Tunnel Divisions: Interactive Sound Mapping of Transitory Public Spaces

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Abstract
We present *Tunnel Divisions*, an interactive musical installation designed for ephemeral interaction in public spaces. Informed by concepts from cultural and media studies along with existing literature on interactive public displays, we designed the installation as an intervention meant for the monotonous parts of everyday life. Our demonstration uses low-cost sensors and musical theory to create a generative sound composition unique to the particular space and the people moving through it. By experiencing the installation, we hope to promote critical thinking about the nature and form of interaction with public spaces.

ACM Classification Keywords
H.5.2 User Interfaces: Auditory (non-speech) feedback.

Introduction
A persistent focus of the human-computer interaction (HCI) community has been how to better engage passersby with interactive devices in public spaces, spurring thorough design requirements [8] and interaction models [4]. We designed *Tunnel Divisions* as a *critical making exercise* to explore musical rather than visual systems for public spaces. *Critical making* is a methodology used in design to connect critical thinking, which is traditionally thought of as conceptually and linguistically based, and physical

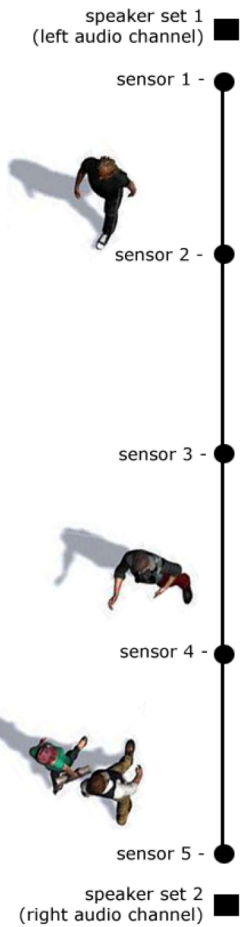

Figure 1. Arrangement of the five PIR sensors and 2 sets of speakers in a corridor. Sensors are 20 feet apart, but can be adjusted to fit other spaces.

making, using making practices as processes of material and conceptual exploration [10]. In designing the piece, we aimed to question trends in HCI literature such as the persistence of visual displays, the prizing of audience attention, and the characterization of "public spaces" as significant places punctuating daily movements as opposed to forgotten spaces in between.

The resulting installation is a low-cost augmentation that adds to the experience of a space without stopping the people moving through it, generating a fleeting sonic map of these transitory spaces through a process we term *data phonolization*. Taking cues from the practice of data visualization in which information is collected and mapped to present a clear visual representation of data, data phonolization similarly draws from large and complex data and distils this information into an organized, perceivable structure. The intent of data phonolization is to encourage listening to sounds within an environment which otherwise promotes the perceptual filtering of noise.

Motivation

Studies of interaction in the context of public and semi-public environments have a continuing presence in HCI. Review of the literature revealed trends in the following three areas: how urban spaces were characterized [4, 6]; which types of technologies proliferate in public settings [3, 9]; and predominant interaction paradigms [7, 11]. Tunnel Divisions is a response to all three.

Tunnel Divisions: Design Goals

Tunnel Divisions is an interactive music installation that uses the rhythms of a public space to organize a generative sound composition. The goal of the installation is to prompt contemplation about the role of interactive surfaces and spaces (ISS) in public life, while creating a sense of joy or wonder for those who participate in the installation. The use of ISS in public spaces carries a set of challenges, such as smooth integration into people's day-to-day movements [5], accumulation of visual clutter [8], and how to solicit attention to convert passersby into "users" of an interactive system in a public space [4]. *Tunnel Divisions* explores these challenges as follows:

1. We use the concept of a "non-place" [1] as a new context for public interaction. These are the places often ignored as we move between lobbies, train stations, offices and other spaces where interactive public systems are usually found. By using this concept, we ask how interactive spaces can enhance or augment people's experiences of the "in-between" without fundamentally changing the identity of that space.

2. We avoid visual primacy in the design, relying on the physical movement of passersby as input, with a musical output response. This is similar to the concept of proxemic interaction [2] in that the space is divided into "zones" which affect system activity as people move through them and trigger sensors. The zones however do not hold different meanings, nor are they imbued with social or cultural significance. The auditory output is specifically designed to preserve the integrity of non-places by not changing their meaning.

3. It does not rely on attracting or holding the attention of passersby, as is a main concern in implementations of public displays [6]. This design decision was made to ask whether attention, or lack thereof, is required for "successful" interactions in public spaces, and how the

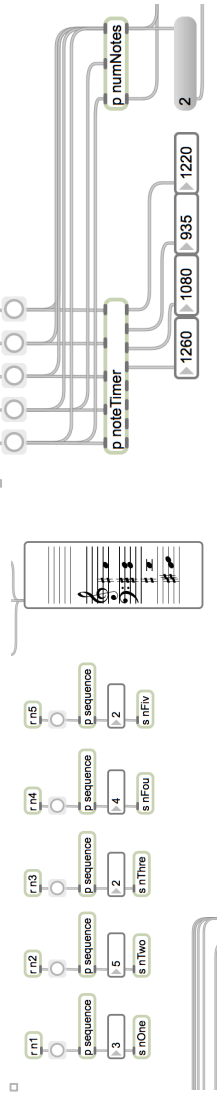

Figure 3. A detail of the sequence subpatchers which are used to select notes from the current key. The output in notation format can be seen on the far right.

Figure 2. Detail of the Max/MSP patch where sensor input feeds into the noteTimer and numNotes subpatchers, which determine the timing of note patterns and the number of notes to be output.

current interaction models used to describe public interaction [7, 11] are affected when design goals shift.

Tunnel Divisions is a physical expression of studies within the digital humanities of the tension between technology and culture in constructing the social meaning of spaces, created with the intent of raising issues for contemplation within the HCI community. We encourage those with an interest in designing interactive systems for public spaces or those with an interest in designing public spaces that may incorporate interactive technologies to experience this demo.

Tunnel Divisions: System Design

Tunnel Divisions is set up in a long hallway-like space such as a corridor or tunnel, where people are moving through as opposed to congregating within the space. The system uses five passive infrared (PIR) motion sensors, an Arduino microcontroller, Max/MSP[1] and Ableton Live[2]. The five sensors are used to divide a space into four measures of music, hence its name: *Tunnel Divisions*. The name also refers to the expression "tunnel vision" where an individual has narrow or limited attention to their surroundings. Individuals moving through the tunnel trigger piano notes, which are output through two sets of speakers.

The speed with which individuals move between sensors determines both the tempo of the subdivision of notes, as well as the complexity of note phrases, and scheduling of key changes. The major pentatonic scale is used to select from five musical notes, the set of which subtly evolves between closely related keys over time based on the density of traffic. The left and right audio channels are positioned at opposite ends of the tunnel, and rhythmically echo each other across different octaves and playing dynamics. The resulting musical composition is an indeterminate, evolving and ephemeral map of a space. Those passing through hear ambient-sounding piano notes echoing in response to the sensors being triggered, and as more people follow or cross paths, these notes develop in frequency and complexity. The system parameters (length/spacing, patches and timers triggered by the sensors, number of sensors, and so on) can be adjusted to fit spaces of different lengths and amounts of traffic.

Observations

To initially evaluate our design, *Tunnel Divisions* was installed for four hours in an underground 100-foot tunnel (with sensors spaced at 20 feet each) connecting two buildings on the University of Waterloo campus chosen for its "non-place" qualities. We observed some of the expected effects of deliberate design decisions, such as the slowing of pace, but not stopping or reversing direction. This supports our goal of becoming part of the space as opposed to overriding or changing the experience of the space. By using music in this drab setting, some passersby commented to their friends that we "really liven[ed] it up", suggesting the idea that the space otherwise ceases to exist when not in use. The sound generated and recordings captured during this instance of Tunnel Divisions act as a data phonolization particular to a time and place.

In this design, we did not aim to interrupt the flow of traffic or disengage people from their environment, but rather connect them to the space. We attempted to challenge existing concepts of motivation for interaction

[1] Max/MSP: https://cycling74.com/products/max/

[2] Ableton Live: https://www.ableton.com/en/live/

Figure 4. A student passes through *Tunnel Divisions* in an underground tunnel on the University of Waterloo campus.

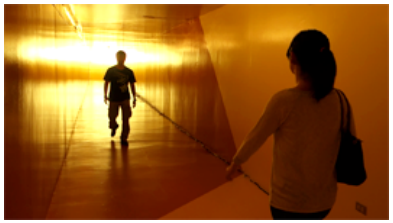

Figure 5. As more people traversed the tunnel, the music reflected this increased traffic through complexity of musical components such as key changes and note phrases.

in public spaces by inverting the sense of choice or control, while leaving the door open to curiosity and exploration [8]. In some cases people appeared uncomfortable and mediated their experiences with technology by staying focussed on their phones, or left headphones on and did not engage. It was unclear whether this was a reaction to being observed, or to the experience itself. The means of moving from indirect to intentional interaction with the system was not a matter of stopping and paying attention, but of removing barriers separating person and environment.

Conclusion

This interactive demo is a response to the way that large public displays can arrest movement and demand the attention of passersby. With *Tunnel Divisions*, we aim to augment the unfolding human experience between point A and point B, as opposed to disrupting the natural flow of bodies through a space. We use sound to emphasize "non-places" by mapping it to transitory environments. We hope the demo participants will question the ways that technology can be used to relate people to the spaces around them, the ways that interactive technologies change the meaning of the spaces they inhabit, and alternative ways to think about the forms and functions that interaction in public spaces can take.

Acknowledgements

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