

Karma Gerçeklik için Ses Etkileşimleri

Cumhur Erkut, cer@create.aau.dk

Associate Professor of Sonic and Embodied Interaction
Multisensory Experience Lab, melcph.create.aau.dk



AALBORG UNIVERSITET
KØBENHAVN



İSİNMA HAREKETLERİ

Opening breath movement



Roll your arms and look back



Throw your hands to front and back



Throw both hands at the same time



Alun laaja hengitysliike.

Small balancing act



Pyöritä käsiä ja katso taakse.

Roll shoulders to front and back



Heiluta käsiä eteen ja taakse.

Roll both shoulders



Heiluta kumpaakin kättä yhtäaikaa.

Open and close



Pieni tasausliike.

Look to the left and right



Pyöritä olkapäätä eteen ja taakse.

Small balancing act



Pyöritä kumpaakin olkapäätä

Lift the ball from the ground, push sideways



Sulkeudu ja avaudu.

Bend sideways



Katso vasemmalle ja oikealle.

Roll the ball in front



Pieni tasausliike.

Small balancing act



Nosta pallo lattialta.

Draw circle with foot & hand



Taivu sivulle.

Stand on the ball of your foot and toes



Pyöritä palloa vartalon edessä.

Lift the ball, push, and drop



Pieni tasausliike.

Closing balancing act



Piirrä jalalla ja kässillä ympyrää.

Stand with the ball at hand



Seiso kantapäällä ja varpailla.

Seiso pallo käessä.

VIRTUAL REALITY AND THE SENSES

STEFANIA SERAFIN - NILS C. NILSSON - GUNHIL ERKUT - ROLF NORDHL
AUGUST 31 - 2017



Sonic Interactions in Virtual Reality:

State of the Art, Current Challenges, and Future Directions

Authors from:
Aalto University
Maastricht University
Carnegie Mellon University
Nils C. Nilsson
Indiana University
University of California, Berkeley

A high-fidelity but efficient sound simulation is an essential element of many VR experiences. Many techniques used in virtual assistants to synthesize rendering techniques are easily modified to account for sound generation and propagation. In recent years, several advances in hardware and software technologies have been facilitating the development of immersive interactive sound-rendering experiences. In this article, we present a review of the main approaches to sound rendering in VR, highlighting the most important contributions. But, as mentioned above, there are many other interesting applications. This is the topic of this article: sound simulation of sound effects and their propagation in spaces together with location rendering to simulate the position of sound sources. We present how four different elements of the sound experience provide us to have better addressed in the literature. Trying to find the trade-off between accuracy and plausibility, we also presented

In recent years, the number of VR experiences has increased. Therefore, the demand for more realistic sound experiences and better sound rendering techniques has increased. In the field of VR, it is not new, although they are always present, that sound is an undervalued modality in VR. An interactive interaction experience, sound can direct the user's attention, affecting his memory and cognitive processing. For example, sound can help to identify objects in a scene or even to detect them. Thus, the auditory sense allows users to interact with information about the environment, regardless of whether it is visual or not. It is a relatively new field of study, but it is already being developed. As far as we know, there are no studies on the relationship between sound and VR. This is the purpose of this article. It is a relatively new field of study, but it is already being developed. As far as we know, there are no studies on the relationship between sound and VR. This is the purpose of this article.

asahi
HEALTH
www.asahi.fi



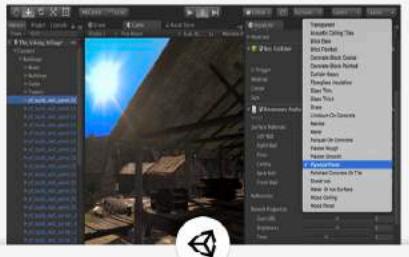
VIVE



oculus



Ya siz?



Unity

[GET STARTED](#)



Unreal

[GET STARTED](#)



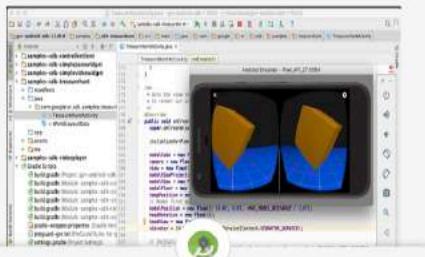
FMOD

[GET STARTED](#)



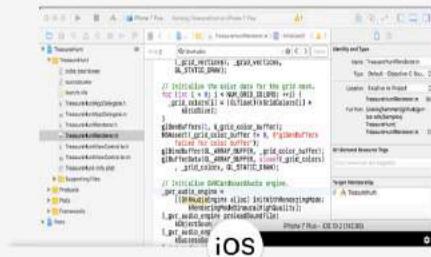
Wwise

[GET STARTED](#)



Android Studio

[GET STARTED](#)



iOS

[GET STARTED](#)



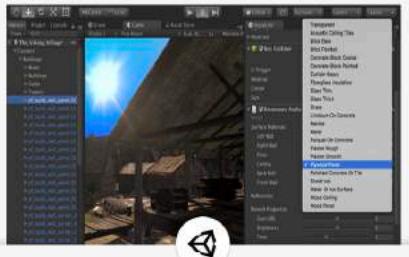
Web

[GET STARTED](#)



DAW VST plugin

[GET STARTED](#)



Unity

[GET STARTED](#)



Unreal

[GET STARTED](#)



FMOD

[GET STARTED](#)



Wwise

[GET STARTED](#)

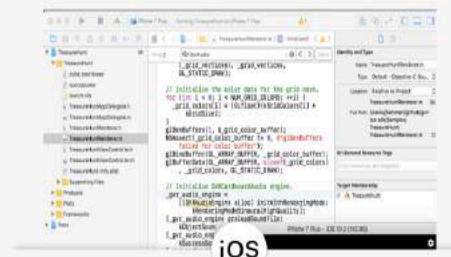
Amazon Sumerian

The fastest and easiest way to create VR, AR, and 3D experiences



Android Studio

[GET STARTED](#)



iOS

[GET STARTED](#)



Web

[GET STARTED](#)

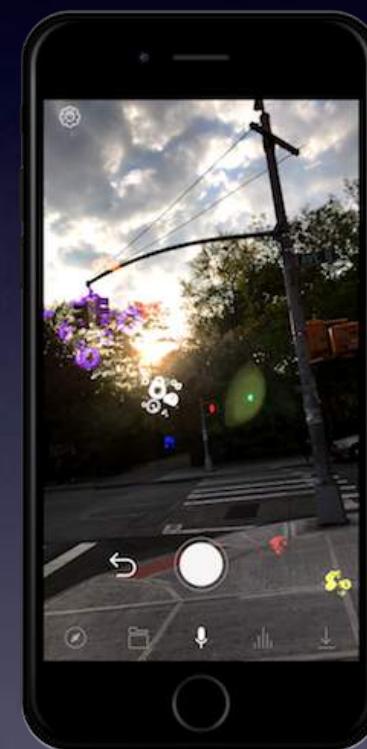


DAW VST plugin

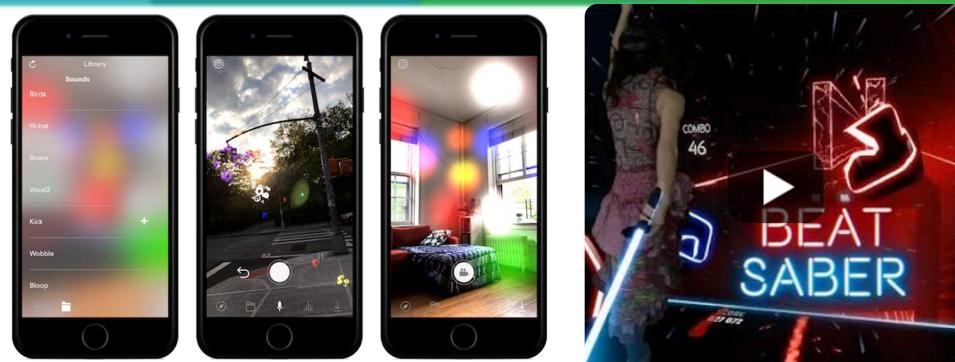
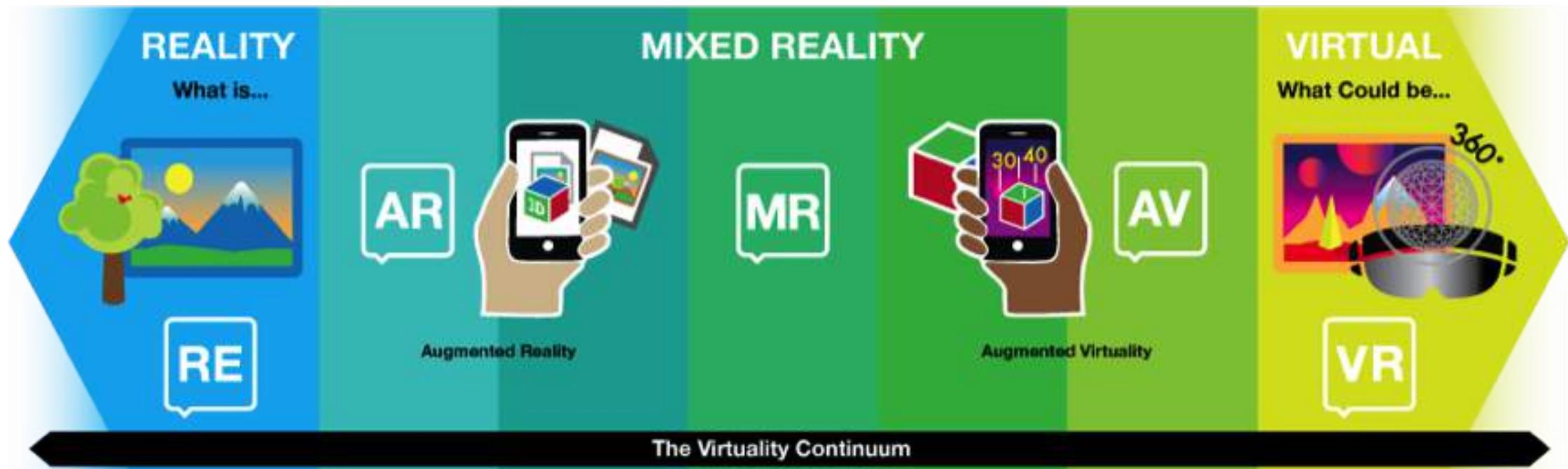
[GET STARTED](#)

Karma Gerçeklik: ilk önemli ses etkileşimleri

<https://youtu.be/ET2CKUqdPCo>



Karma Gerçeklik?



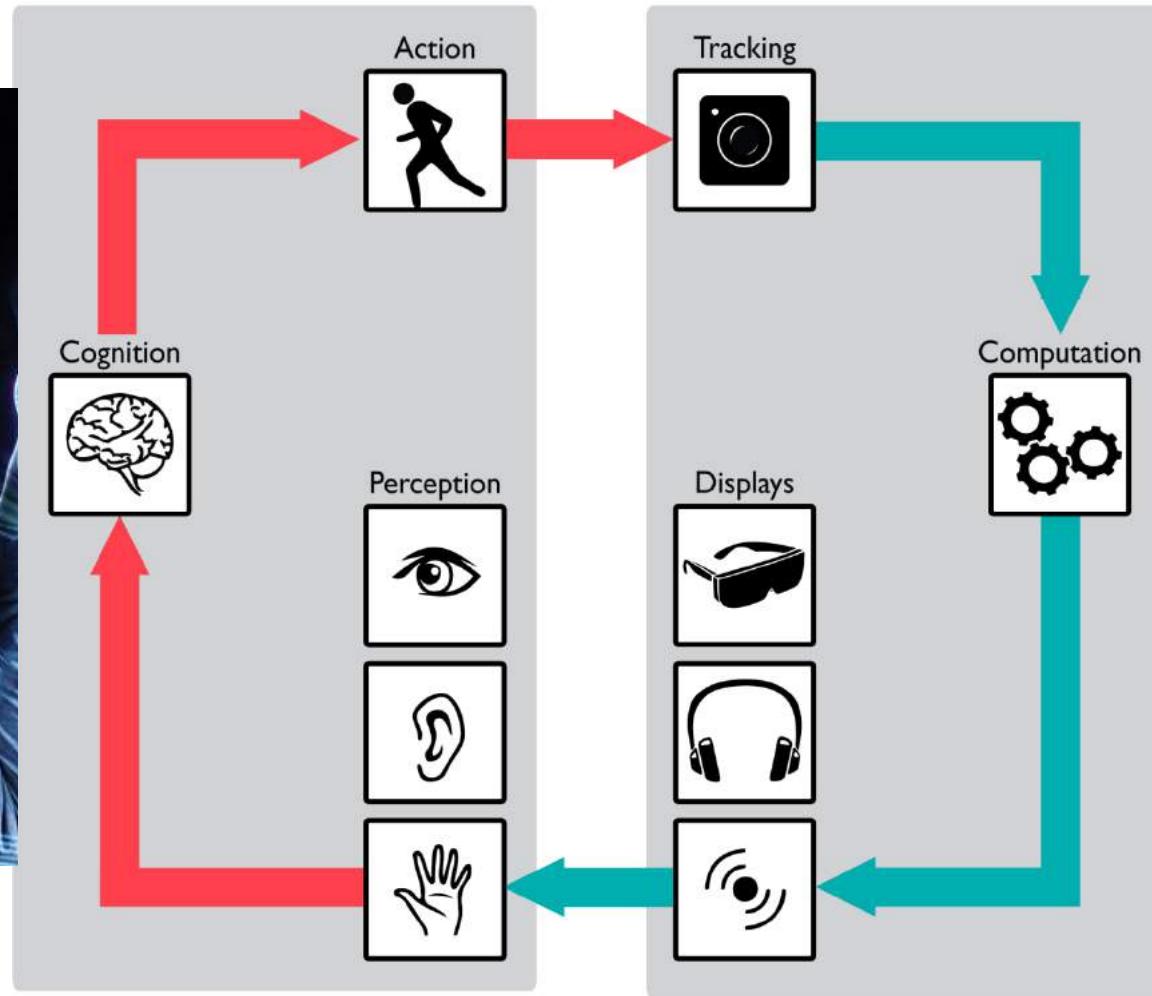
Karma Gerçeklik?



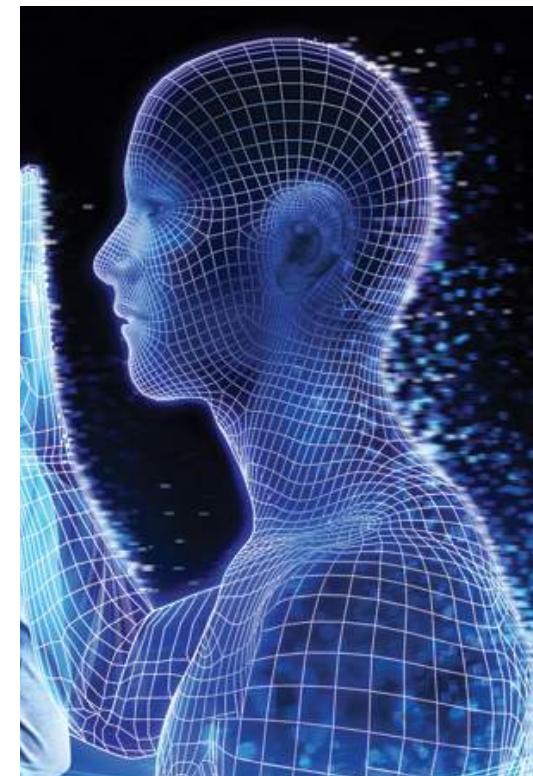
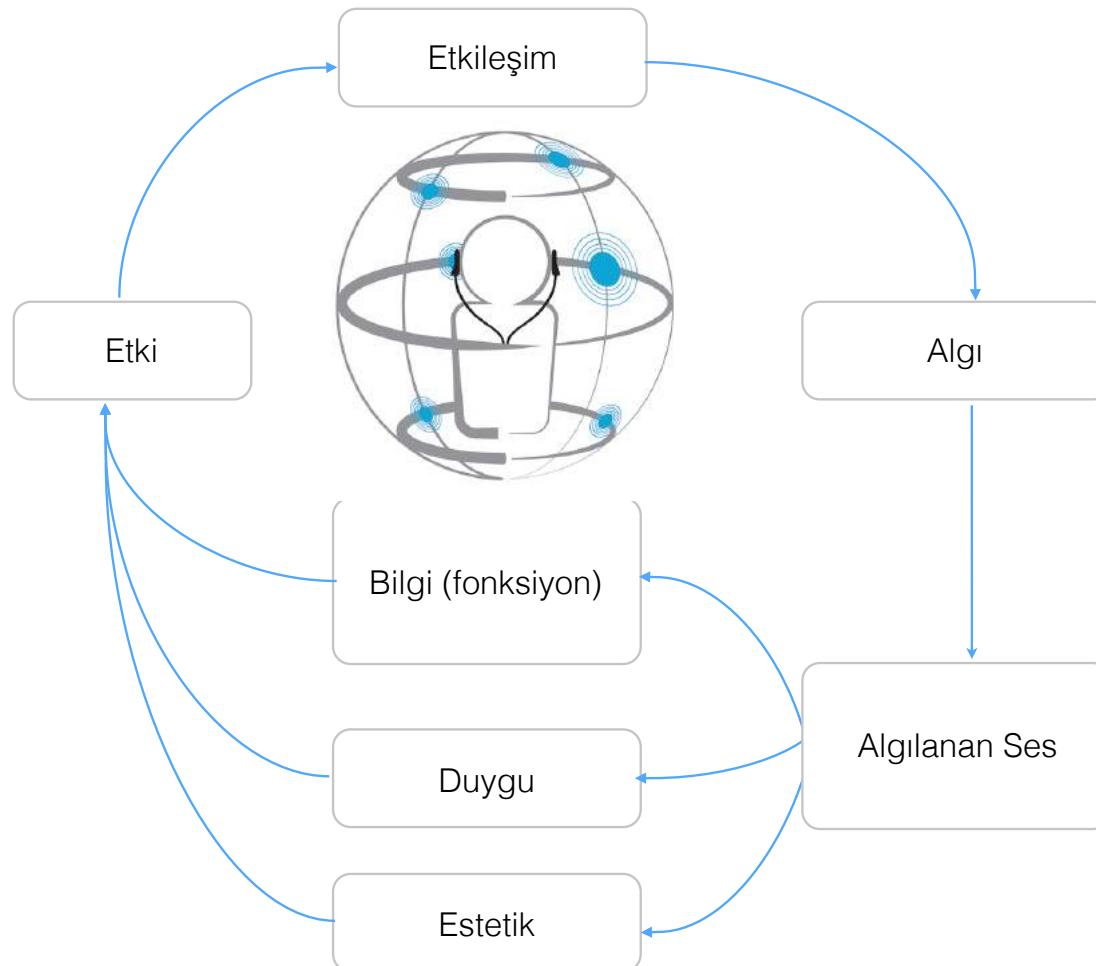
Ses Etkileşimleri?

USER

SYSTEM



Ses Etkileşimleri?



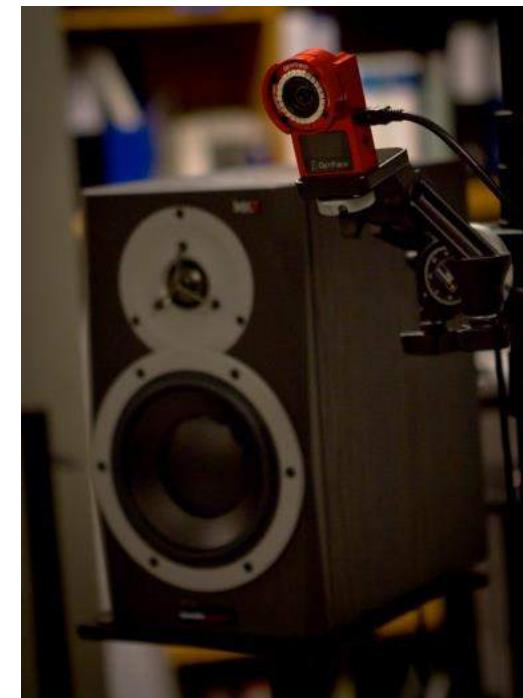
<https://melcph.create.aau.dk>

The page displays a grid of 14 portrait photos of lab members, arranged in three rows. The first row contains six photos: Stefania Serafin (Prof., lab director), Rolf Nordahl (Assoc. Prof., lab director), Cumhur Erkut (Assoc. Prof.), Jon R. Bruun-Pedersen (Asst. Prof.), Francesco Grani (Asst. Prof.), and Niels C. Nilsson (Asst. Prof.). The second row contains five photos: Michele Geronazzo (Postdoctoral researcher), Smilen Dimitrov (External lecturer), Ali Adjourlu (PhD Fellow), Lui A. Thomsen (PhD Fellow), and Vanessa Carpenter (PhD Fellow). The third row contains three photos: Emil R. Høeg (Research Assistant), Razvan Paisa (Research Assistant), and Anastasia Andreasen (Research Assistant). To the right of the grid is the MELC Ph.D. Lab logo, which features a stylized eye icon above the text "M.E.LAB". Below the grid is the Aalborg University logo, which consists of a stylized flame icon and the text "AALBORG UNIVERSITET".

Stefania Serafin Prof., lab director	Rolf Nordahl Assoc. Prof., lab director	Cumhur Erkut Assoc. Prof.	Jon R. Bruun-Pedersen Asst. Prof.	Francesco Grani Asst. Prof.	Niels C. Nilsson Asst. Prof.
Michele Geronazzo Postdoctoral researcher	Smilen Dimitrov External lecturer	Ali Adjourlu PhD Fellow	Lui A. Thomsen PhD Fellow	Vanessa Carpenter PhD Fellow	
Emil R. Høeg Research Assistant	Razvan Paisa Research Assistant	Anastasia Andreasen Research Assistant			

VR sistemleri, 64xWFS, Taban ve Topuk Haptik Araçlar





Ses Arabirimleri



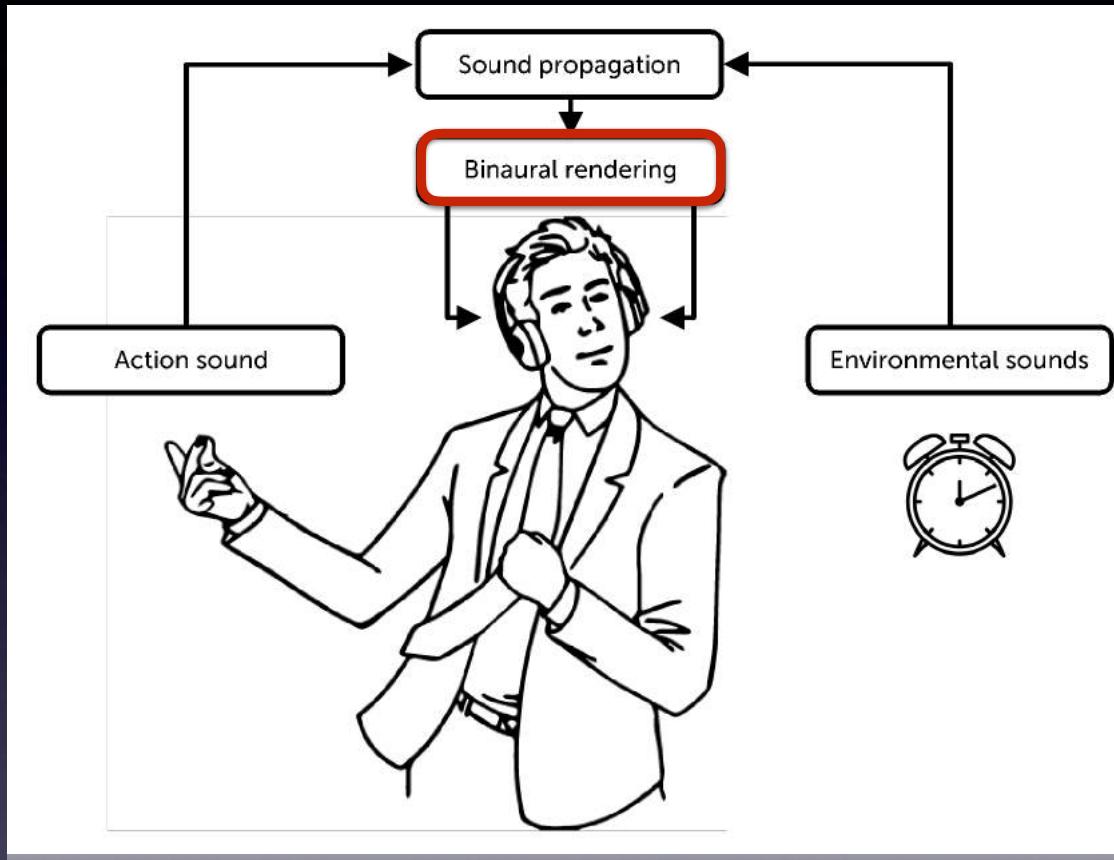
Ses Arabirimleri



Alistirma / Problem

- Download the CIPIC HRTF database & the corresponding software.
- Using CIPIC database, produce at least 16 sounds with 4 **azimuth** and 4 **elevations**. Observe the quality of the result.
- (Record the same sounds using the **dummy head** in the lab & compare)
- Create a short soundscape where 3D sound plays a meaningful role.
- **DUN:** Benzeşimler MATLAB üzerinde uygulanacak, Resonance Audio ve benzerlerine taşınmaları özetlenecek.
- **BUGUN:** Amazon Sumerian @ <https://aws.amazon.com/sumerian/> + UNITY NATIVE AUDIO Plugin SDK

Demo: <https://tinyurl.com/ybv7mzjn>



I) Giriş: kuram ve pratik

{Välimäki, 2012}

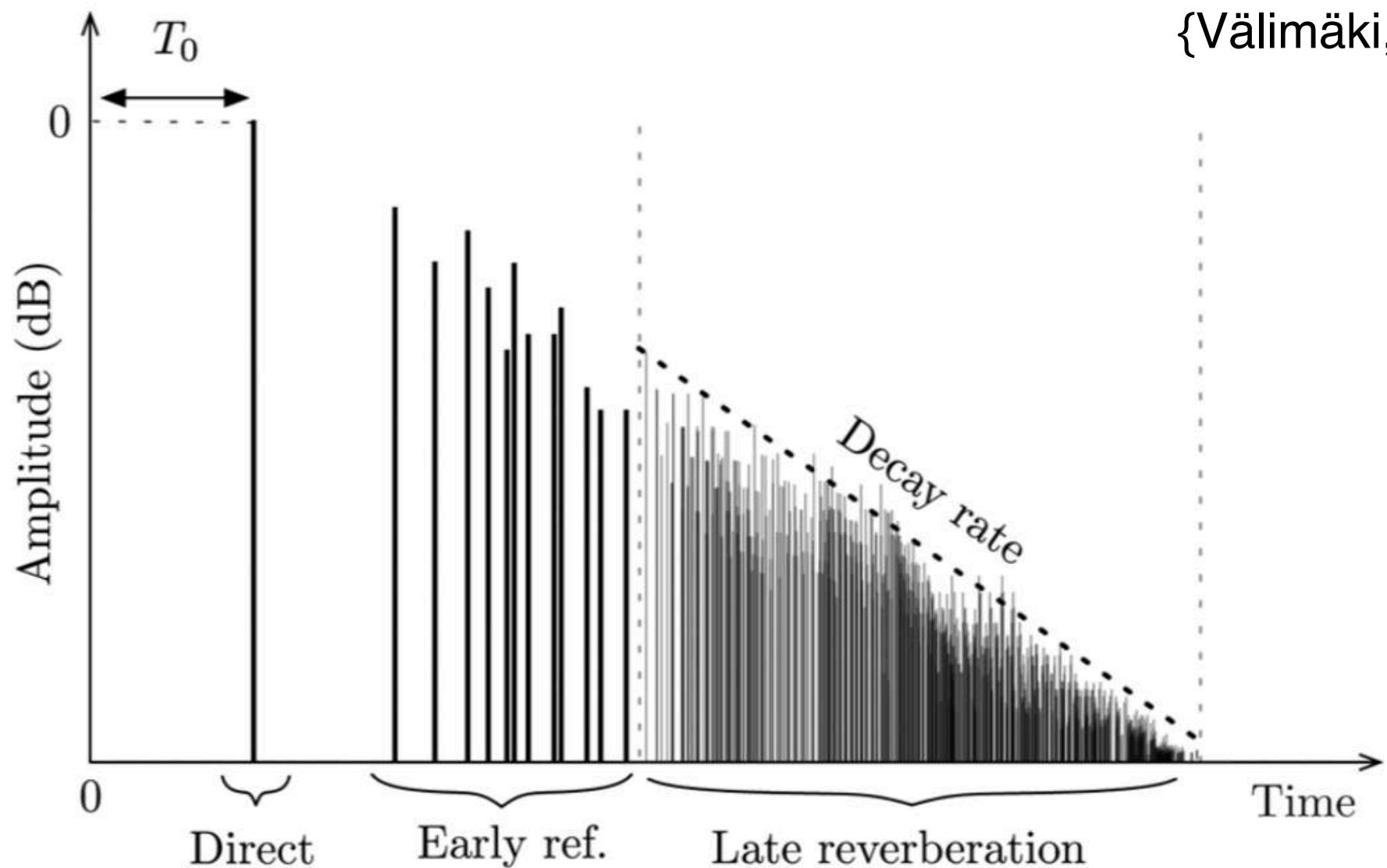


Fig. 1. Schematic example of a generic room impulse response.

{Välimäki, 2012}

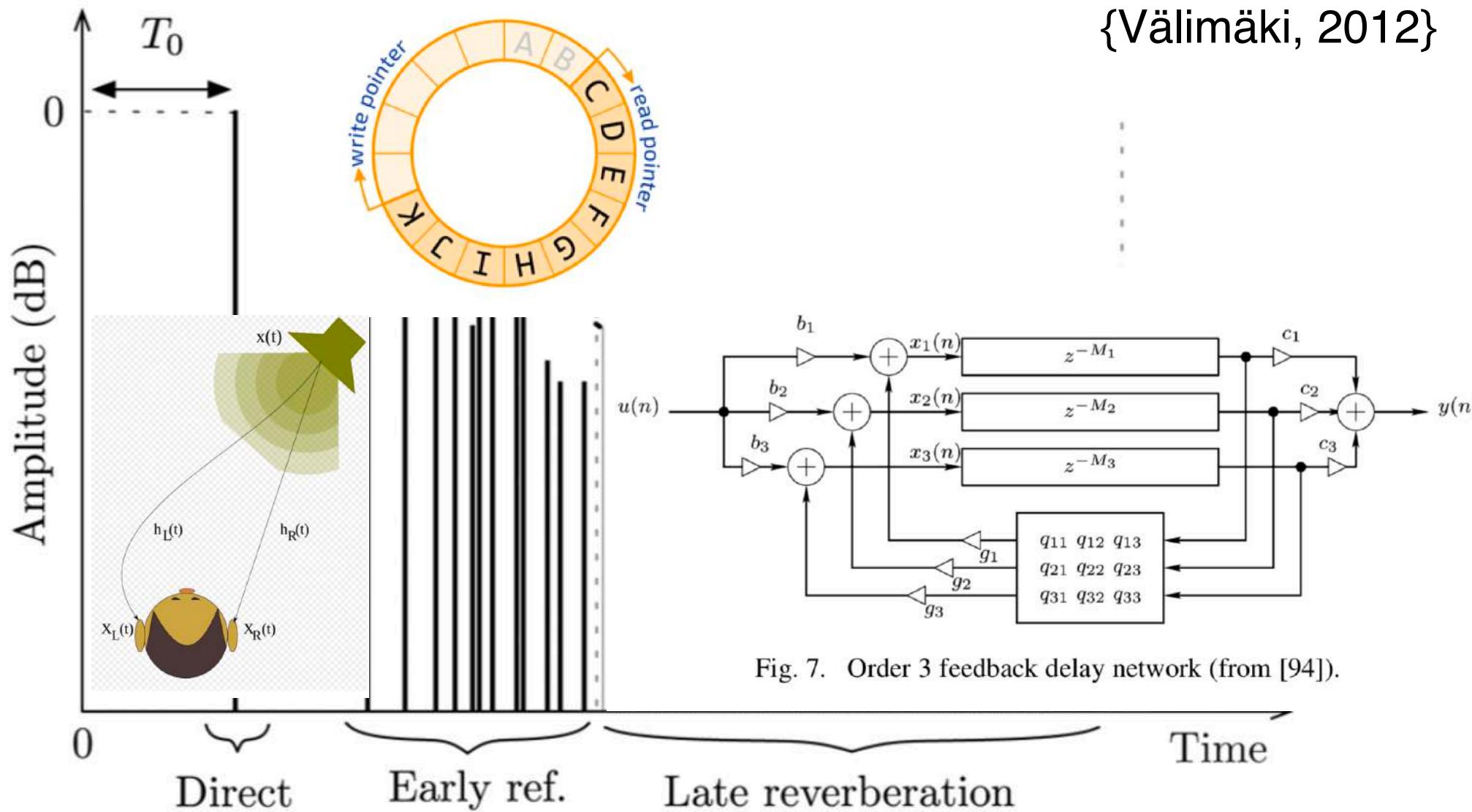
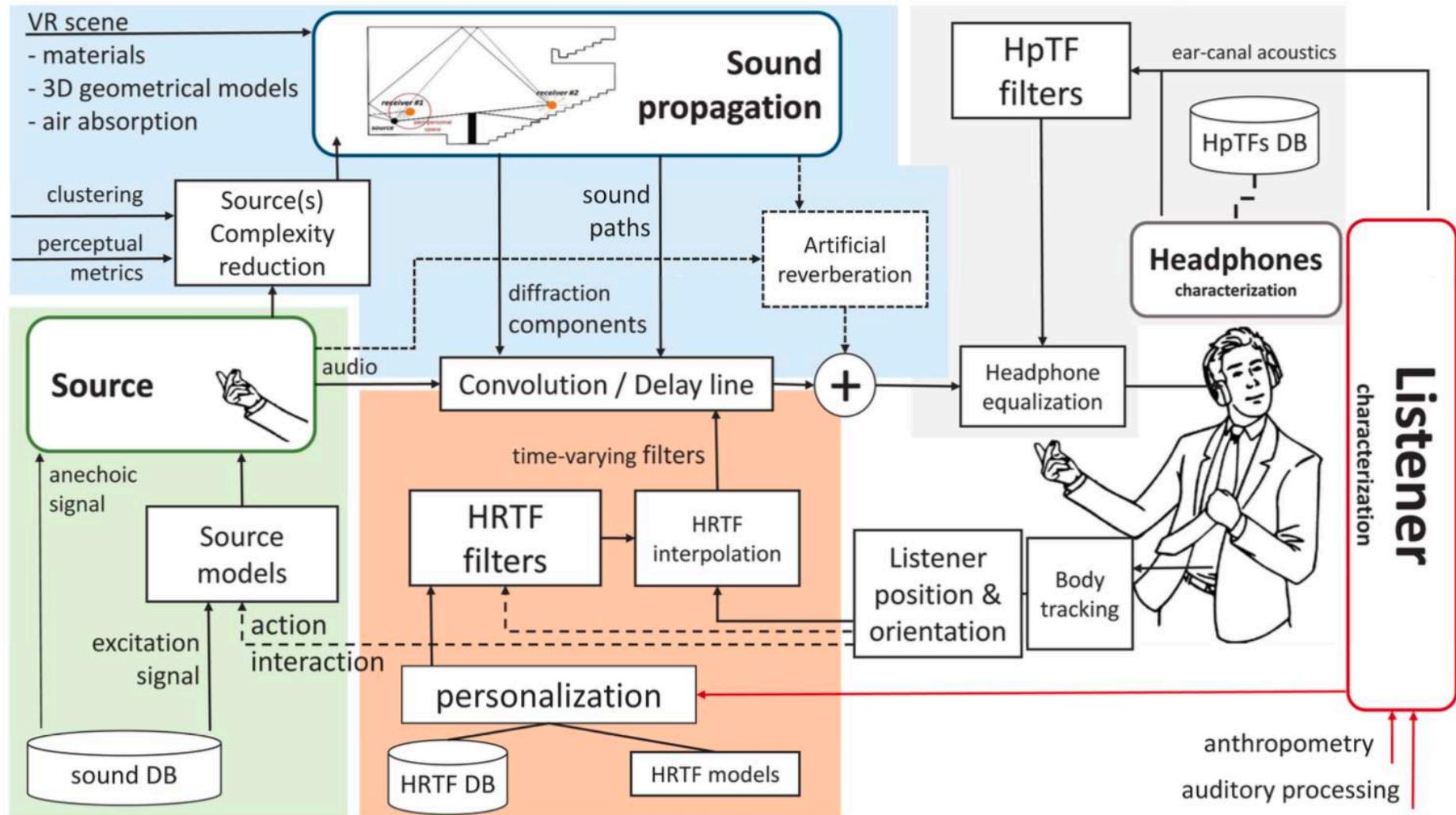


Fig. 7. Order 3 feedback delay network (from [94]).

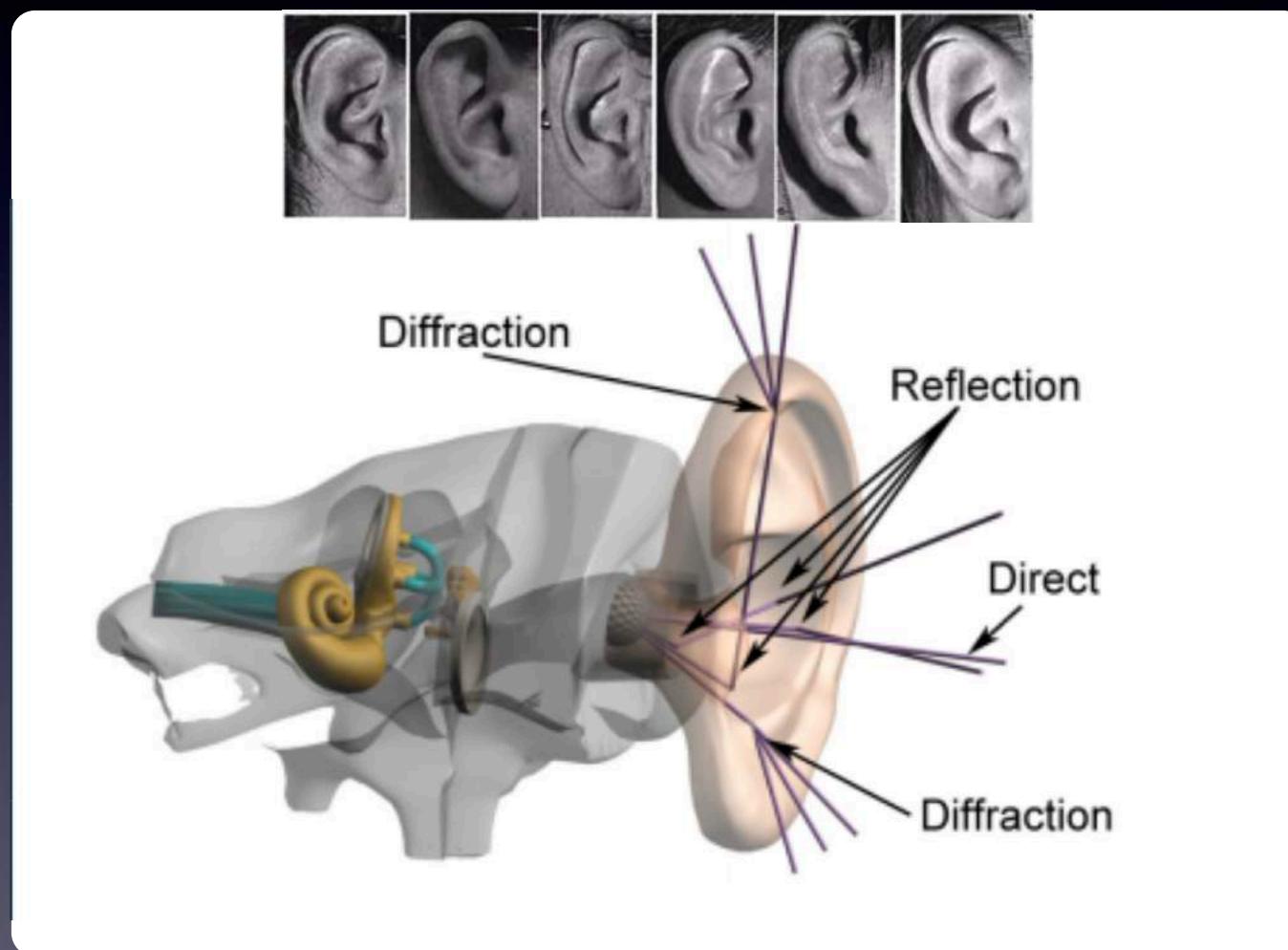
Fig. 1. Schematic example of a generic room impulse response.

Kulaklık için uzamsal ses işleme: Ayrıntılar



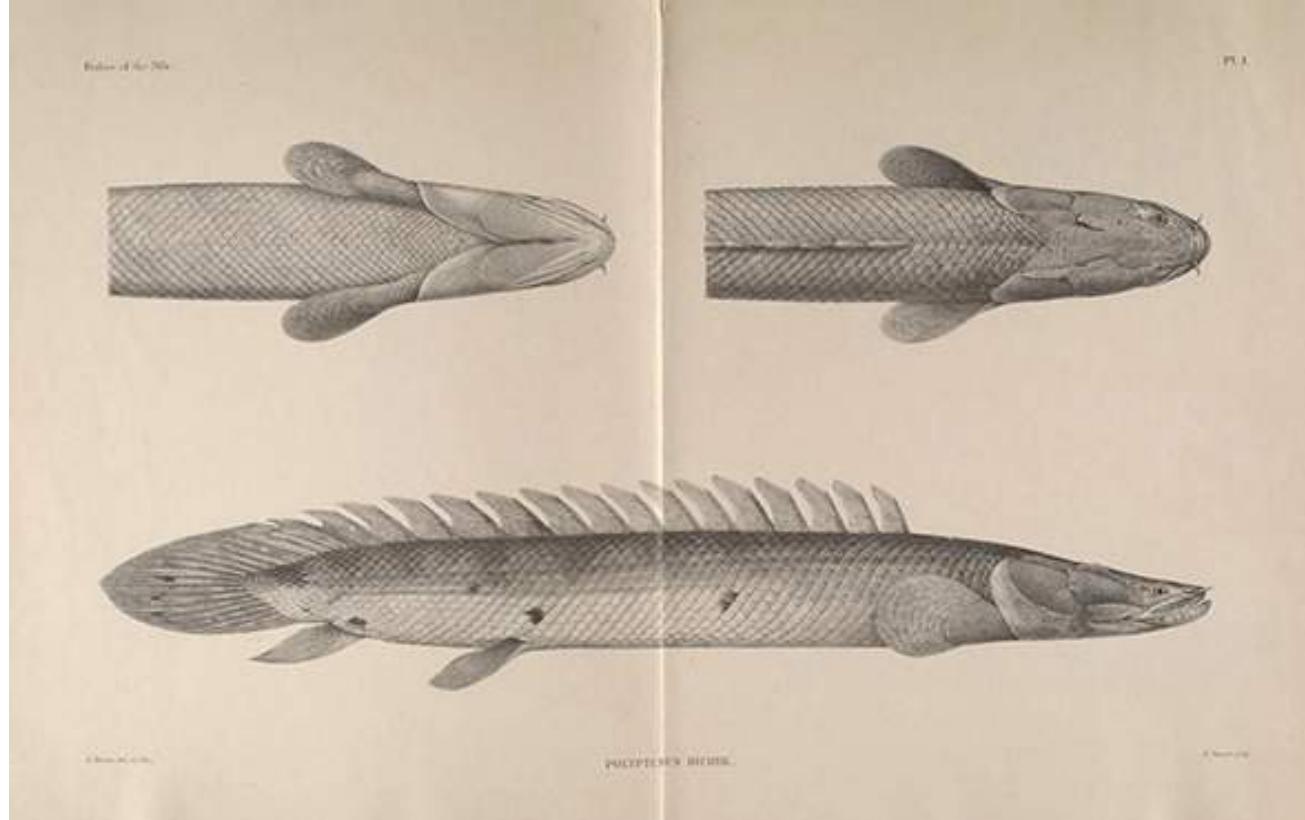
Seslerin konumlarını nasıl kestiriyoruz?

Head-related transfer functions (HRTF) / impulse responses (HRIR)



Polypterus

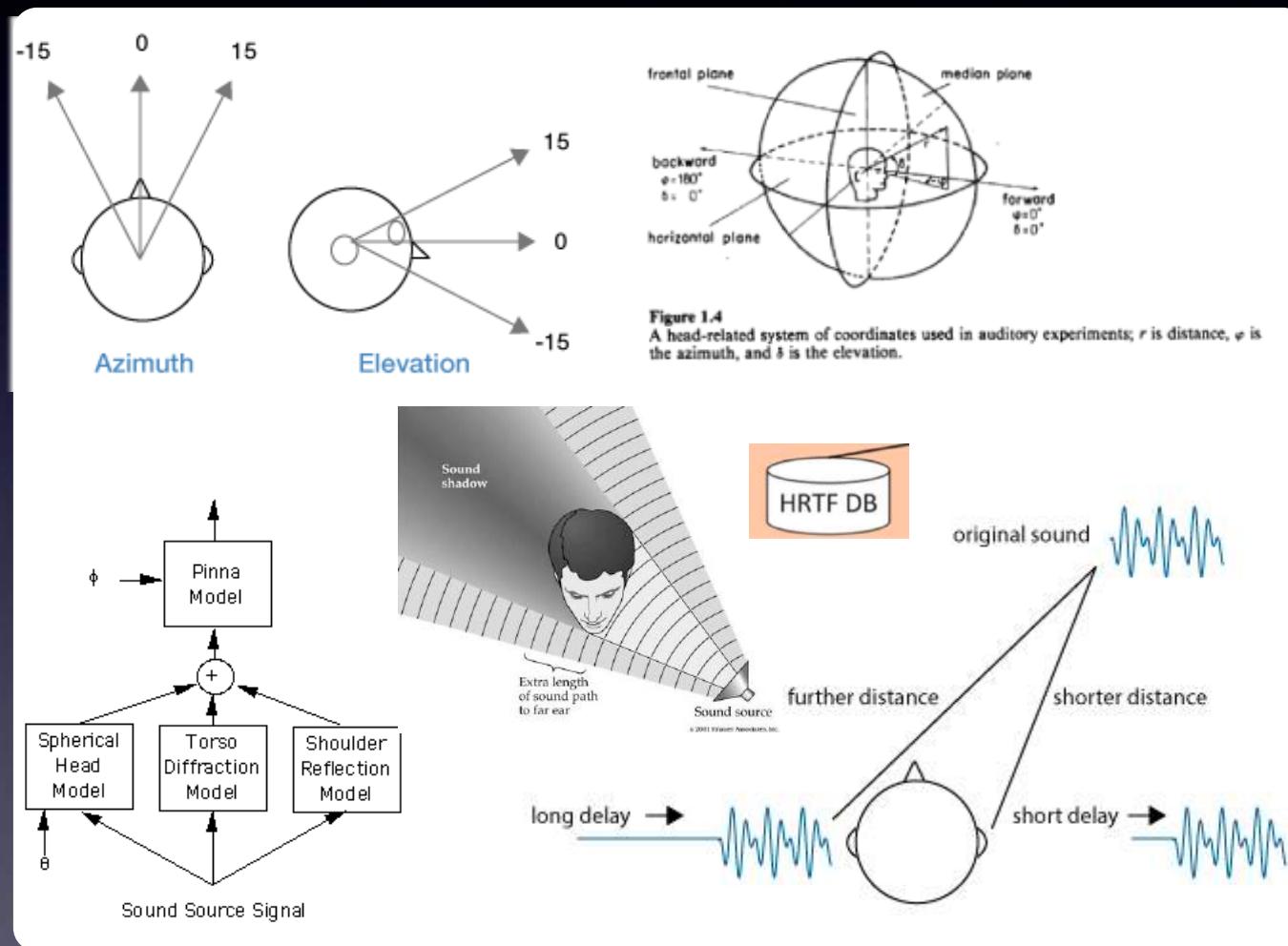
Bu balığın işitme duyumuzun temellerini oluşturduğu düşünülüyor.



J S Anderson, J D Pardo, H C Maddin, M Szostakiwskyj, and A Tinius. 2016. Is there an exemplar taxon for modelling the evolution of early tetrapod hearing? Proc. R. Soc. B 283, 1832: 20160027–4. <http://doi.org/10.1098/rspb.2016.0027>

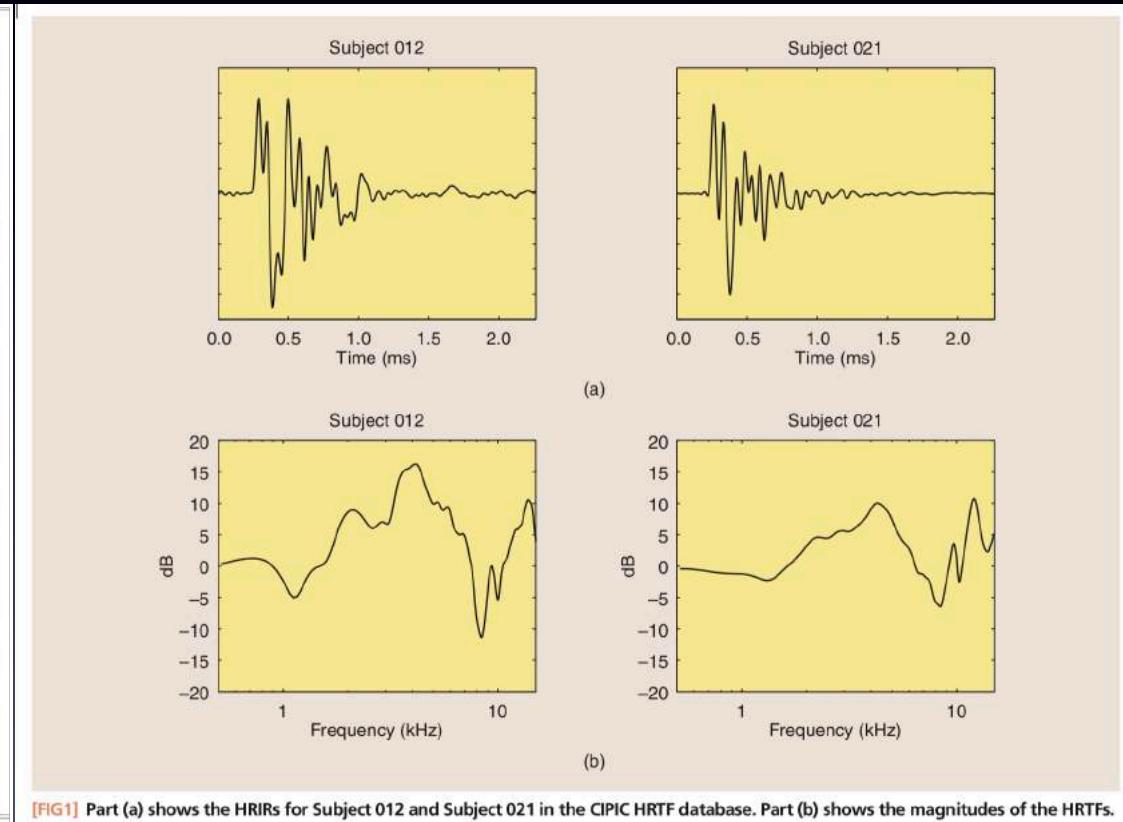
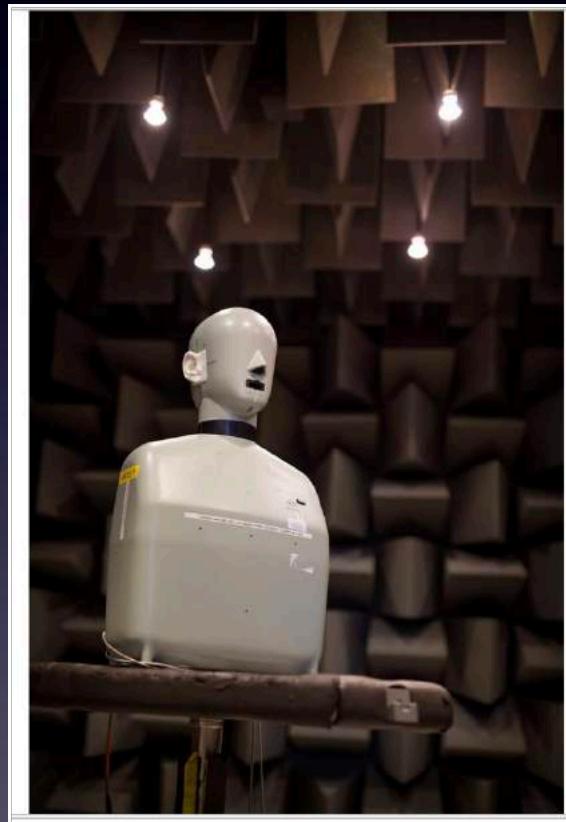
Kavramlar

Azimuth, Elevation, IR, TF, Inter-aural Level/Time Differences

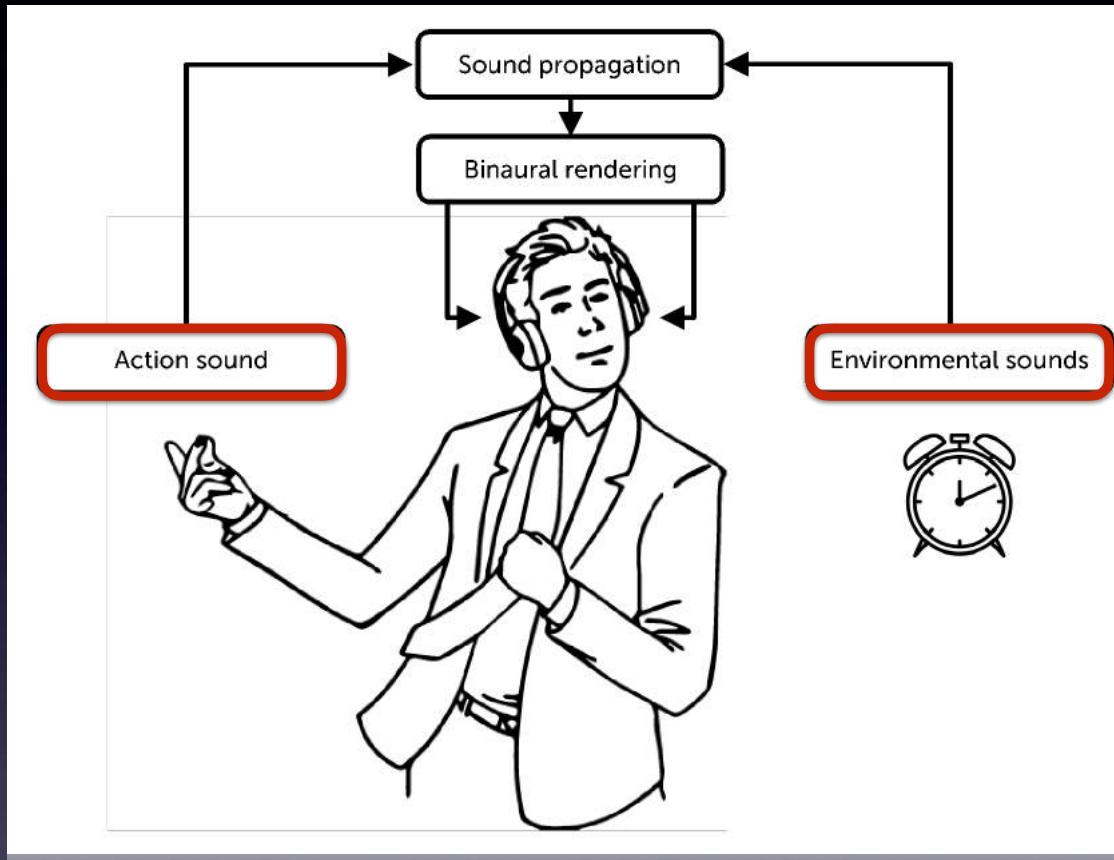


HRTF/HRIR nasıl ölçülüyor?

Yapay kafa (solda), bireysel HRIR/HRTF ölçümleri (sagda)



[FIG1] Part (a) shows the HRIRs for Subject 012 and Subject 021 in the CIPIC HRTF database. Part (b) shows the magnitudes of the HRTFs.



II) Ses kaynaklarının sınıflandırılması ve modellenmesi (hareket ve çevresel etkileşimler)



VR audio

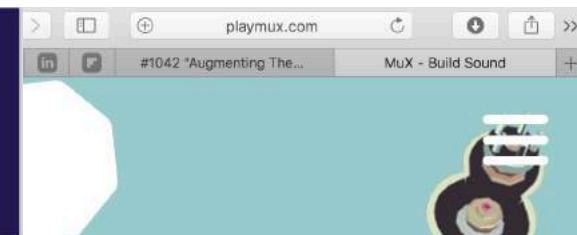


AALBORG UNIVERSITY
DENMARK

Virtual reality musical instruments

Guidelines for multisensory interaction design

Stefania Serafin, Cumhur Erkut, Juraj Kojs, Niels C. Nilsson, and Rolf Nordahl
 {sts,cer}@create.aau.dk, j.kojs@miami.edu, {ncn,rn}@create.aau.dk



Introduction

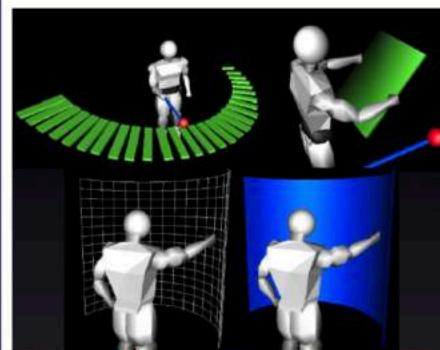
- ▶ Rapid development of low cost virtual reality displays such as the Oculus Rift HTC Vive, OSVR and Samsung Gear VR has boosted the interest in immersive virtual reality music applications.
- ▶ We have recently suggested nine principles for design and evaluation of VR musical instruments (VRMIs) [5].
- ▶ How does these design and evaluation guidelines apply to historical VRMIs?

Guidelines

1. Design sound, visual, touch and proprioception in tandem, and consider the mappings between these modalities
2. Reduce latency
3. Prevent or limit cybersickness
4. Do not copy but leverage expert techniques
5. Consider both natural and magical interactions
6. Consider the ergonomics of the display
7. Create a sense of presence
8. Consider the representation of player's body
9. Make the experience social

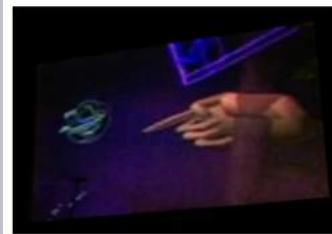
ALMA VRMIs

Mäki-Patola and his colleagues presented a software system designed to create virtual reality musical instruments within the ALMA Project [2, 4], and provide case studies on a virtual xylophone, a virtual membrane, a virtual air guitar, and a gestural FM synthesizer



Lanier's VRMIs

VRMIs to be played in consort in a complete virtual world [3]: the Rhythm Gimbal, the CyberXylo, and the CyberSax.



AAU VRMIs

Gelineck and his colleagues proposed physics-based VRMIs: a flute and a drum [1]. The size of the VRMIs can be changed while playing.



They focus on learnability and visualization within pedagogical settings.



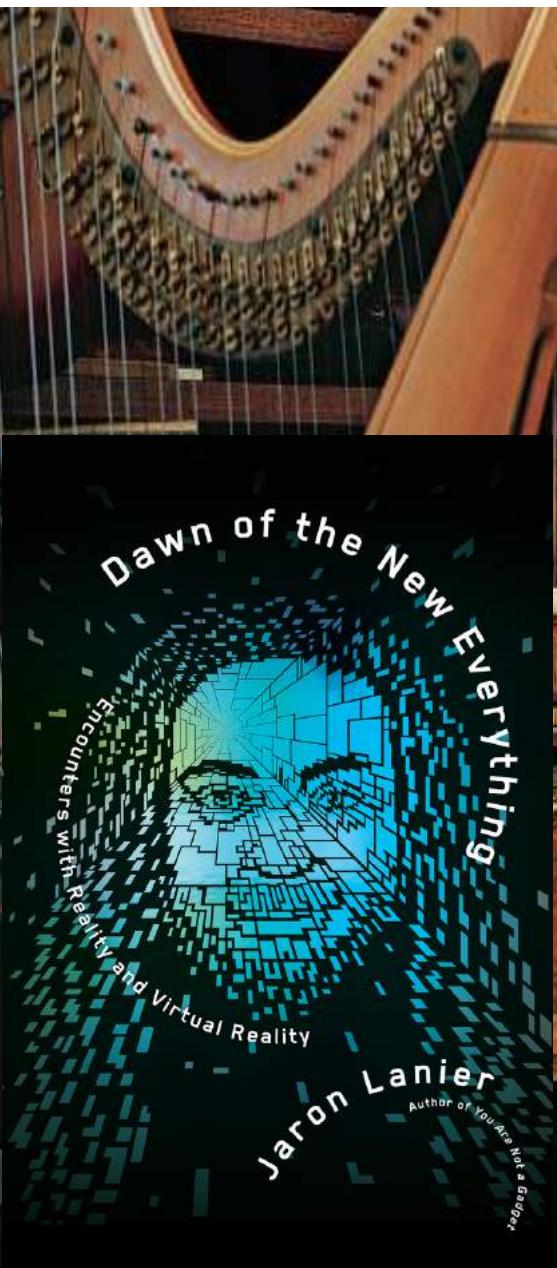
Intonarumori

<http://playmux.com>

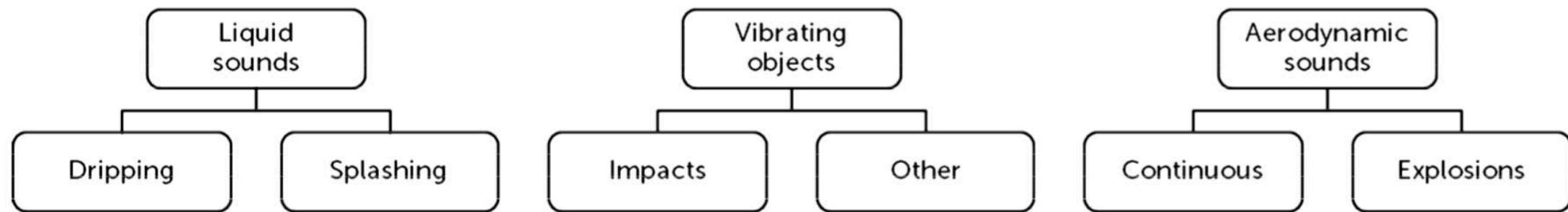
Click to
watch the
trailer







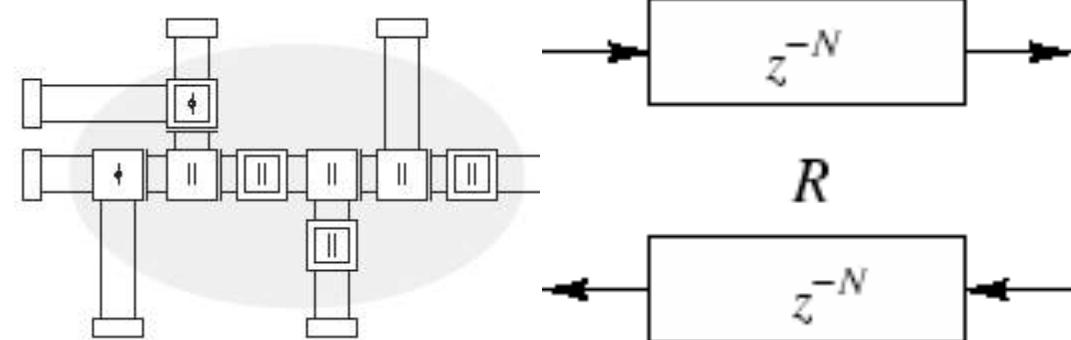
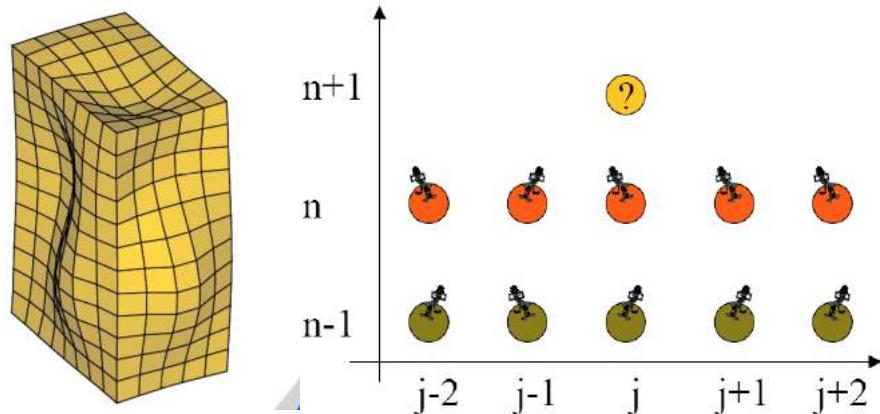
Sınıflama (Gaver'93)

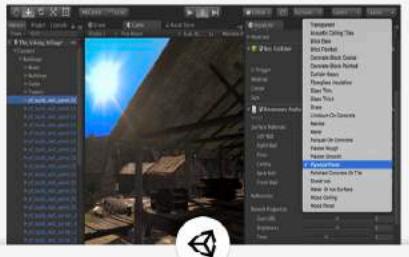


Modelleme (Erkut'05, Välimäki'06)

$$KP + i\omega CP - \omega^2 MP = i\rho\omega F$$

M, C, and K are mass, damping, and stiffness matrices





Unity

[GET STARTED](#)



Unreal

[GET STARTED](#)



FMOD

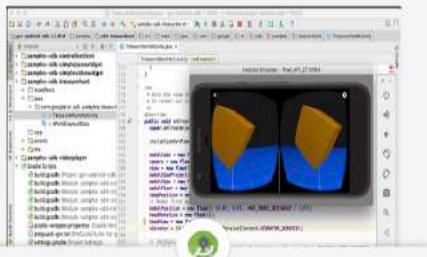
[GET STARTED](#)



Wwise

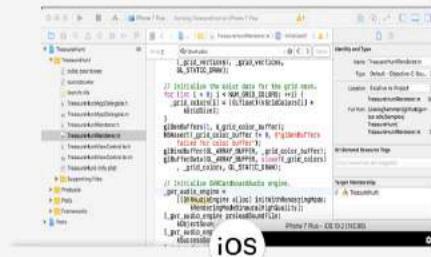
[GET STARTED](#)

Trend: Sondan sona yapay öğrenme (Gabrielli 2018)



Android Studio

[GET STARTED](#)



iOS

[GET STARTED](#)



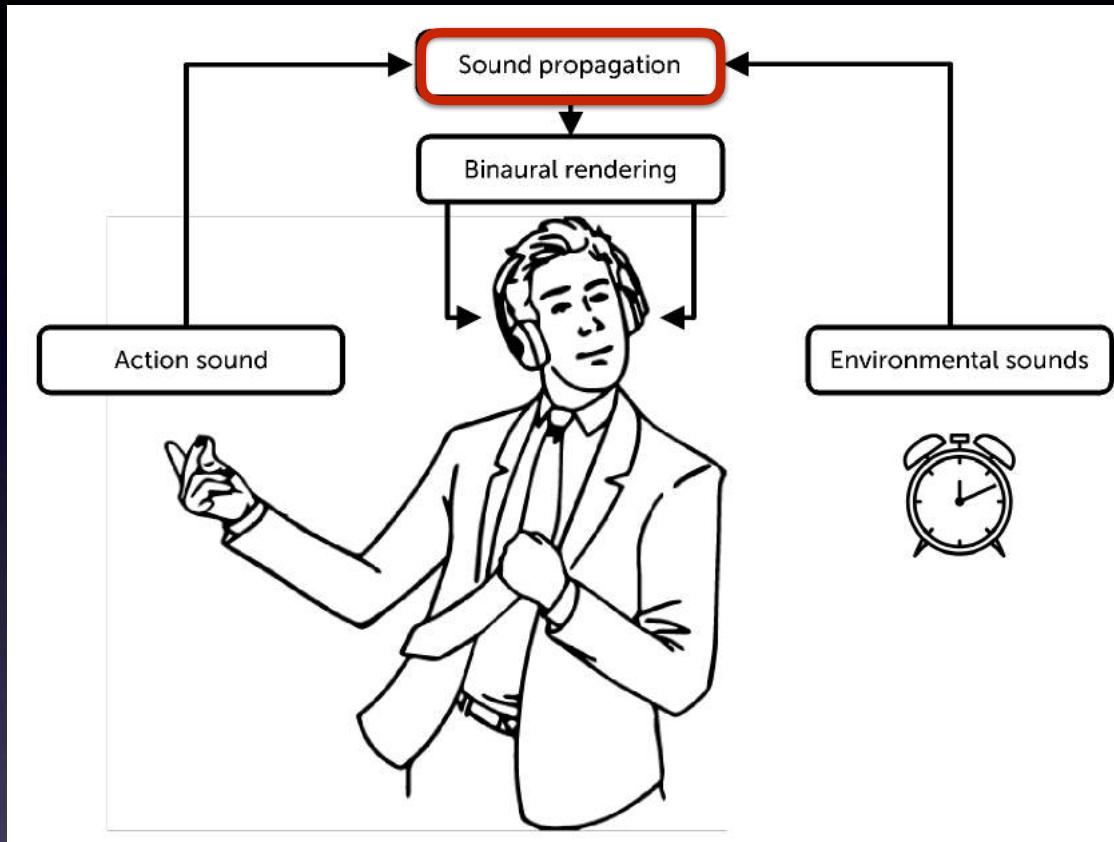
Web

[GET STARTED](#)



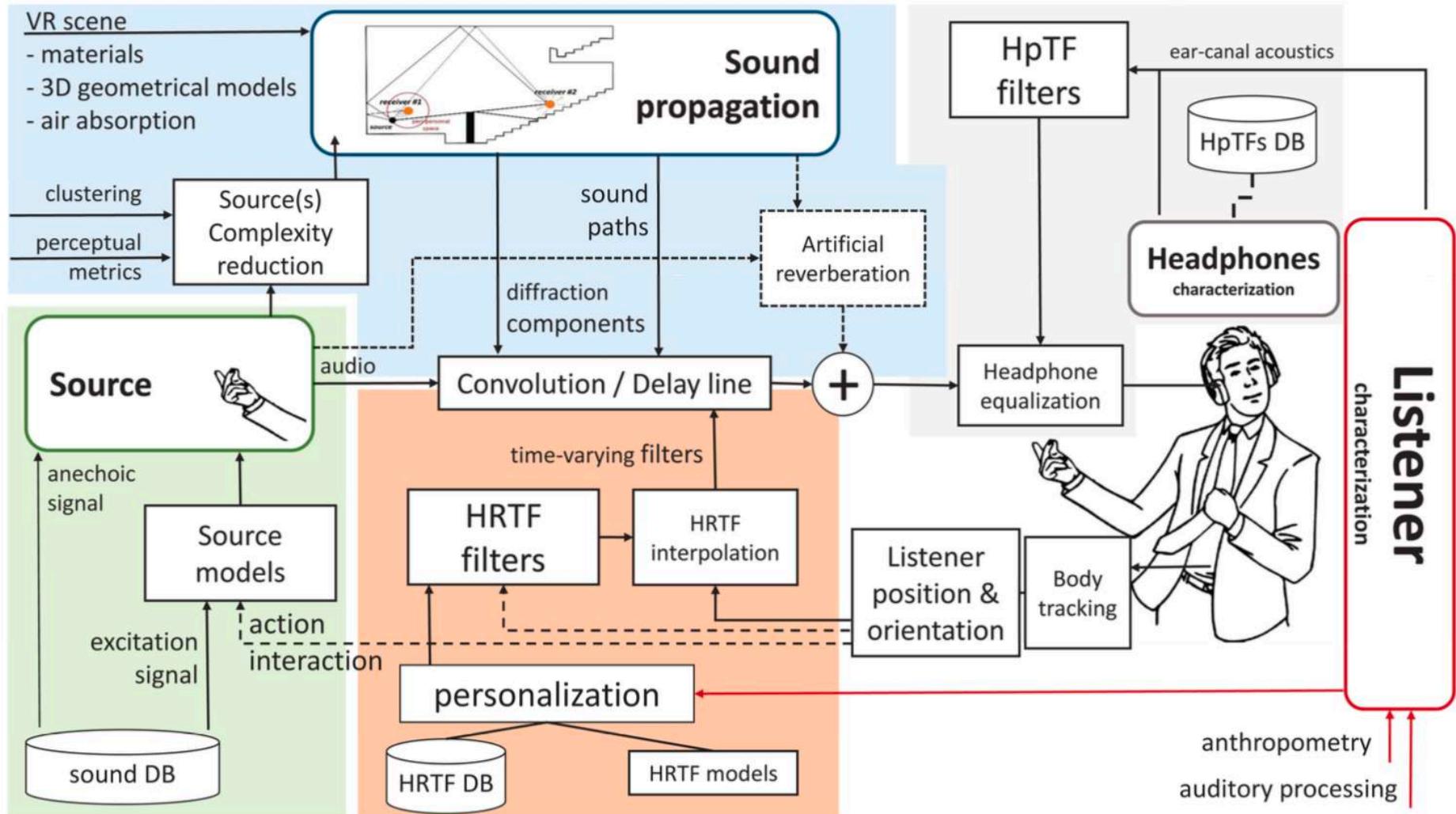
DAW VST plugin

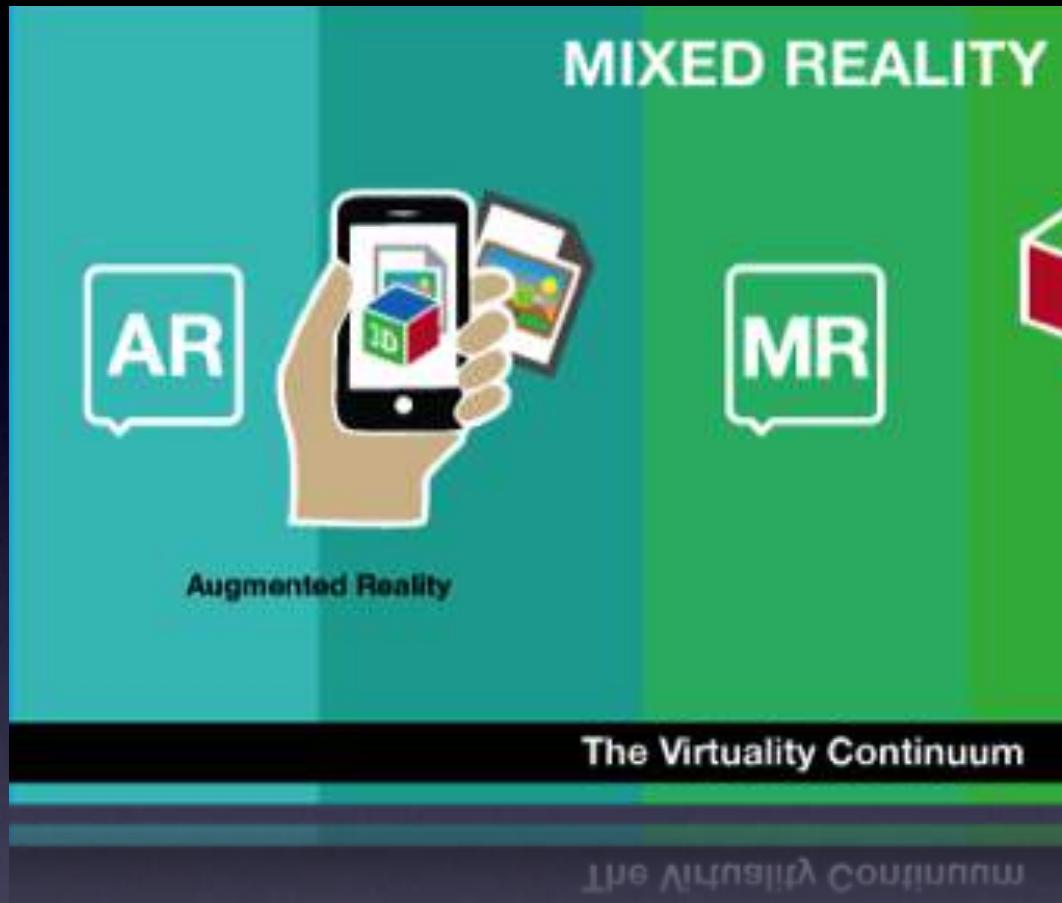
[GET STARTED](#)



III) Sanal ortamda ses yayılımı (dalga, geometrik ve karma modeller)

A VR system for binaural rendering





AR/MR audio

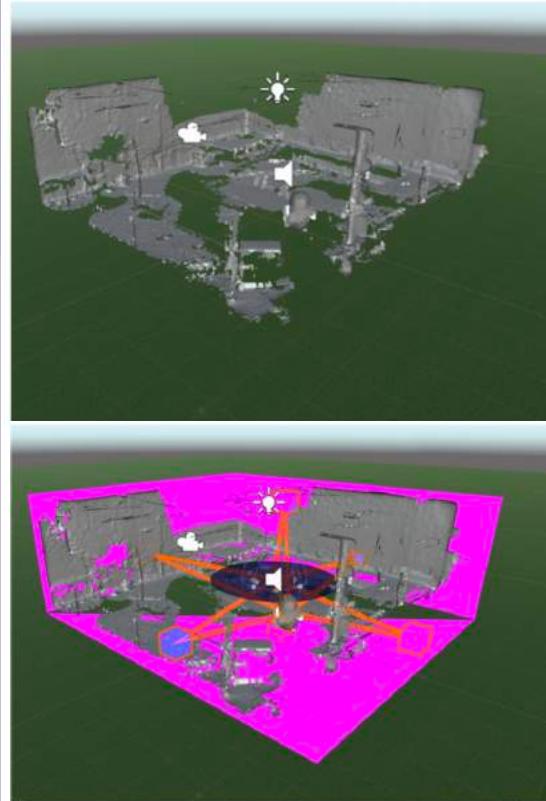


ScattAR

A Mobile Augmented Reality Application that uses Scattering Delay Networks for Room Acoustic Synthesis

Alex Baldwin, Stefania Serafin, and Cumhur Erkut

abaldw15@student.aau.dk, sts@create.aau.dk, cer@create.aau.dk



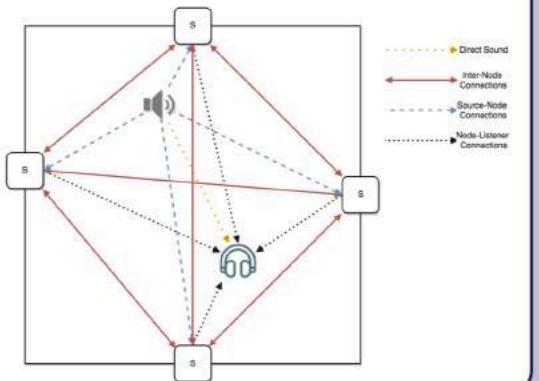
Introduction

We present a mobile Augmented Reality (AR) application, where a sound source is placed on a drone that floats in a real room. We read the audio content from a file as samples.

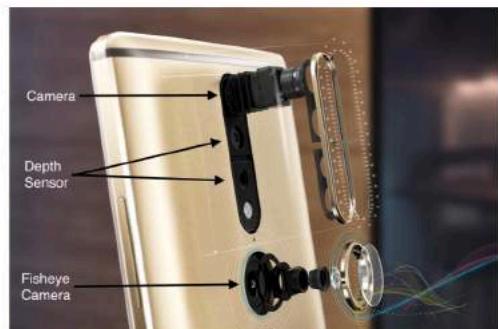
Our application renders the direct path (green rays in the figure) from the source to the listener, together with six first-order reflections (red rays) from nearby walls, floor, and ceiling, plus an efficient reverberation.

Scattering Delay Networks

Formulation after [1].

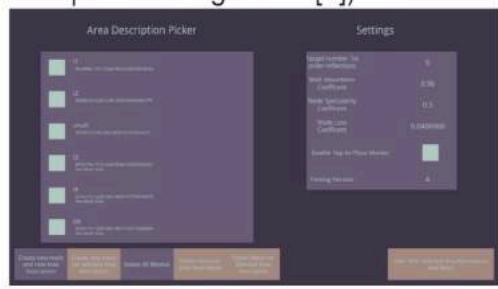


Hardware, Operation, and UI



Operation:

1. Scan room (via Tango API)
2. Load mesh (via OrbCreation [2])
3. Motion Tracking (via Tango API)
4. Auditory Rendering
 - Direct sound (Unity Ray Tracing)
 - Paths (via the spherical Fibonacci point set algorithm [3])



Conclusions

- Our AR audio application efficiently renders a moving sound source in a given room.
- First AR application of SDNs [1]? Currently, With positive-real scattering parameters.
- Future: computational benchmarking, frequency-dependent scattering filters.
- Perceptual properties of the implementation remain to be evaluated.

References

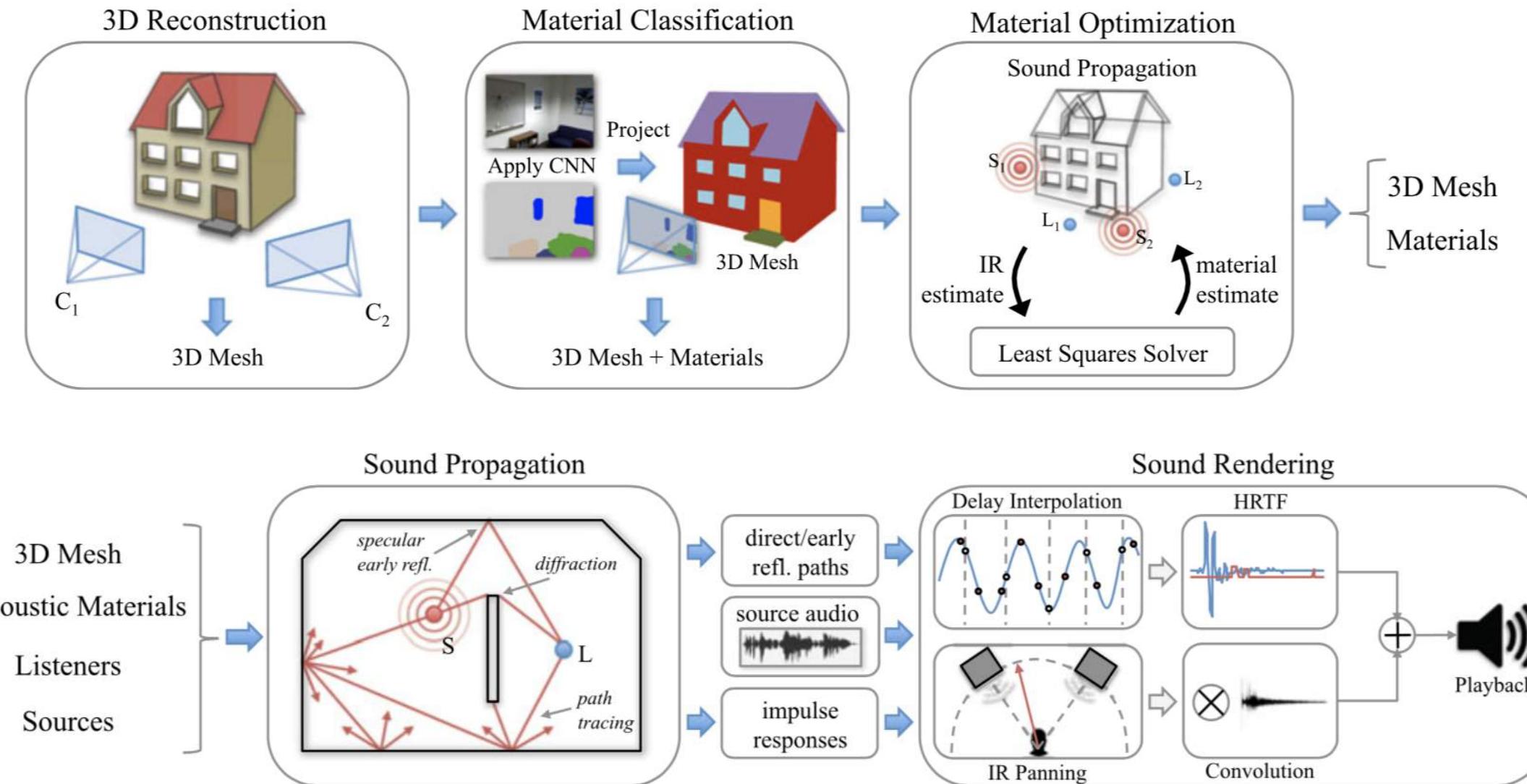
- [1] E. De Sena, H. Hacıhabıboğlu, Z. Cvetkovic, and J. O. Smith, "Efficient synthesis of room acoustics via scattering delay networks," *IEEE/ACM Transactions on Audio, Speech, and Language Processing*, vol. 23, pp. 1478–1492, Sept. 2015.
- [2] Orbcreation, "Simple .obj." Unity Asset Store, October 2014. Version 1.4 for Unity 4.5.0.
- [3] R. Marques, C. Bouville, M. Ribardière, L. P. Santos, and K. Bouatouch, "Spherical fibonacci point sets for illumination integrals," in *Computer Graphics Forum*, vol. 32, pp. 134–143, Wiley Online Library, 2013.

Demo
ScattAR



Mobile AR In and Out: Towards Delay-based Modeling of Acoustic Scenes

Cumhur Erkut, Alex Baldwin, Jonas Holfelt & Stefania Serafin



Schissler, Loftin & Manocha, "Acoustic Classification and Optimization for Multi-Modal Rendering of Real-World Scenes"

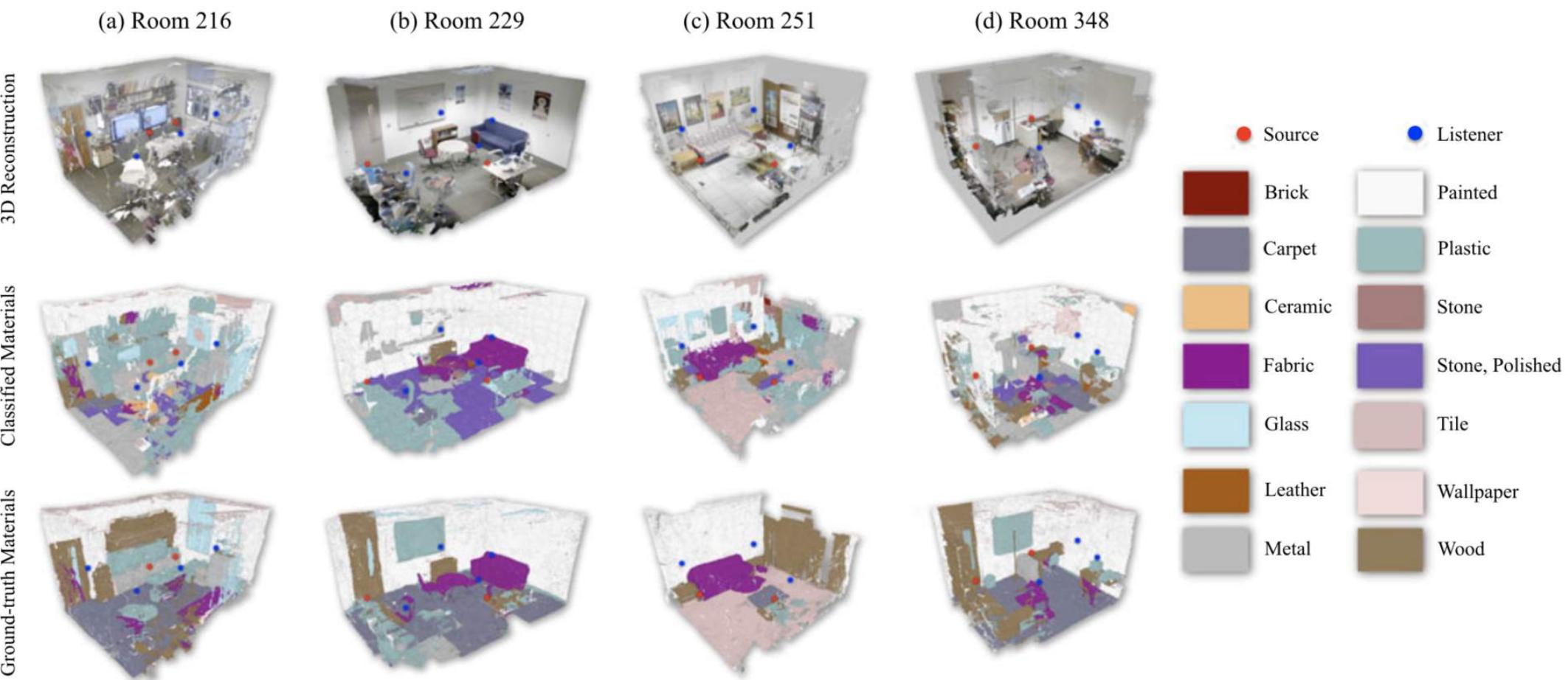
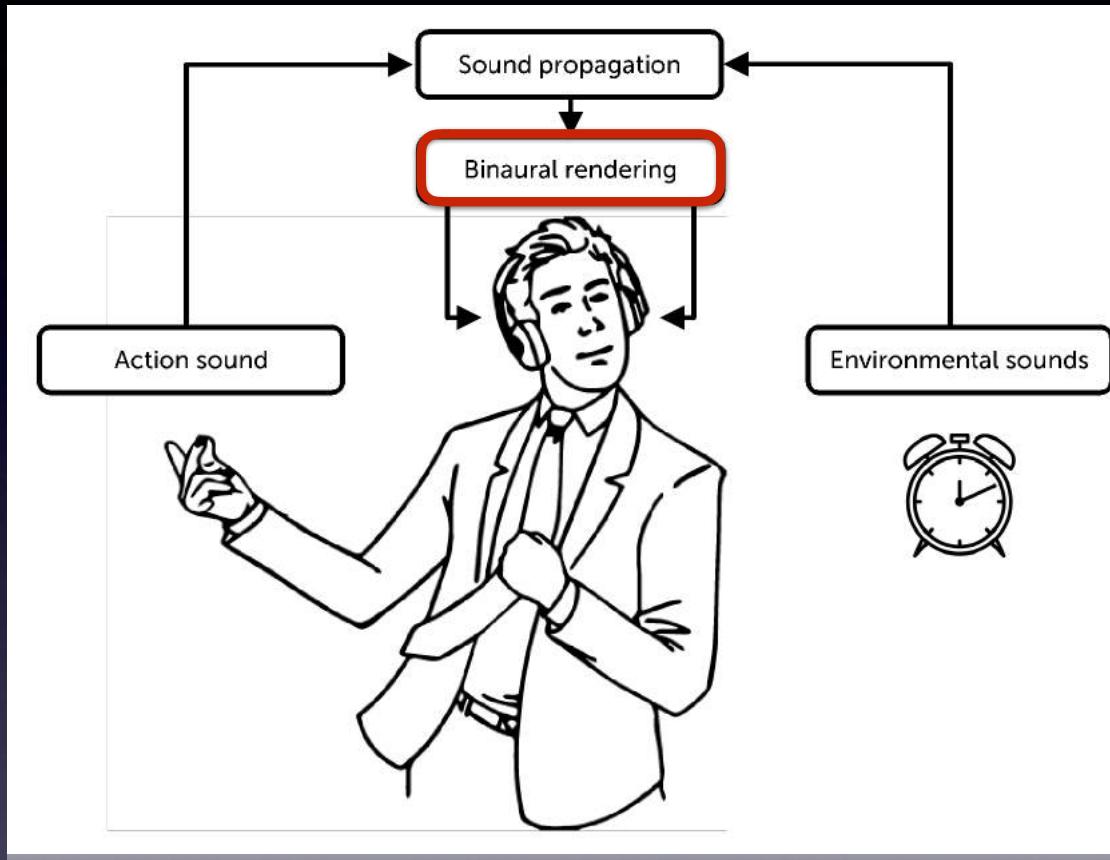


Fig. 4. The results of our visual material classification algorithm for the four benchmark scenes. Colors indicate the material category that has been assigned to each triangle of the reconstructed model. The middle row shows the results of our material classification, and the bottom row shows the manually-generated ground-truth classification that are used for validation. The source and listener positions for the acoustic measurements within the real room are shown as red and blue circles, respectively. These are used to optimize the acoustic materials present in the scenes.



IV) Kullanıcıya sunum ve etkileşim (kulaklık/hoparlör bazlı teknikler)

AMBEO

3D AUDIO TECHNOLOGY BY SENNHEISER



CAPTURING



MIXING

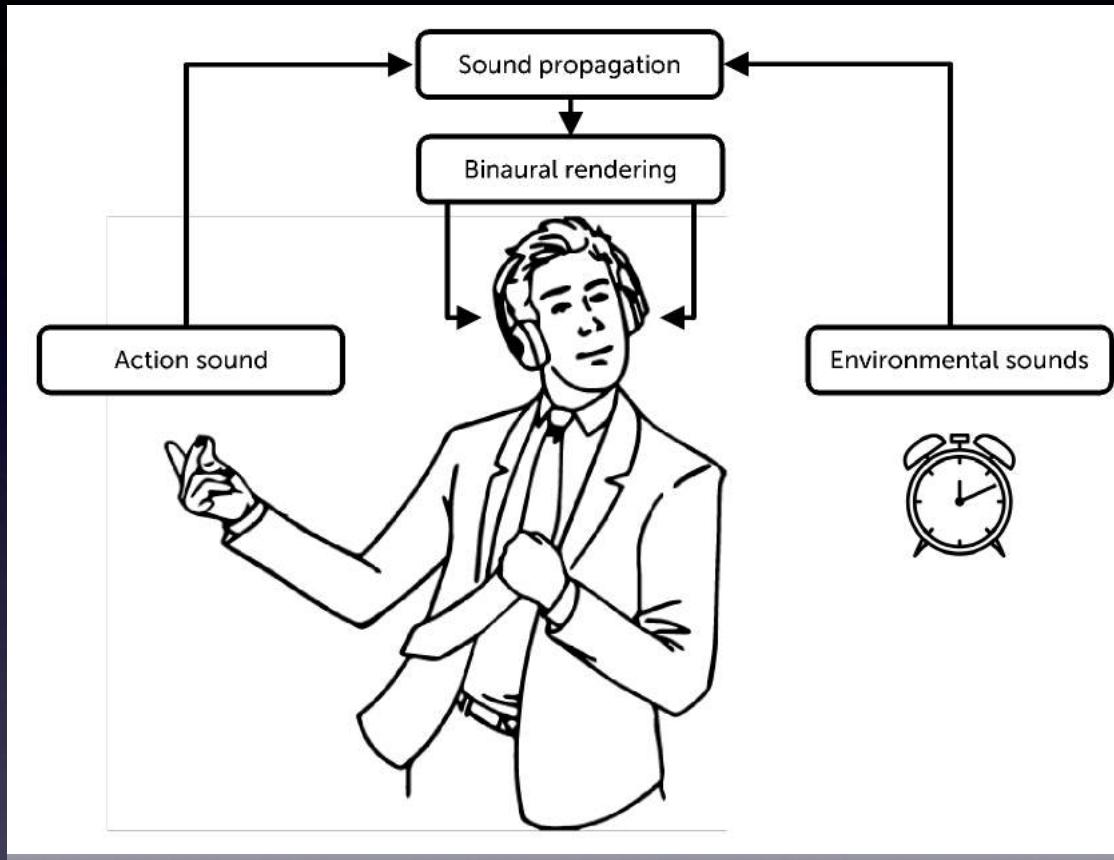


PROCESSING



LISTENING





V) Yeni uygulamalar ve çözüm bekleyen sorunlar

Zorluklar

- Ön/arka ayrımı
- Yükseklik hataları
- Seslerin kafa içine yerleşmesi
- Renklenme

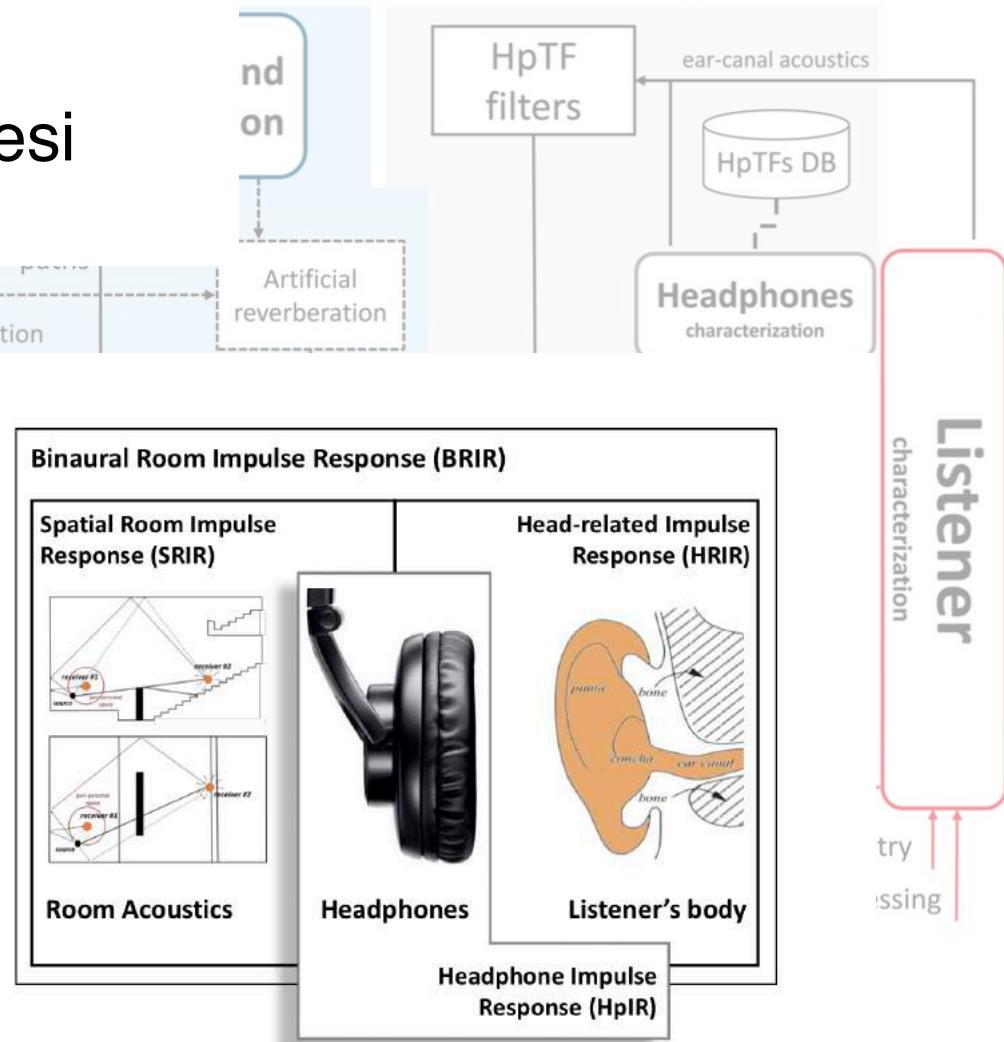
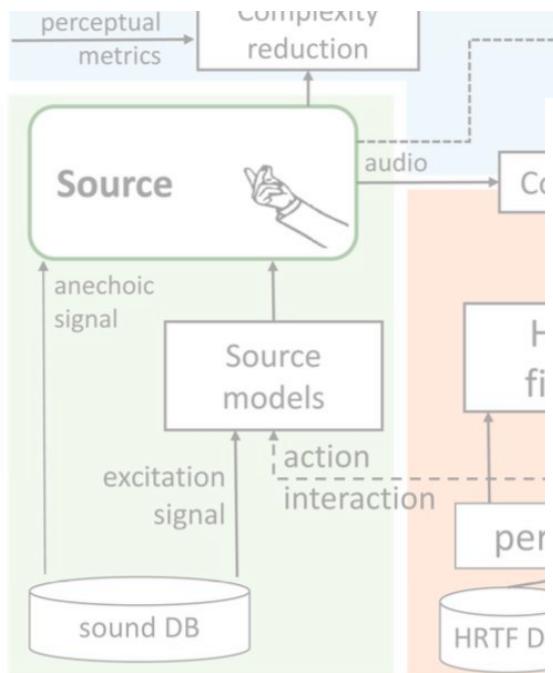






Figure 4.5: A small environment was created, to simulate relative size as well as possible. The room is supposed to represent a large room of 9x7x4 meters

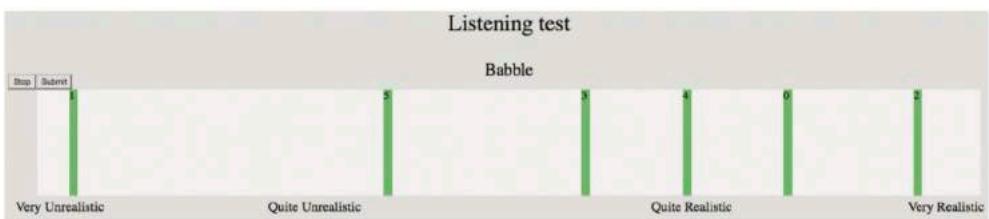


Figure 4.7: The scale used to evaluate the subjective perceptual quality of synthesized effects [42]. Here the participant can play a sound by clicking on of the green bars, and then drag them to place them on the scale.

**AGENCY AND VIRTUAL BODY OWNERSHIP
OF A VIRTUAL BAT'S AVATAR IN VR**

Anastassia Andreasen

Aalborg University Copenhagen

Department of Architecture Design and Media Technology

Spring 2016

Özet ve Gelecekteki Çalışmalar



HOW ARCORE IS DIFFERENT FROM TANGO AND ARKIT?

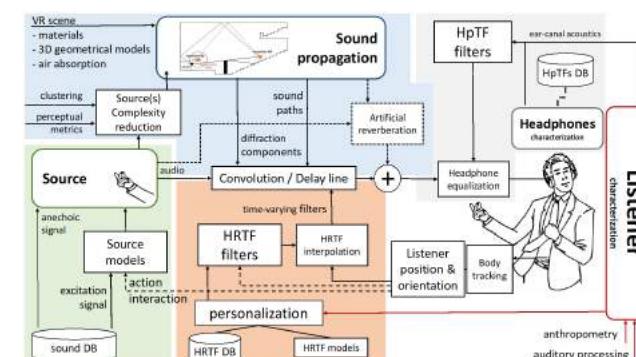


Yeni Donanım

Yeni Yazılım

Artırılmış Gerçeklik

Sanal Gerçeklik



KAYNAKLAR

- Stefania Serafin, Michele Geronazzo, Cumhur Erkut, Niels Christian Nilsson, and Rolf Nordahl. 2018. Sonic Interactions in Virtual Reality: state of the art, current challenges and future directions. *IEEE Computer Graphics and Applications* 38, 2: 31–43. <http://doi.org/10.1109/MCG.2018.193142628>
- Stefania Serafin, Niels Christian Nilsson, Cumhur Erkut, and R Nordahl. 2016. Virtual reality and the senses. White paper financed by the Danish Sound Innovation Network. Retrieved on <2018-07-02 Mon> from https://issuu.com/danishsound/docs/dtu_whitpaper_2017_singlepages
- I.Jason Jerald. 2015. The VR Book. Association for Computing Machinery and Morgan & Claypool Publishers <http://doi.org/10.1145/2792790>
- I. Dieter Schmalstieg and Tobias Hollerer. 2016. Augmented Reality. Addison-Wesley.

KAYNAKLAR

- Vesa Välimäki, Julian D Parker, Lauri Savioja, Julius O Smith III, and Jonathan Abel. 2012. Fifty Years of Artificial Reverberation. *IEEE/ACM Transactions on Audio, Speech and Language Processing* 20, 5: 1421–1448. <http://doi.org/10.1109/TASL.2012.2189567>
- Vesa Välimäki, Jyri Pakarinen, Matti Karjalainen, and Cumhur Erkut. 2006. Discrete-time modelling of musical instruments. 69, 1: 1–78. <http://doi.org/10.1088/0034-4885/69/1/R01>
- Leonardo Gabrielli, Stefano Tomassetti, Carlo Zinato, and Francesco Piazza. 2018. End-to-End Learning for Physics-Based Acoustic Modeling. *IEEE Transactions on Emerging Topics in Computational Intelligence* 2, 2: 160–170. <http://doi.org/10.1109/TETCI.2017.2787125>
- Carl Schissler, Christian Loftin, and Dinesh Manocha. 2018. Acoustic Classification and Optimization for Multi-Modal Rendering of Real-World Scenes. *IEEE Transactions on Visualization and Computer Graphics* 24, 3: 1246–1259. <http://doi.org/10.1109/TVCG.2017.2666150>