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# ***The Living Tree: Using Surface Transducers to Explore the Secret Life of Trees through Sonic Interactions***

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**Abstract**

This paper presents the demo of the interactive listening installation *The Living Tree*, where surface transducers were deployed in a real-life setting to design immersive and affectively engaging sonic interactions exploring the life of trees. The surface transducer technology emits vibrations through whatever material you press it against, turning the material into a speaker. We present the design of the project which we will demo at DIS and elaborate on how surface transducers can be used as a design material for creating rich interactive experiences.

**Author Keywords**

Sonic Interaction Design; Surface Transducers; Interactive Design Materials; Affective Engagement

**ACM Classification Keywords**

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**Introduction**

Sound and sonification in the design of interactive systems and technologies is a widespread concern across the joint fields of Human-Computer Interaction (HCI) and Interaction Design. Recent work at DIS

### Touched Echo

A prominent example of interactive installation design with surface transducers is Markus Kison's *Touched Echo* [9]. The installation takes the user back to the air raid of the German city Dresden at the end of WWII. With a view of the now rebuilt city, users can gain access to a soundscape of the bombings via a sonified metal banister. Transducers vibrate the sound directly into the banister hiding it in the metal. Users can only access the recordings by positioning the elbows on the banister and covering their ears with their hands, making the sound travel through the bone in the lower arms via bone conduction.



Figure 1: A man listening to *Touched Echo*. Photo by Markus Kison from [www.markuskison.de](http://www.markuskison.de). All rights to the artist.

dealing explicitly with audio aspects of designing interactive systems includes research on sonification approaches to representing various forms of visual data [8], the use of audio cues to raise awareness and foster interaction when designing public displays [10] and, in a slightly different vein, interactive sound feedback for dance pedagogy based on the practice of vocalizing while moving [3]. This body of research points to the diversity and richness in experimenting with sound and sonification to explore the multi-sensuous design potential of digital and interactive technologies. In this paper, we add to this growing body of work by presenting a design project – *the Living Tree* – that explores a particular form of sound technology, surface transducers, as a design material used to create novel forms of sonic interactive experiences.

In short, surface transducers are a loudspeaker technology that produces sound by vibrating the surface of a solid material [2]. Attached to a wall, a window or even a tree, a surface transducer turns the object into a speaker. Unlike a traditional loudspeaker, surface transducers have no cone to produce sound waves. They use the movement of their own mass to set the mounted surface into motion and thereby push the surrounding air. This makes it possible to attach sound directly to objects and hide auditory content within physical materials. Furthermore, surface transducers are capable of producing a phenomenon called bone conduction [7], e.g. used in the crafting of hearing devices. When a surface transducer is put in physical contact with your head its vibrations are applied to your skull. This results in sound being transferred directly to your inner ear, making the sound appear inside your head instead of through the air. This

way, bone conduction offers opportunities for novel and rich experiences with sound and bodies.

We start out by positioning our experiment within the frame of Sonic Interaction Design [4] and then move onto describing the basic outset and assumptions behind the featured demo in this paper, *the Living Tree*. In this interactive sound installation, we used surface transducers to embed different sounds in trees to create an interactive experience in a forest. We worked with an external partner, the Danish Nature Agency, in order to communicate complex and historic values of old and protected trees in a new and more engaging way to their users. We present the design process and the interactive setup, which is what we will be demoing at DIS. Finally, we discuss and reflect on the findings from the design process.

### Related Work

The use of sound or sonification as a way to improve existing forms of interaction, or to explore novel forms of interaction, has been an area of inquiry within HCI and interaction design for several decades now. As early as 1986, Gaver coined the term 'auditory icons' describing 'ways to represent dimensional data as well as conceptual objects in a computer system' [6]. In our design explorations of surface transducers, we have been drawing extensively on the work of Franinović and Serafin, who have coined the term sonic interaction design (SID) in their edited volume on the subject from 2013 [4]. In the introduction, Franinović and Serafin argue that sonic interaction design is intended to present an agenda for interaction design, where sound and interaction is in focus. SID is not in itself a novel field of research but seeks to aggregate existing approaches within this overall heading in an attempt to

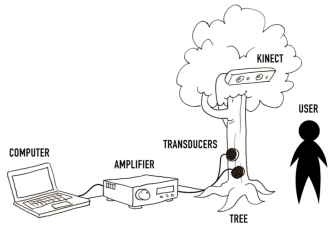


Figure 2: The technical setup using a Kinect sensor to trigger different sounds dependent on a person's movements around and interaction with the tree.

put forth an agenda emphasizing the overall aesthetic and experiential aspects of sound in interactive systems design. As such, it is less the functional and efficiency-oriented uses of sound that are in focus and more the performative aspects of sonic behavior in a designerly perspective. What characterizes SID is the attempt to ground a way of thinking about and working with sound as an 'active medium that can enable novel phenomenological and social experiences with and through interactive technology.'" [4, p. vii]. In this paper, we follow this invitation and specifically investigate how surface transducers can function from a designerly point of view in the creation of multimodal, tactile and interactive sonic experiences.

### The Living Tree

*The Living Tree* evolved in a project collaboration with the Danish Nature Agency (DNA) under the Ministry of Environment and Food of Denmark. Today, 500.000 Danish trees are about to receive government protection due to their age, unique looks or historical importance in collaboration with Danish citizens across the entire country. We conducted intensive field research and did interviews with a number of stakeholders to arrive at a design concept where we would physically integrate sound into trees using surface transducers. We designed several versions with different forms of interactive elements and sounds communicating values and information about the old trees. This opened up a design space where users could learn about the trees and interact with them in a new and more bodily engaging way than the Nature Agency had presented before. By attaching surface transducers onto the roots of the trees without hurting them, we could hide the technology from users. This made it possible for us to create affectively engaging

experiences [5] of the trees as actual living sound sources using soundscapes and haptic vibrations.

In our explorations, we worked with three different uses of surface transducers in the design of three distinct listening experiences. One of the concepts was called *Microhabitats*. Trees provide a home to a number of bats, bugs, woodpeckers and other kinds of animals that live inside the tree. By creating auditory peepholes [2] inside of its trunk, we designed an experience where users could activate different sound sources, imitating these animals by exploring the tree. Another concept was called *Time Tree*, where the age of the tree was in focus as many of them are hundreds of years old. By climbing upwards, users could experience different soundscapes from different time eras making the users experience some of the same sounds as the tree might have experienced during its life.

The concept we will demo at DIS is called *the Living Tree*. Here, we use soundscapes inspired by fictional characters and ambiances from movies and literature such as "giants", "monsters" and the like, to provide an augmentation of the inner life of a tree, which is otherwise inaccessible to our senses. Using Kinect sensors, we give people the ability to interact with the tree by moving around and climbing on it, causing the tree to react differently, expressing itself with different sounds. When a person approaches the tree a sound of heavy breathing appears from it, and if a person makes direct contact with the tree by touching it or placing their ear directly onto the trunk, sounds of water running through the wooden veins combined with a heavy pulse and breathing make the tree come alive sonically. The intention is to make participants form a different relation to the tree to affect their ties to trees



Figure 3: Testing surface transducers on an actual tree in the wild.

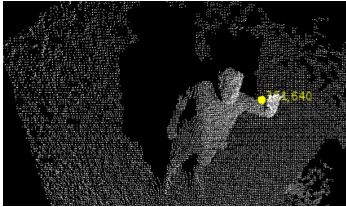


Figure 4: 3D output from Kinect showing how the tree reacts to human interaction.



Figure 5: Users can experience a hidden auditory world within the trunk of the tree, with help from surface transducers.



Figure 6: A smaller scale implementation of the project adapted to be used indoors, which is how we would demo the installation at DIS.

and the woods in general at a higher level. The *Living Tree* is thus about expanding our knowledge about trees by creating a multi-sensuous and affectively engaging experience that lets people explore how trees are not only resources, but living creatures with personality, character and expression.

### Conclusion

In all three concepts we have used the surface transducers to change the way people think about trees, making them reflect upon them as living beings and habitats for other species rather than a resource of man. In *the Living Tree*, we have designed an interactive listening experience which conveys this overall agenda through different technological means. The design explores the variety of experiential outcomes that the surface transducer technology can provide; hidden auditory content that adds new meaning to an object, haptic feedback that augments objects through sonic interaction and the potential to create affectively engaging listening situations combining the materiality of the tree, the quality of the soundscape and the interactive experience of exploring the combination of the two. We believe there is great potential in further investigating the use of surface transducers as a design material when designing rich interactive experiences and hope to contribute to furthering this research through this demo.

### References

1. Peter Dalsgaard and Christian Dindler. 2009. "Peepholes as Means of Engagement in Interaction Design". *Nordes 2009: Engaging Artifacts Oslo, No. 3*. Oslo, Norway.
2. Dayton Audio. 2017. Tech Note: "Understanding Exciters – Principles and Applications". Retrieved May 5, 2017 from [https://www.parts-](https://www.parts-express.com/pedocs/buyer-guides/understanding-and-using-dayton-audio-exciters.pdf)

[express.com/pedocs/ buyer-guides/understanding-and-using-dayton- audio-exciters.pdf](https://www.parts-express.com/pedocs/buyer-guides/understanding-and-using-dayton-audio-exciters.pdf)

3. Jules Françoise, Sarah Fdili Alaoui, Thecla Schiphorst, and Frederic Bevilacqua. 2014. "Vocalizing dance movement for interactive sonification of laban effort factors". *In Proceedings of the 2014 conference on Designing interactive systems (DIS '14)*. ACM, New York, pp. 1079-1082.
4. Karmen Franinović, Christopher Salter. 2013. "The Experience of Sonic Interaction". *Sonic Interaction Design*, pp. 39-75. Cambridge, MA, The MIT Press.
5. Jonas Fritsch. 2009. "Understanding Affective Engagement as a Resource in Interaction Design". *Nordes 2009: Engaging Artifacts Oslo, No. 3*. Oslo, Norway.
6. William W. Gaver. 1986. "Auditory Icons: Using Sound in Computer Interfaces". *Human-Computer Interaction*. Taylor & Francis, pp. 167-177.
7. Paula Henry and Tomasz R. Letowski. 2007. "Bone Conduction: Anatomy, Physiology, and Communication". Aberdeen Proving Ground, U.S. Army Research Laboratory.
8. Trevor Hogan, Uta Hinrichs, and Eva Hornecker. 2017. The Visual and Beyond: Characterizing Experiences with Auditory, Haptic and Visual Data Representations. *In Proceedings of the 2017 Conference on Designing Interactive Systems (DIS '17)*. ACM, New York, NY, USA, pp. 797-809.
9. Markus Kison. 2007. "Silent and Invisible WWII Memorials Using Bone Conduction - 'Touched Echo'". Website retrieved April 8 from: [http://www.markuskison.de/touched\\_echo.html](http://www.markuskison.de/touched_echo.html)
10. Hannu Kukka, Jorge Goncalves, Kai Wang, Tommi Puolamaa, Julien Louis, Mounib Mazouzi, & Leire Roa Barco. 2016. Utilizing Audio Cues to Raise Awareness and Entice Interaction on Public Displays. *In Proceedings of the 2016 ACM Conference on Designing Interactive Systems - DIS 16*, Brisbane, Australia.



