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School of Arts, Design  
and Architecture

# Designing Virtual Worlds

## Storytelling with VR Sound

*Prof. Sebastian J. Schlecht*

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School of Electrical  
Engineering

# Learning Goals

**After this section, you can recognize fundamentals in**

- **Spatial Sound in VR**
- **Narrative Roles of Sound in VR**
- **Sonic Interactivity**

# Disclaimer

- **Narrow definition of VR**
- **HMD + Headphones + Controller/  
Handtracking**
- **Own productions or commercially  
available experiences**

**Mostly this =>**





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# Sound in Storytelling

# Sound in VR - What is your expectation?

- Is VR more like cinema or more like game?

Physics or  
Artistic Control?

e.g., Oculus' View

100% Acoustic  
Accuracy

100% Control



<https://www.oculus.com/story-studio/blog/binaural-audio-for-narrative-vr/>

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# Spatial Sound

# Spatial Audio in VR

## Overview



### Headlocked

- Non-diegetic
- Ambient Music



### Ambisonics

- Diegetic
- Environment  
Ambience
- 360 video

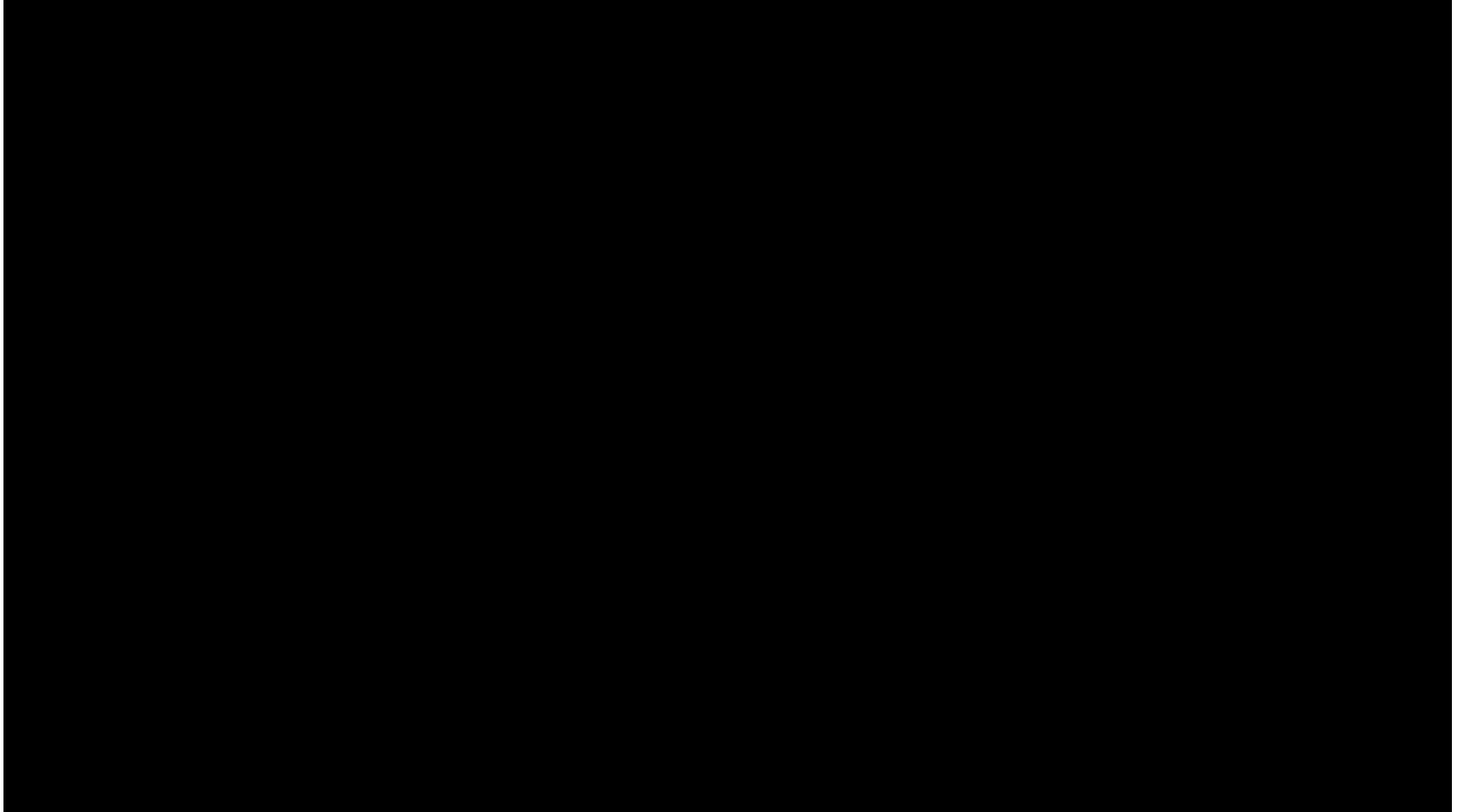


### Sound Objects

- Diegetic
- Localized
- Interactive

# Inside the Quartet

360 Video + 3D models





# Audio in VR

## Inside the Quartet



- **Voice-over**
- **Own Instrument (Special Case)**



- **Field Recording**



- **Music Performance**

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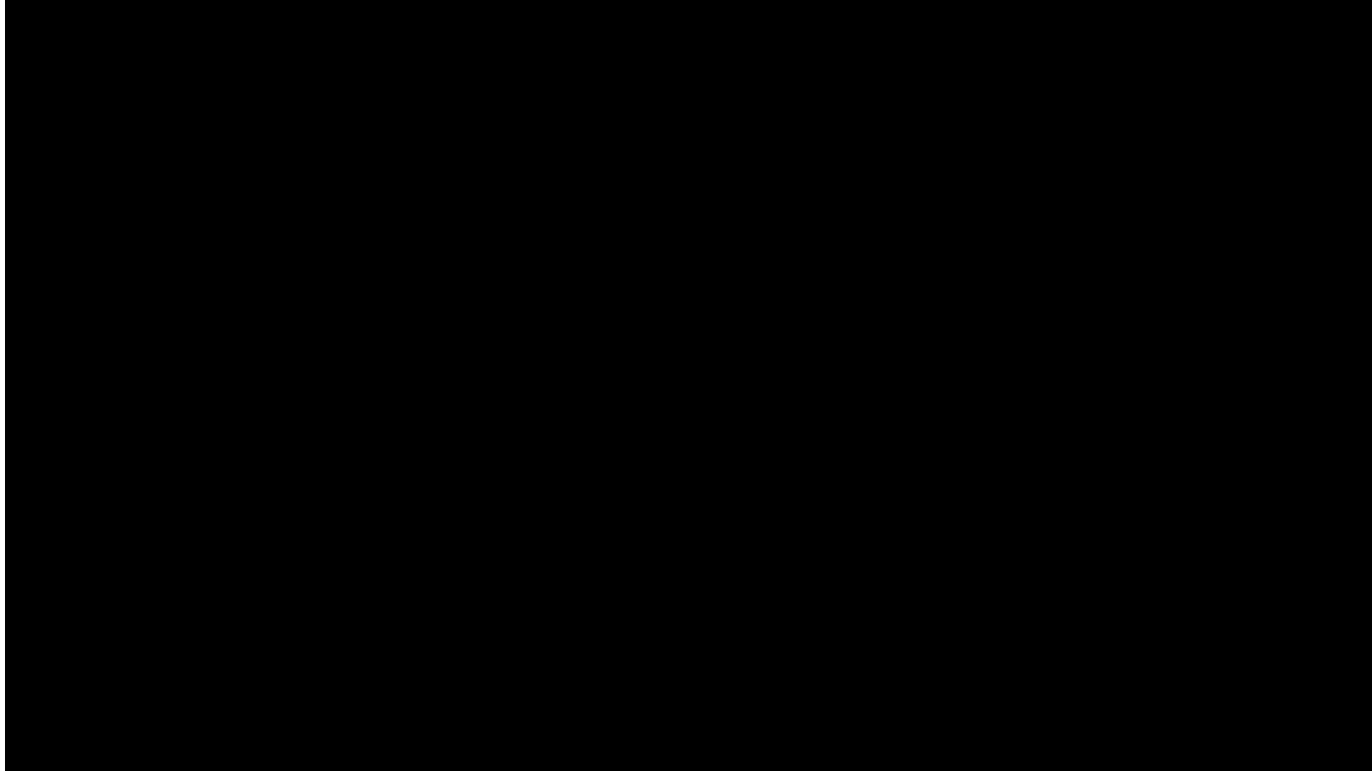
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# Narration



# Sonic Environment

## Example Notes on Blindness



Notes on Blindness: Into Darkness VR experience teaser trailer  
<https://www.youtube.com/watch?v=9ViF0GBt6fQ>

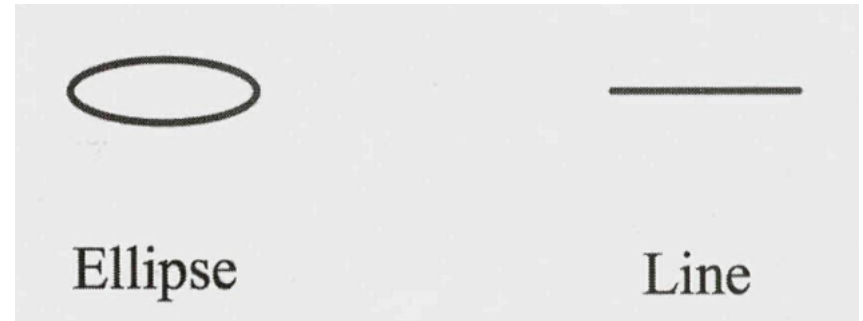
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# Invisible World

Can you hear the difference between hot and cold water?

We learn about the world through sound

- Weight / Viscosity / Stiffness
- Speed / Timing
- Emotions / Health
- Atmosphere / Community



- You Can Hear The Difference Between Hot and Cold Water  
[https://www.youtube.com/watch?v=Ri\\_4dDvcZeM](https://www.youtube.com/watch?v=Ri_4dDvcZeM)  
- Thoret, E., Aramaki, M., Kronland-Martinet, R., Velay, J.-L. & Ystad, S. From Sound to Shape: Auditory Perception of Drawing Movements. J Exp Psychology Hum Percept Perform 40, 983–994 (2014).

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# Emotions of sound

## Affective Foley

- **Angry**
- **Fear**
- **Happy**
- **Sad**

# Cross Modal Interactions

## Example Parchment-skin illusion

Rub your hands together and hear a soft sound,  
and your skin feels soft

1. Jousmäki, V. & Hari, R. Parchment-skin illusion: sound-biased touch. *Curr Biol* 8, R190–R191 (1998).

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# Binaural Proximity



Virtual Barber  
Shop

Virtual Barber Shop  
<https://www.youtube.com/watch?v=IUDTlvagjJA>

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# Attention Guidance

## Example Allumette

- **Audio gives 360 awareness**
- **Suggests where to look**



Allumette by Penrose Studio  
[https://www.oculus.com/experiences/rift/  
926273867499264/](https://www.oculus.com/experiences/rift/926273867499264/)

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# Sound of Space

Every building or space has its characteristic sound of intimacy or monumentality, invitation or rejection, hospitality or hostility.

— Juhani Pallasmaa, 2005  
The Eyes of the Skin



the Wikidrummer

<https://www.youtube.com/watch?v=mY-f68J5PPo>

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# Sonic Interactivity

# The Swayze Effect

## PRESENCE Without AGENCY



**For example in  
Inside the  
Quartet**

The Swayze Effect  
<https://www.oculus.com/story-studio/blog/the-swayze-effect/>

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# Level of Audio Interactivity

**Static**

**Interactive**



- **Pre-recorded**
- **Fixed Timeline**

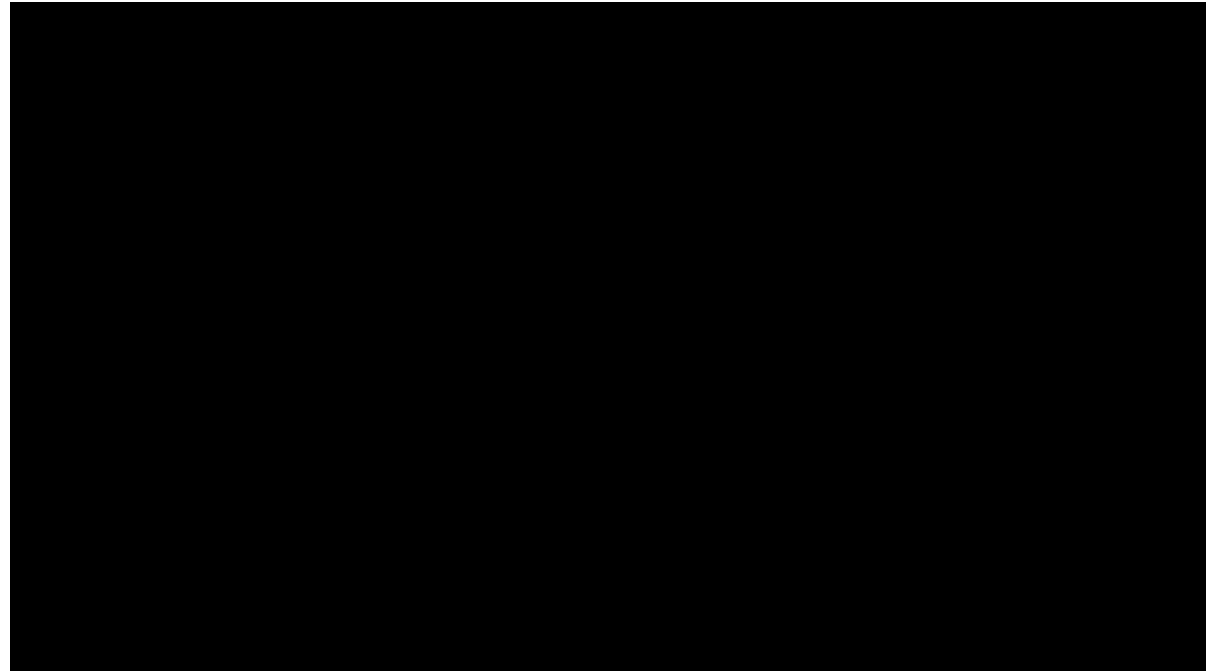
- **Triggered**
- **Sample-based**

- **Generative**
- **Physics-based**

# Space Walk

## Binauralized Sound Layers Supporting Scientific Visualizations

VISUAL LAYER	MUSICAL ELEMENT
Planet Surface	low drone
Suomi 100 Satellite	voices melody
Ionosphere	percussions (crotales)
Magnetic Field	spoken voices (whispers and space history comment)
Magnetosphere	string chords (tremolos)



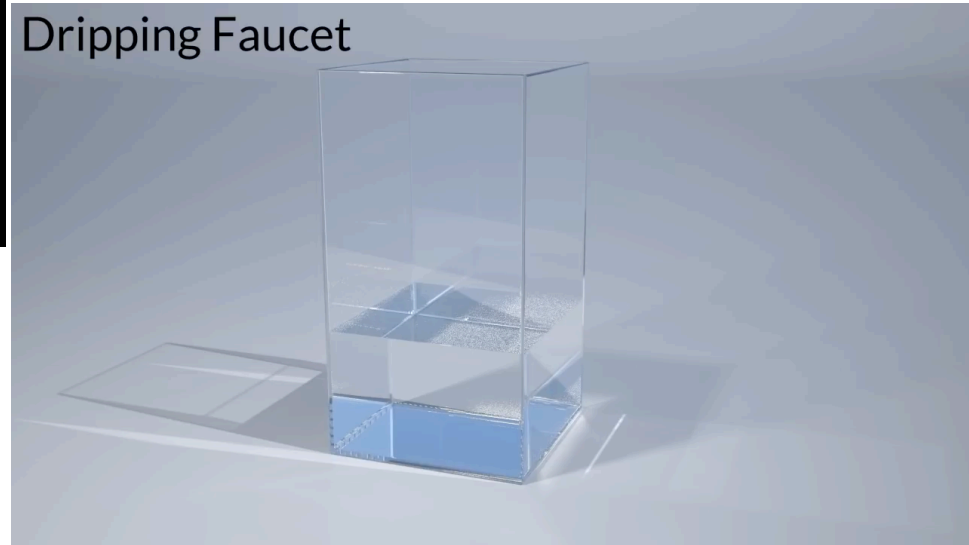
1.Mancianti, A., Schlecht, S. J., Välimäki, V., Järvinen, R. & Kallio, E. Space Walk - visiting the solar system through an immersive sonic journey in VR. in Nordic Sound and Music Conference (2021).

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# Physical Simulation

## Rube-Goldberg Contraption

### Dripping Faucet



1. Zheng, C. & James, D. L. Toward high-quality modal contact sound. *Acm T Graphic* 30, 1 (2011).
2. Langlois, T. R., Zheng, C. & James, D. L. Toward animating water with complex acoustic bubbles. *Acm Transactions Graph Tog* 35, 95 (2016).

# Room Acoustic Illusion

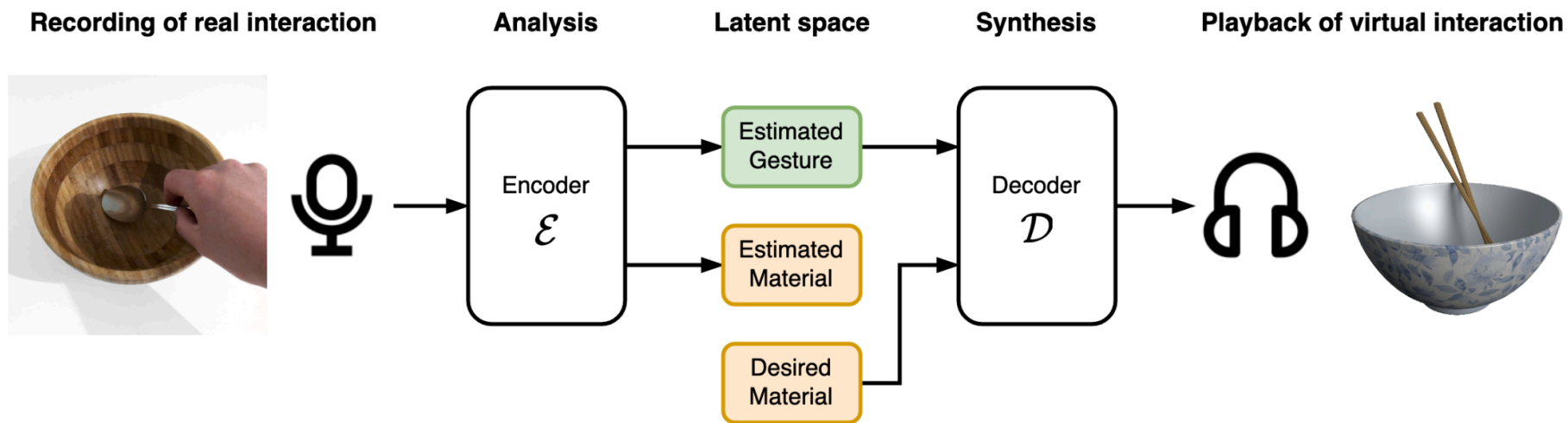


*McKenzie, T., Schlecht, S., Pulkki V. Acoustic Analysis and Dataset of Transitions between Coupled Rooms, I3DA, 2021*

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# Towards Substitute Reality

## Machine-learning based Timbre Transfer



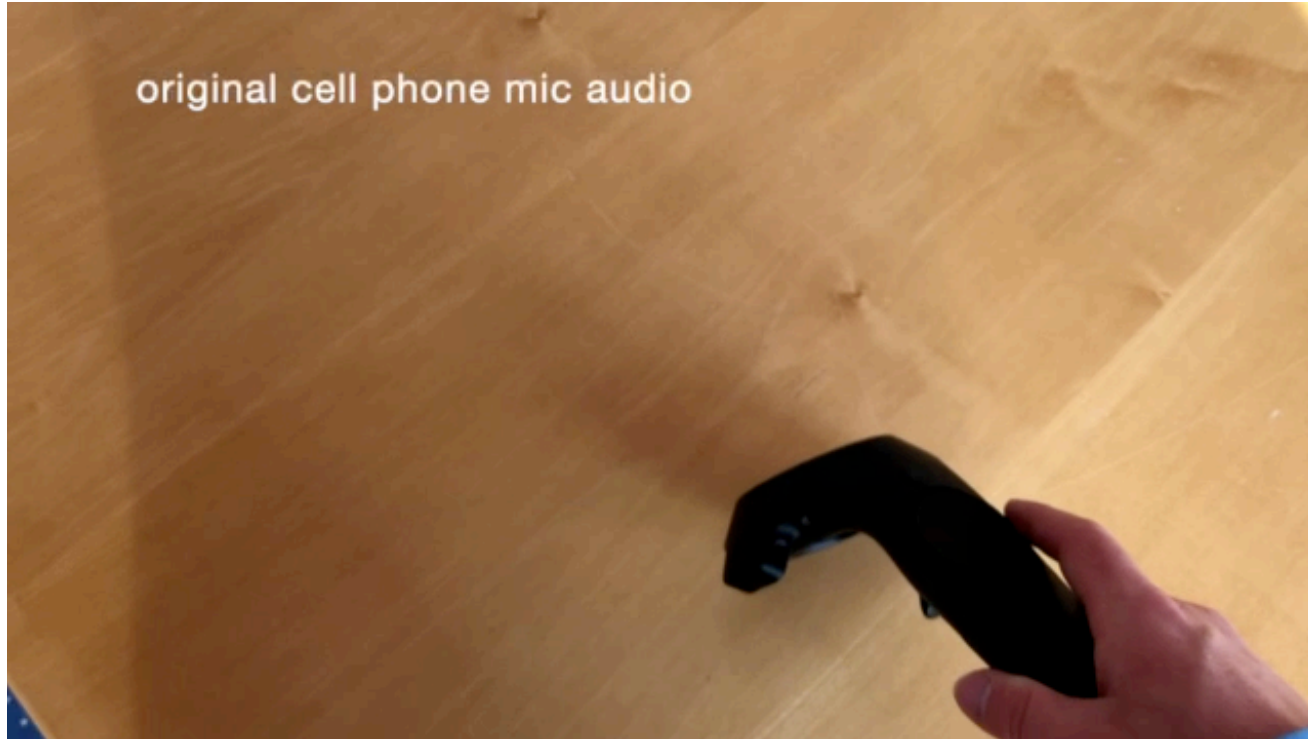
Simon Schwär, Meinard Müller, and Sebastian J. Schlecht  
A Variational Y-Autoencoder for Disentangling Gesture and Material of Interaction Sounds  
In AES 4th International Conference on Audio for Virtual and Augmented Reality (AES AVAR)

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**Comments or  
Questions?**