our current and future life with coronavirus and demonstrates how we might control our coexistence in virtual space.

Full Paper:
https://doi.org/10.1109/VISAP60414.2023.00009
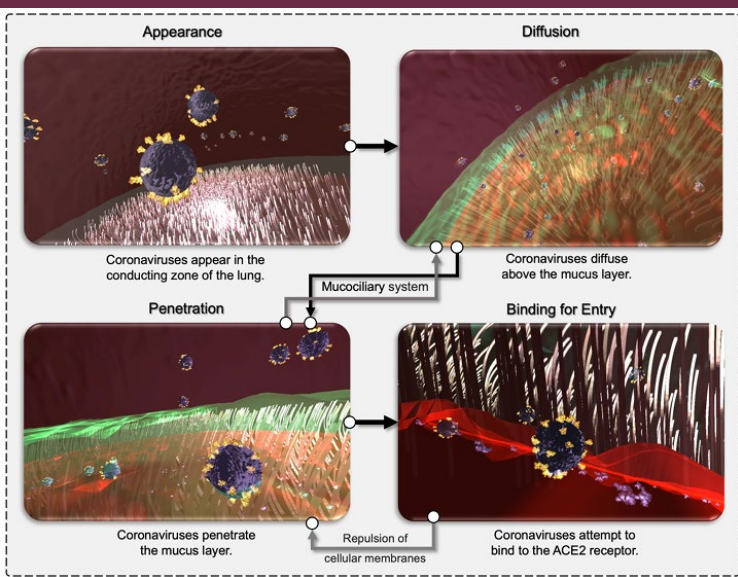Audiovisual Demo:
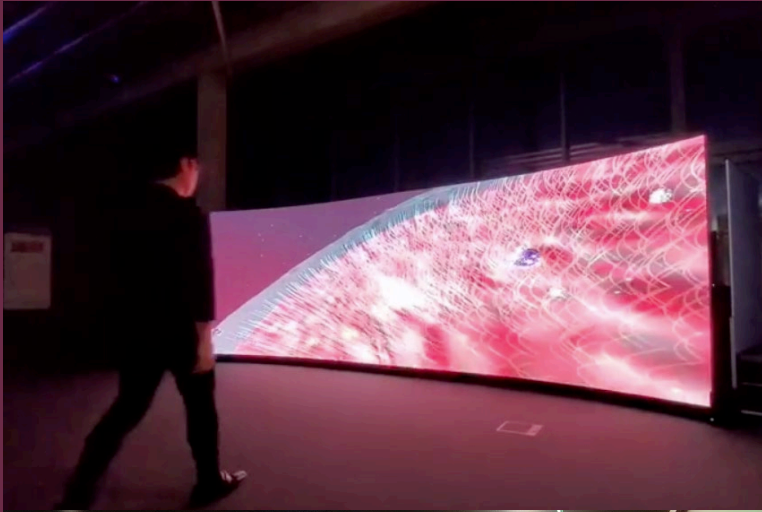https://www.myunginlee.com/covid

Footage

- Ars Electronica Festival, Linz, Austria, September 2022,
- AlloSphere, UC Santa Barbara, US, January 2023
- Santa Barbara Center for Art, Science and Technology (SBCAST), US, February 2023
- IEEE VISAP, Melbourne, Australia, October 2023

Appearance — Coronaviruses appear in the conducting zone of the lung.

Diffusion — Coronaviruses diffuse above the mucus layer.

Mucociliary system

Penetration — Coronaviruses penetrate the mucus layer.

Repulsion of cellular membranes

Binding for Entry — Coronaviruses attempt to bind to the ACE2 receptor.

Coherent Digital Multimodal Instrument Design and the Evaluation of Crossmodal Correspondence

- UC Santa Barbara Ph.D. Dissertation (September 2023)
- Invited Talks:
  IRCAM Forum (November 2024), Seoul National University (July 2023) ,
  Ewha Womans University (July 2023), University of Maryland College Park (April 2023)

Figure 4.2: Examples of successful gestural detection of the instrumentalists from videos
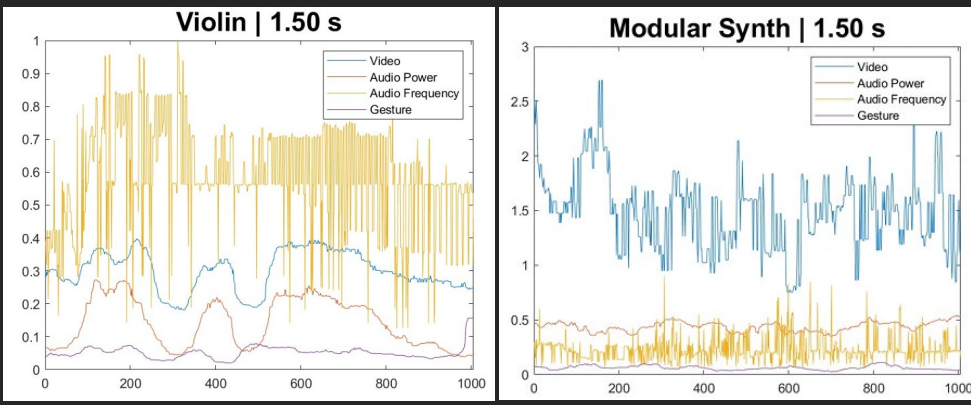
Multimodal analysis of experiencing different instruments:
While violin shows high correlation between video, gesture, and audio,
modular synth performance shows low correlation.

Abstract

The rapid development of the current availability of advanced hardware and software is opening up new opportunities for digital creation every day. This situation provides great freedom for new artistic expressions with advanced audio, graphics, interface, and algorithms, including machine learning. However, while our nature is multimodal, these modalities in the digital domain are genuinely separate, and the computational platform allows innumerable varieties of linkages among them. For this reason, the holistic multimodal experience is highly dependent on the design and connection of different modalities. This dissertation explains the properties of coherent digital multimodal instruments and discusses their creative opportunity from the process of music composition and performance. The chapters introduce the related projects with their design process, demonstrating the role of crossmodal correspondence in scientific simulation and proposing a numerical method to evaluate the crossmodal correspondences using the correlation coefficient between the modalities. This dissertation aims to contribute to reorganizing the design process of multimodal instruments beyond the old and recent customs.

"We do art when we communicate through forms whose connections are not accessible to the conscious mind yet we intuitively recognize them as something meaningful."
- Albert Einstein

Likewise, this series of research states that digital art created from coherent multimodal instruments can be a language that brings a group of people together with various expertise to create, share, and understand a novel experience.
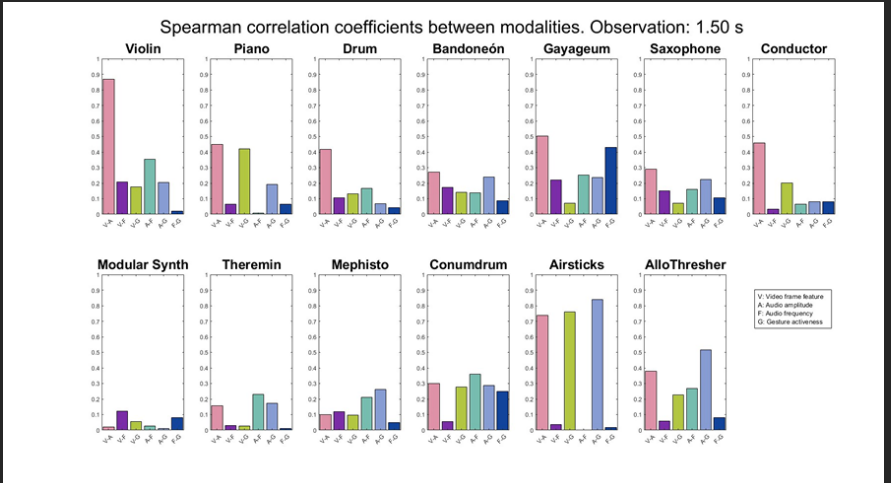

Figure 4.6: Spearman correlation coefficients between modalities with long observation time. V: video inter-frame, A: audio (amplitude), F: audio (pitch), G: Gesture

AlloThresher (2024)
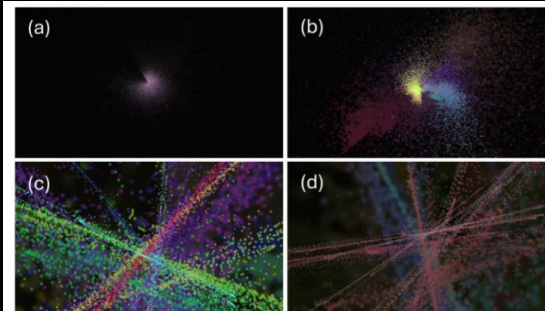
|International Computer Music Conference (ICMC), 2024.
 Paper + Performance
|ACM SIGGRAPH DAC SPARKS, December 2022.

Multimodal Interactive Granular Synthesis

- Paper: Myungin Lee, Jongwoo Yim, "AlloThresher: Multimodal Granular Synthesizer," International Computer Music Conference (ICMC), July 2024.
https://www.researchgate.net/publication/382330556_AlloThresher_Multimodal_Granular_Synthesizer

Figure 1. Schematic of AlloThresher instrument

Figure 3. Exemplary graphics of AlloThresher (a) Small actuation with single granular source (b) Moderate actuation with multiple sources, (c) Dynamic actuation, (d) Actuation with high reverberation
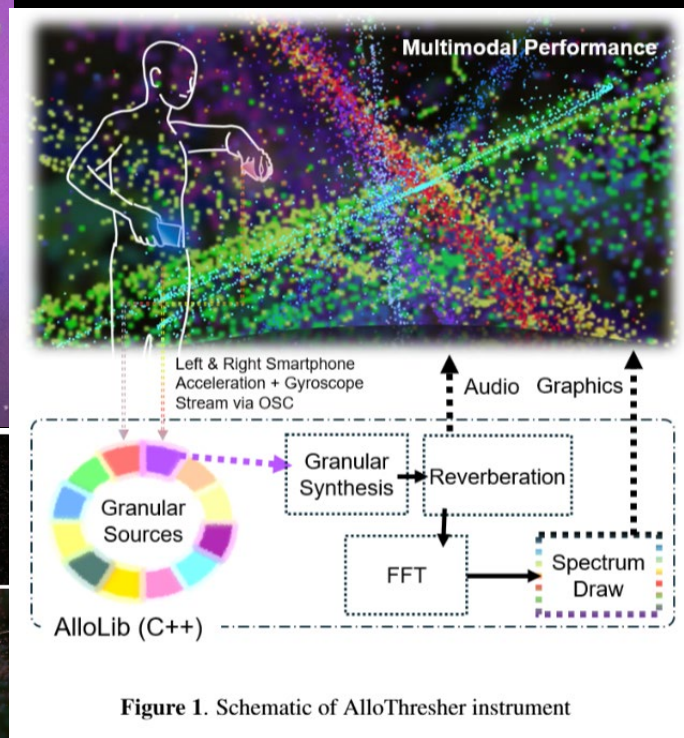
AlloThresher is a multimodal instrument with audiovisual granular synthesis using the gestural interface.

Granular synthesis is a sound synthesis method that creates complex tones by combining and mixing the simple micro-sonic elements called grains. With two smartphones in both hands, the gestural interface interpreted from the sensors enables you to precisely and intuitively decide and play the parameter of the granular synthesis in real-time. Graphically, the corresponding visuals are generated simultaneously for each granule based on the spectrogram of the sound that morphs and blends dynamically with the gesture. By breaking conventional interfaces like knobs and sliders, this seamless connection between modalities utilizes the profound advantage of the gestural interface. Moreover, the presence and gesture become part of the space and the performance so that the audience can observe and cohesively connect the audio, visual, and interface simultaneously. While some modern digital media arts focus on the novelty of a specific technology in a single domain, this presentation and instrument suggest there are unique and creative opportunities when the multimodal digital instruments are designed cohesively over the different modalities.

This work is a collaborative work with Prof. Jongwoo Yim in Seoul National University.

-Video Available at https://www.myunginlee.com/allothresher

AlloLib Playground & Selected Series (2018-2022)

Interactive Audiovisual Development Platform

| AlloSphere & AlloPortal, UC Santa Barbara, USA
| CREATE ENSENBLE, Laptop orchestra performance,

The Center for Research in Electronic Art Technology (CREATE), UC Santa Barbara, USA

Role in the Project:
Core development of general-purpose audiovisual instruments using C++
for artist creation and education dealing with graphic rendering, sound
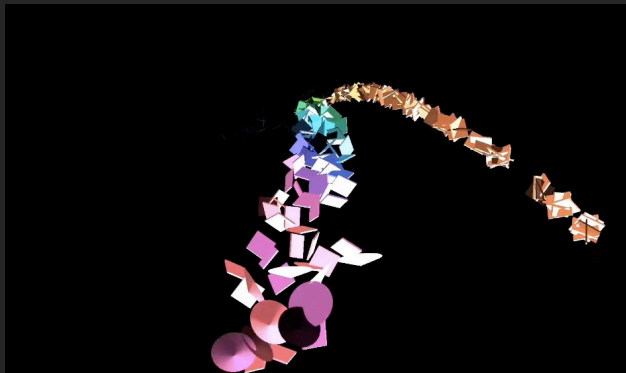sonification, interactivity, and simulation.

Footage of the Exemplary Works

Audiovisual Bach Sonata No. 1 In B Minor BWV 1014

CREATE ENSENBLE Laptop Orchestra
Audiovisual Performance

Dynamic Generative Audiovisual

Network Music Jam with
Professor Chris Chafe's group in Stanford
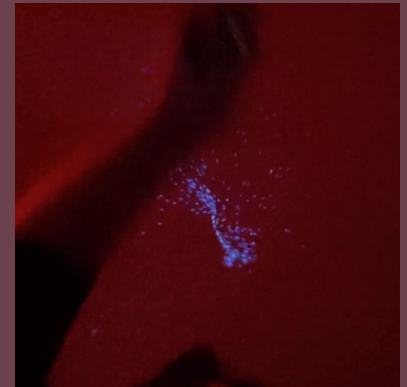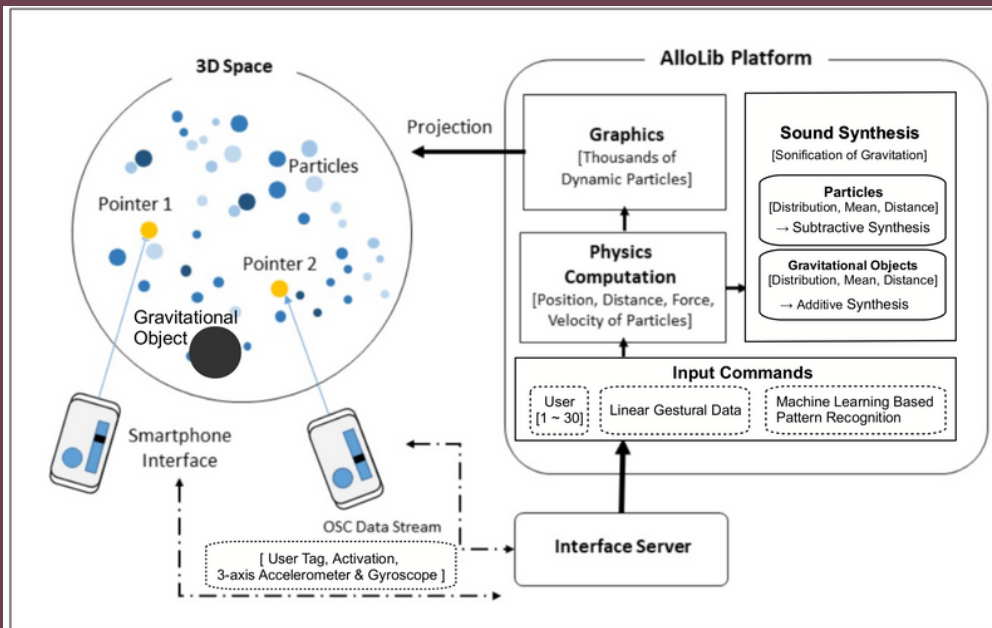

Multimodal Interactive Granular Synthesis

Audiovisual Demo available:
https://www.myunginlee.com/music-activity

Entangled (2021)

A Multi-Modal, Multi-User Interactive Instrument in Virtual 3D Space Using the Smartphone for Gesture Control

| New Interfaces for Musical Expression (NIME'21)

Snapshoots of the performance
The environment is designed for a dark 3D XR space (AlloSphere, AlloPortal)

Entangled, a multi-modal instrument in virtual 3D space with sound, graphics, and the smartphone-based gestural interface for multi-user is introduced. Within the same network, the players can use their smartphone as the controller by entering a specific URL into their smartphone's browser. After joining the network, by actuating the smartphone's accelerometer, the players apply gravitational force to a swarm of particles in the virtual space.

Machine learning-based gesture pattern recognition is parallelly used to increase the functionality of the gestural command. Through this interface, the player can achieve intuitive control of gravitation in virtual reality (VR) space. The gravitation becomes the medium of the system involving physics, graphics, and sonification which composes a multimodal compositional language with cross-modal correspondence.

Entangled is built on AlloLib, which is a cross-platform suite of C++ components for building interactive multimedia tools and applications.

Audiovisual Demo available:
https://www.myunginlee.com/entangled

Inspiration (2018)

Deep neural network-based music source conducting system
| International Computer Music Conference (ICMC), 2018

"What if we can conduct the music that we are hearing?"

Reproduction of music signals based on the interpretation of music & gestures

Developed and performed a machine learning-based real-time music signal interpretation and reproduction using musical gestures derived from the cell phone.
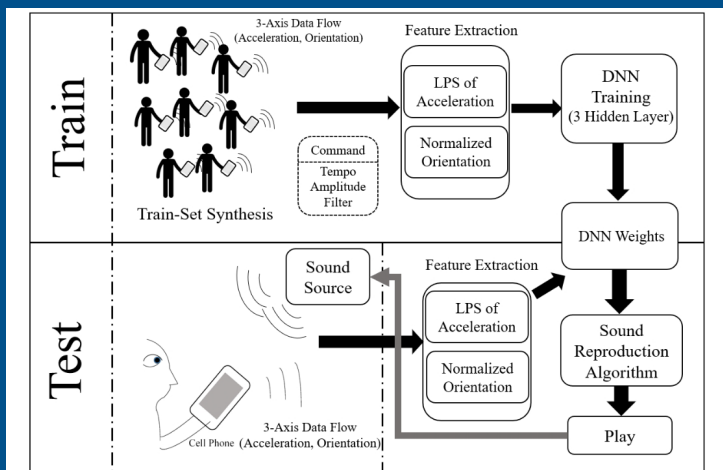
Figure 1. The structure of the proposed DNN based music source conducting system.

Conducting is one of the most exquisitely developed connections between music and gestural activity.

I proposed a system that can interact with music sources using a gyroscope and accelerometer-based controller inspired by conducting activity.

The system gives interactive and intuitive musical experiences to the user with the existing music source using a smartphone with the sensors. By using a deep neural network (DNN), the algorithm simultaneously derives the temporal, amplitude, and frequency response from the input data.

While conventional studies on the analysis of conducting gesture have a limitation with modeling complex model, the proposed system classifies various messages with high accuracy.

Audiovisual Demo available:
https://www.myunginlee.com/music-source-conducting-system
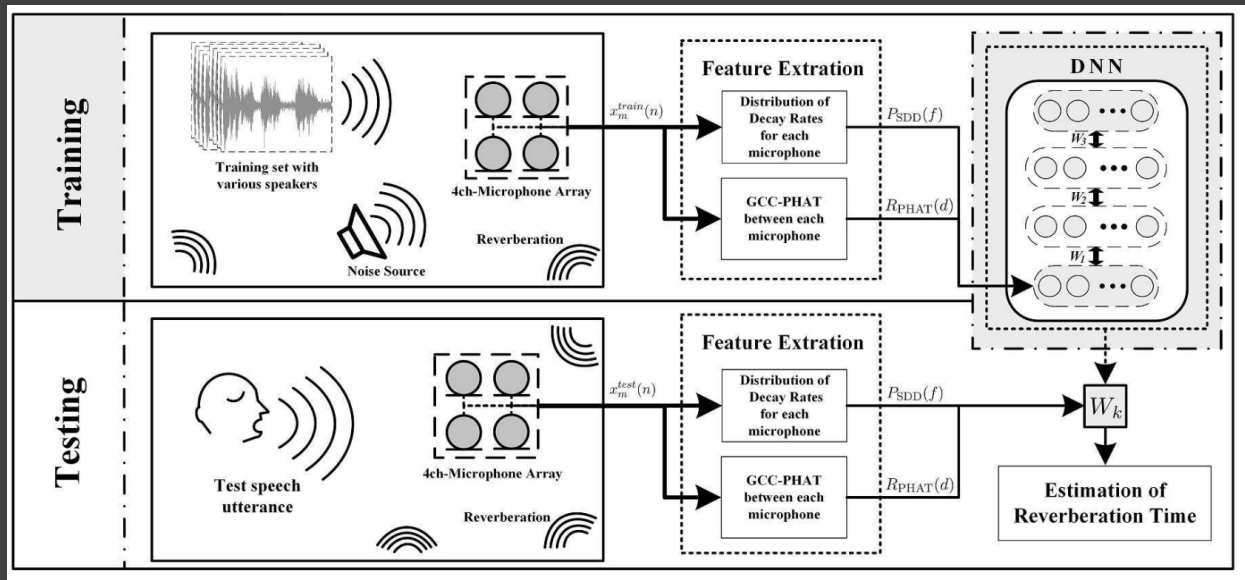
Demonstration and presentation on the research in ICMC 2018

Blind Reverberation Time Estimation (2015-2017)

Machine learning-based room acoustic information from sound sources received by microphones.

Proposed blind reverberation time estimation using deep neural networks (DNN) using multi-channel microphone

Reverberation causes a performance degradation in distinct speech processing. For this reason, quantitatively estimating the amount of reverberation from the signal received by the microphone has been an important task for characterizing room acoustics and compensating for degradation due to an algorithm.

In this research, a novel method that estimates the reverberation time (T60) based on multi-channel microphones using a deep neural network (DNN) is proposed.

Each channel's distribution of the decay rates for each frequency and the generalized cross-correlation with phase transform (GCC-PHAT) between the microphones are adopted as the input feature vectors for DNN training.

Those refined features enable the DNN composed of multiple nonlinear hidden layers to learn the nonlinear relationship that labels the reverberation time from the input features, which is known to be challenging with low-order features.

The proposed algorithm is evaluated with extensive noisy conditions, and the results show the advantage of employing multi-channel signals with spatial features when compared with conventional methods.
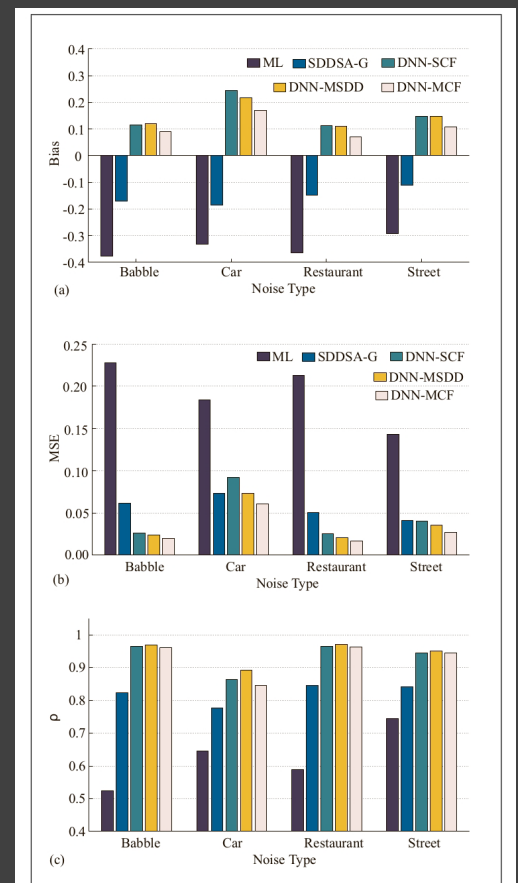

Figure 4. T_{60} estimation algorithm performance in various noise environments for all SNRs: (a) bias (b) MSE, and (c) ρ.

Webpage with the Paper Access:
https://www.myunginlee.com/reverberation-time-estimation

FractalBrain (2024)

A Neuro-interactive Virtual Reality Experience using EEG for Mindfulness
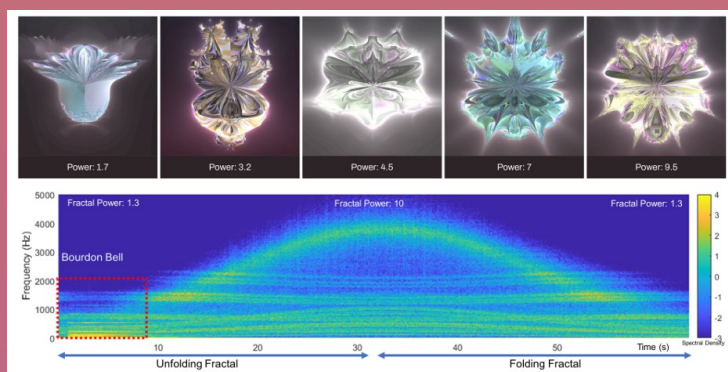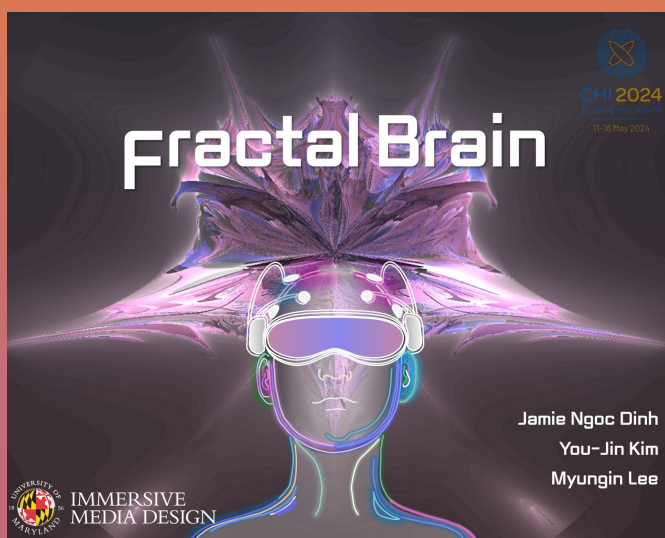

Fig. 3. Exemplary visual instances with various fractal parameters (up) and audio spectrogram of FractalBrain's phrase: unfolding and folding structure over time (down)

Mindfulness has been studied and practiced in enhancing psychological well-being while reducing neuroticism and psychopathological indicators. However, practicing mindfulness with continuous attention is challenging, especially for beginners. In the proposed system, FractalBrain, we utilize an interactive audiovisual fractal with a geometric repetitive pattern that has been demonstrated to induce meditative effects. FractalBrain presents an experience combining a surreal virtual reality (VR) program with an electroencephalogram (EEG) interface. While viewing an ever-changing fractal-inspired artwork in an immersive environment, the user's EEG stream is analyzed and mapped into VR. These EEG data adaptively manipulates the audiovisual parameters in real-time, generating a distinct experience for each user. The pilot feedback suggests video potential of the FractalBrain to facilitate mindfulness and enhance attention.

SELECTED STUDENTS' PROJECTS (2023-2024)

IMMERSIVE MEDIA DESIGN

In IMD, over 50 projects by my students have been presented regularly as public exhibitions.
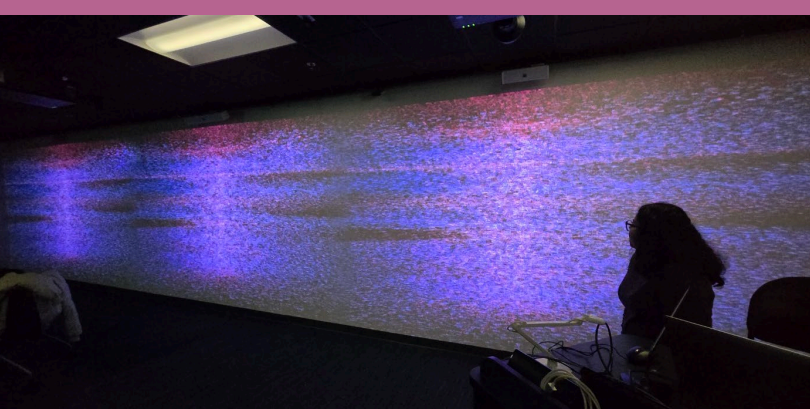

Linear Algebra in Augmented Reality

Ananya Srinivasan (CS)

Dream of Manta Ray (Gestural interaction)

Noah Bissell (IMD & Art)
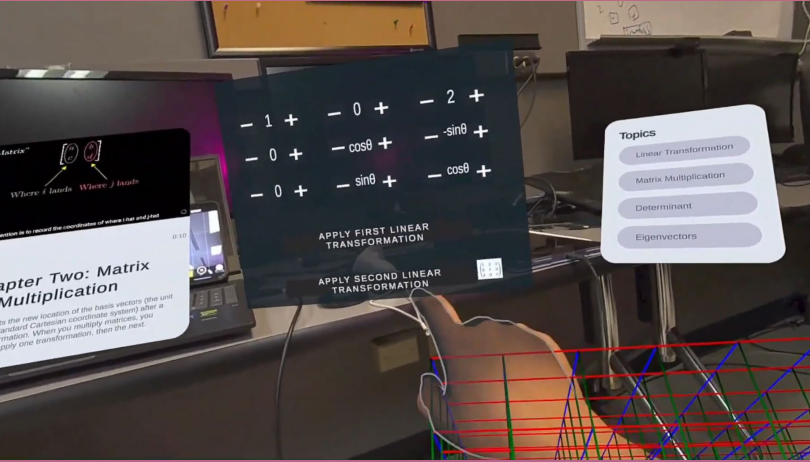
Voice of Silence (data visualization)

Maria Pacheco (IMD & CS)

Dental VR Simulation (Voice-LLM) Aiden Hu (CS)
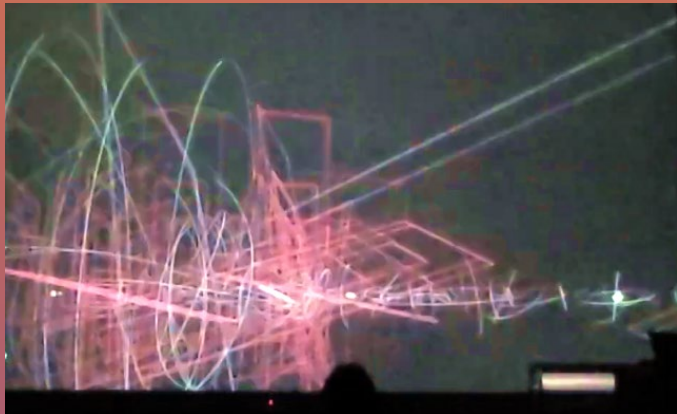
SELECTED STUDENTS' PROJECTS
AlloLib Audiovisual Concerts (2022)
| MAT 276IA, MUS 109IA, MUS 209IA
: Direct Digital Synthesis - Processing and Composition

Graduate Students

Instructor: Myungin Lee
(Spring 2022, Fall 2022)

MAT 276IA, MUS 109IA, and MUS 209IA are undergraduate and graduate-level combined courses for real-time audiovisual composition.
Using C++-based AlloLib, students extend their own creativity in audio, visualization, composition, programming, and interactivity.
Their final works are performed as an immersive audiovisual concerts and exhibitions

"Vibrato" - Sabina Hyoju Ahn
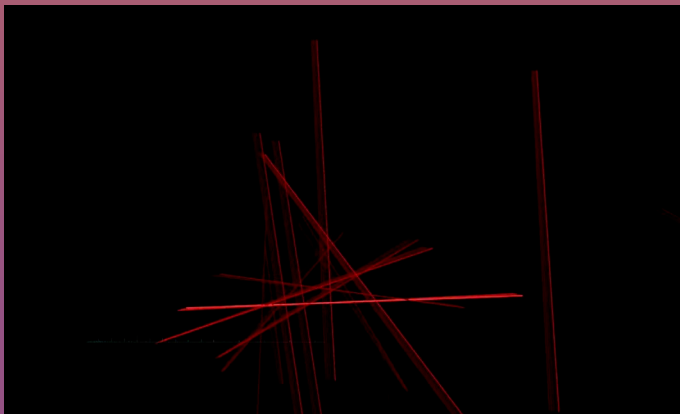
"Congestion" - Deniz Çağlarcan

"Strings" - Jack Kilgore

"Unfolding Dimensions" - Pau Roselló Diaz

"Sitting on A Swing at the Event Horizon" - Yifeng Yvonne Yuan

Class materials including the concert & catalog:
https://www.myunginlee.com/teaching

SELECTED STUDENTS' PROJECTS
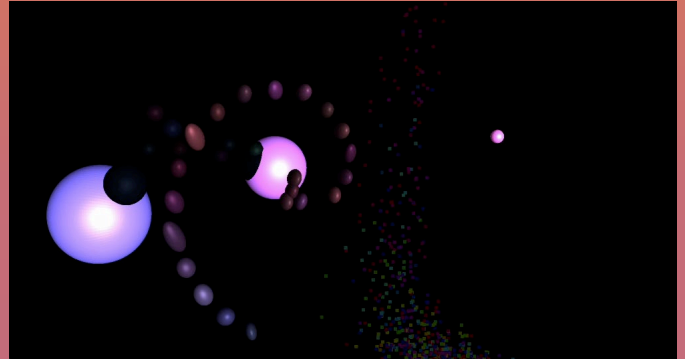**AlloLib Audiovisual Concerts (2022)**
| MAT 276IA, MUS 109IA, MUS 209IA
 : Direct Digital Synthesis - Processing and Composition
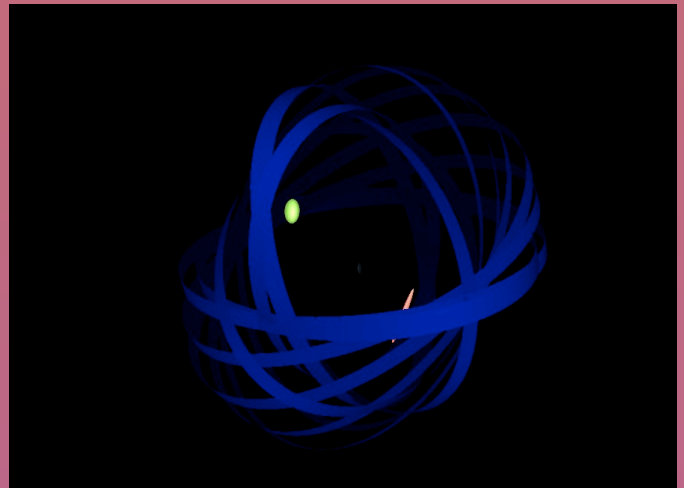
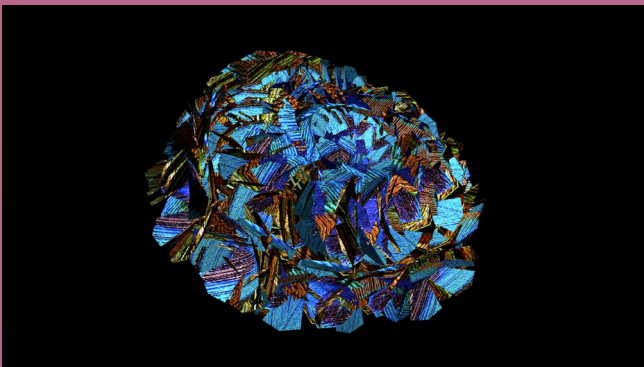**Undergraduate Students**

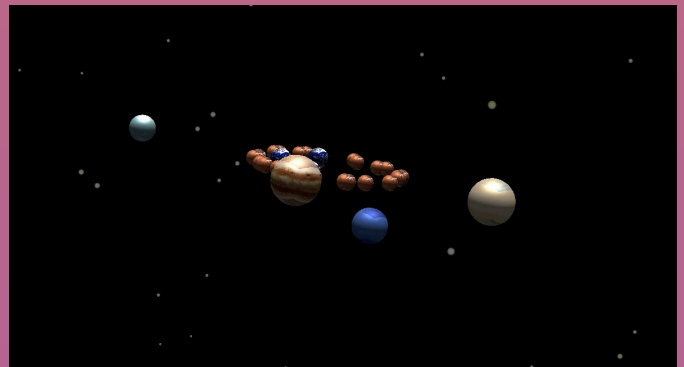*"Alien March"* - Brandon Nadell

"Space" - Selina Liu

"Meshed" - Tommy Crahan

"Imprisoned Devotion" - Laila Roshan

"Bloom" - Tal Halperin

"Planetary Emissions" - Henry Jurney

Class materials including the concert & catalog:
https://www.myunginlee.com/teaching

End of the Portfolio

Please understand the projects on the review are not listed.
If you would like to know more about the details,
please send me an email to myungin@umd.edu

Myungin Lee (Ph.D.)
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University of Maryland-College Park
www.myunginlee.com

LinkedIn   Google Scholar   GitHub