Sonic Interactions as Situated Urban Practice with BIKES

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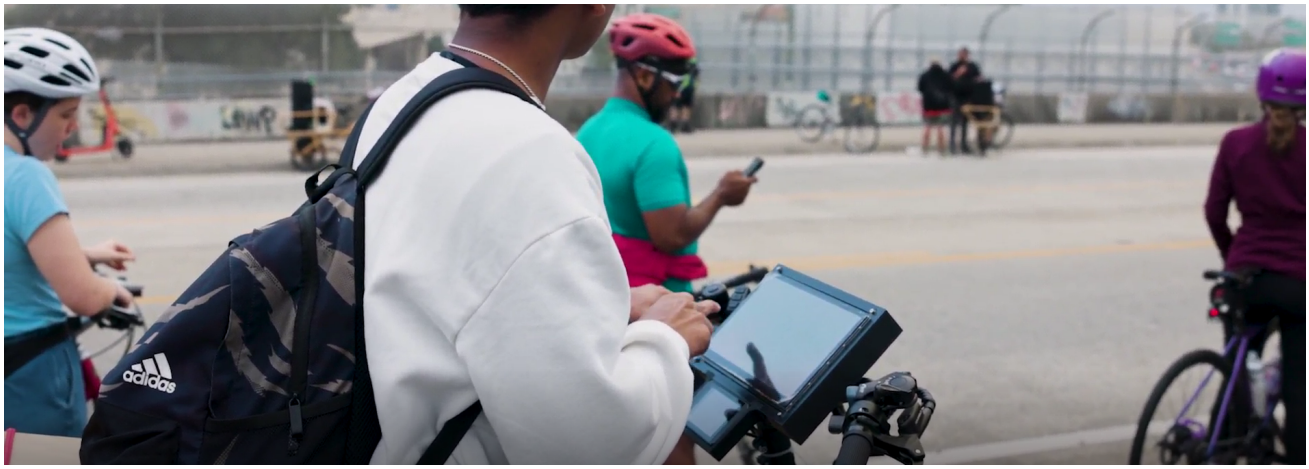

Figure 1: Impromptu installation with BIKES on a bridge over a 14-lane freeway.

Abstract

This paper presents a practice-based artistic approach to urban sonic intervention using a moving networked instrument. BIKES consists of four electric cargo bicycles equipped with battery-powered sound systems and interconnected through a mesh network. Operating both in motion and as an impromptu installation, the instrument enables critical and engaging forms of situated urban practice. This potential was explored through a group ride in the inner city of Atlanta, following a route that highlighted shortcomings in urban design as well as cultural specificities of the city. The activation demonstrates how BIKES can function as an interface for engaging with the acoustic, social, and environmental affordances of urban space. Sonic interactions during the ride and at selected stops engaged the riders of the four BIKES as individual listeners, the group as a coordinated collective, and incidental audiences across multiple levels. Based on these observations, the paper proposes a provisional framework that differentiates between individual, co-present, and environmental scopes of acoustic interaction in urban settings.

Keywords

Urban Soundscape, Situated Urban Practice, Networked Music Instrument, Bicycles

1 Introduction

BIKES[1] is an ongoing artistic research project that explores a moving networked instrument for music and sound art in urban surroundings. Four electric cargo bikes, each equipped with a battery-powered sound system and an onboard computer with a touchscreen interface, are connected through a wireless mesh network. As a distributed instrument, the system can be used both in motion and for impromptu interactive sound installations.

With its mobile and accessible nature, combined with its interactive capacities, BIKES is intended for several use cases, including critical acoustic interventions and forms of positive engagement connected to local identity. The underlying hypothesis is that this type of instrument enables immediate and direct interaction with its surroundings, including the site itself as well as the people encountered. The city-specific activations facilitated by the instrument are more than isolated artistic encounters. Without moralizing, they engage with political aspects of urban space. The instrument as a whole is conceived as an acoustic interface for engaging with the surroundings by challenging, complementing, and celebrating them.

As an expressive and interactive instrument, BIKES operates on different levels. It functions as an immersive sound system that can be deployed easily, increasing accessibility. The networked nature of the system, together with its user interfaces, allows for interactive installations that support multi-user interaction. Finally, this is not a mobile but a moving instrument. This distinction is crucial, as sound production, spatial perception, and interaction are directly shaped by continuous motion through the environment rather than by relocation between static sites.

The instrument is designed to be more than a musical instrument or a system for sound installations. It is an interface to the social-ecological affordances of urban surroundings, revealing problems and shortcomings while also celebrating local qualities and cultural specificities. After several test runs and smaller activations, BIKES was deployed in a dedicated group ride in Atlanta, exploring the full potential of the instrument. Through the situated urban practice presented here, we aim to develop a method that can be translated to other urban settings, as many underlying conditions are shared across cities worldwide.

[1] https://l42i.music.gatech.edu/bikes

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While no single framework formally classifies urban sound art according to audience scope, distinctions between individual, social, and environmental address recur across soundscape theory, sound installation practice, and contemporary sound studies. Building on these perspectives, this paper introduces the scope of acoustic interaction as an analytical lens for differentiating relevant practices. Activations can be categorized by their *scope of address*: whether the sonic situation is primarily oriented toward (i) an individual listener, (ii) a selected or co-present audience, or (iii) the surrounding urban environment and incidental audiences. This distinction reflects longstanding debates concerning soundscape, listening, and public sound practice [1, 15].

Rather than aligning with a single category, a moving instrument such as BIKES enables dynamic shifts between these scopes: from rider-centered listening to co-present audience situations and engagement with the surrounding urban soundscape. The activation presented in this paper leverages this capacity to engage with a range of aspects of the urban soundscape and infrastructure.

The basic technology and approach of the instrument were introduced in a dedicated publication [11], followed by an in-depth discussion of the interdisciplinary nature and educational concepts of the project [2]. This paper contextualizes BIKES as an instrument for situated urban practice within a practice-based artistic research approach. Section 2 introduces relevant related work, followed by an overview of the system and its technology in Section 3. Section 4 provides a detailed account of the group ride, followed by a discussion and situated reflection in Section 5, and a conclusion in Section 6.

2 Related Work

The following section reviews urban sound art and musical practices in which locomotion serves as a central organizing principle. This includes moving listeners, either walking or using other means of transportation, but also moving sound sources in situated urban activations. A core use case of mobility in urban sound art is locative media—making use of position tracking, geotagging, and related technologies to create site-specific experiences [22]. Other examples foreground acoustic interactions, sometimes at a city-wide scale. The listed examples differ significantly in scope and technology, but they all create engagement between participants, listeners, and their surroundings.

2.1 Soundwalks: Listening in Motion

The soundwalk is a well-established form of sonic urban practice. It is inherently site-specific and is often used as a means to increase the audience's awareness of its surroundings. Early examples, such as Max Neuhaus' *Listen* (1966), are not based on advanced technology. Neuhaus handed out a single printout reading *Listen* to each participant and then led them on a walk through urban settings with the instruction to listen carefully to their environment [13]. This work does not emit additional sound but instead centers listening as a critical practice.

Neuhaus continued this line of work with *Times Square* (1977). He installed a sound generator and a loudspeaker in a street grate beneath *"... one of the loudest places in the world."* [13]. Still active today, the installation emits sound events that bear a close resemblance to the surrounding city noises, thus challenging the perception of incidental audiences. This example juxtaposes existing urban sounds with intentionally introduced sounds.

Christina Kubisch's *Electrical Walks* (2003) uses magnetic headphones to make electromagnetic signals in urban surroundings audible. The concept has been realized in many different locations and cities, always based on a map marked with local acoustic landmarks to guide listeners [14]. This approach gives participants the opportunity to discover unseen and unheard signals in urban surroundings, particularly those resulting from electromagnetic pollution.

Sonic City (2003) is a soundwalk that uses *the city as an interface* for an interactive experience [5]. Participants are equipped with environmental and biometric sensors, as well as a laptop for sound generation, worn as part of a wearable setup. While moving through the city, the system creates sound events based on movement and mobility, as well as on light intensity, pollution, temperature, and acceleration, which are played back over headphones. This playful and engaging approach creates an inherent site-specificity, combining environmental and behavioral information while also revealing critical conditions in the surroundings.

With the widespread adoption of smartphones, soundwalks became a common practice. Equipped with GPS and onboard signal processing capabilities, these devices enabled the straightforward implementation and dissemination of soundwalk-related concepts. Geolocation in particular emerged as a central operational paradigm in contemporary soundwalk and locative audio practices [4].

2.2 Vehicle-Centered Concepts

Using vehicles instead of walking creates a shift in site relevance and sonic intervention principles. An early car-based example, *Drive-in Music* by Max Neuhaus, is based on an arrangement of radio transmitters, each playing different content on the same frequency [13]. In 1967, the transmitters were arranged alongside a street in Buffalo, New York, each covering a different section of the street. Cars passing through would receive location-dependent content when tuned to the correct frequency. This represents a clear connection between movement, technology, and environment, though only for those inside the car.

Using geolocation techniques such as GPS, Teri Rueb explores the concept of the *mobile playhead*, in which a vehicle's movement through GPS coordinates triggers site-specific soundscapes, effectively turning the highway into a non-linear musical score. The study emphasizes how the car's velocity dictates the temporal flow of the acoustic narrative [20].

Car-Horn Concerts have emerged as a practice in which cars function as distributed sound sources. Sometimes parked and sometimes in motion, radio signals or other control mechanisms are used to coordinate which car honks and when. In city-scale performances such as *Yokomono-Pro* [7], the car horn shifts from a traffic signal to a rhythmic and spatial element. The movement of the vehicles contributes to the acoustic perception of urban space.

Large-scale sonic interactions in urban environments intervene in public space and address invited as well as indeterminate, incidental audiences, treating the city as an acoustic and social interface. In this context, sound is regarded as a political economy and a mode of intervention in public life [1]. *Harbour Symphony* was first performed at the Newfoundland Sound Symposium in 1983 [16]. A fleet of boats and ships in the harbor sounded their horns, synchronized through cues sent via radio. A version

composed by Hildegard Westerkamp for EXPO '86 in Vancouver included over 100 ship horns. This large-scale performance exemplifies how a moving, inherently spatial work of sound art can reach a large, partly incidental audience.

Given their accessibility and ubiquity, bicycles have been frequently used in sound art and musical activations in urban settings. The bicycle is understood as an *interface between civility and nature, between poetics and technological evolution* [18]. Critical Mass rides, for example, have been referred to as a *performative critique of motorized space* [3]. Bicycle-based sound art combines mobility, listening, and urban intervention. While some examples, such as *Movable Party* [10], use the bicycle as a stationary power source, mobility usually serves as the central organizing principle.

Mauricio Kagel's piece *Eine Brise* (1996) is written for 111 cyclists [9].[2] The audience is positioned at a street corner while the convoy rides past, making the piece last up to 90 seconds. According to the score, the riders ring their bells, whistle, and sing while passing. In this example, movement and site play a vital role in the experience.

Kaffe Matthews has explored vehicles for sound art in different projects, including kayaks [6] and bicycles. Her ongoing *Sonic Bikes* project frames cycling as a mode of musical interaction and urban exploration [17]. The bicycles feature two rider-facing loudspeakers and a subwoofer under the seat, creating a sonic experience for the rider. Matthews uses GPS sensors on the bikes to generate dynamic, site-specific sound streams when participants follow predefined routes. Later versions of the bikes incorporate various sensors to track motion and environmental data.

During the 2020 COVID lockdown, Dom Whiting began riding his bike through neighborhoods while playing drum and bass music through PA loudspeakers [19]. After spontaneously attracting crowds behind him, his DJ bike rides developed into large-scale organized events that closed down parts of major cities, with up to 5,000 riders. The music is streamed to multiple bikes for synchronous playback, increasing the area covered, with up to 15 loudspeakers. This form of activation operates on a wide scale, both in terms of traffic impact and acoustic emission.

These examples illustrate how bicycles can operate across all three scopes of address: for individual riders, for co-present audiences, and at the scale of the urban environment.

3 The Technology of BIKES

3.1 Hardware

BIKES is based on four electric cargo bicycles that are interconnected to act as a single instrument. While technical details have been presented in [11], this section introduces the basic functionality of the system in its current version. Figure 2 shows a single bike equipped with all necessary technology during an installation. The cargo bikes are designed and manufactured by our project partner Edison Electric Bike Co.[3], an Atlanta-based enterprise. A wooden box is mounted to the rear, housing a *Behringer U-PHORIA UMC22* audio interface, a mesh router, and other peripherals. A battery-powered *Mackie Thrash212* loudspeaker with a 12" woofer and 1300 W output is strapped to the box. A *Raspberry Pi 5* with a 10" touch display is attached to the handlebar in a custom-designed and fabricated housing and connected to the peripherals in the rear. The touch display is used for interactive installations and provides a minimal interface for riders.

[2]https://www.wisemusicclassical.com/work/69768/Eine-Brise--Mauricio-Kagel/
[3]https://edisonbicycles.com/

Figure 2: One of four bikes with mounted technology.

All components are powered by onboard batteries, enabling operation over extended periods without external power. This autonomy is critical for group rides, during which the bicycles move continuously through heterogeneous urban environments and stop only briefly at selected locations.

3.2 Network

After initial experiments with a standard WiFi network in a star topology, BIKES was updated to a mesh network to increase system robustness during movement. Each bike hosts a *Ubiquiti UAP-AC-M-US UniFi* mesh router, directly connected to the Raspberry Pi via Ethernet. This upgrade improved the performance of the system, reducing connection dropouts and increasing range.

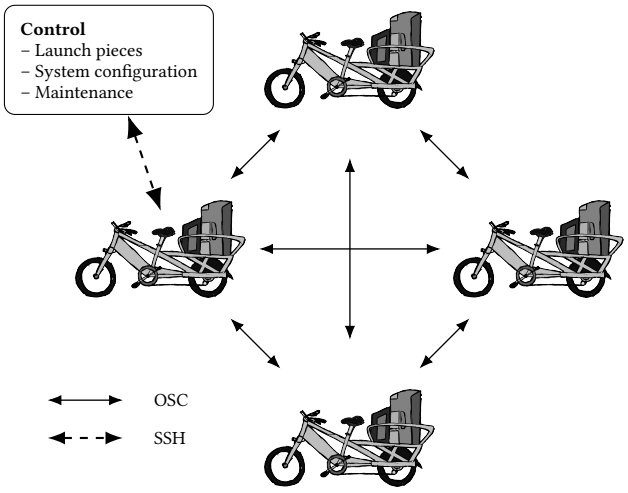

Figure 3: Fully connected mesh network with control access.

The mesh configuration enables a decentralized network, as illustrated in Figure 3. Inter-bike communication is predominantly realized via Open Sound Control (OSC) for control and synchronization data. Real-time audio is not shared at this stage, given the limited performance of low-latency audio transmission over WiFi. The system can be accessed using additional devices, usually a laptop, for configuration and maintenance via the Secure Shell (SSH) protocol. In this case, the laptop connects to any of the mesh routers to access all four nodes.

3.3 Software

Figure 4 shows the core software components on a single bicycle. All software runs on the Raspberry Pi, which is connected to the touch display, router, and audio interface.

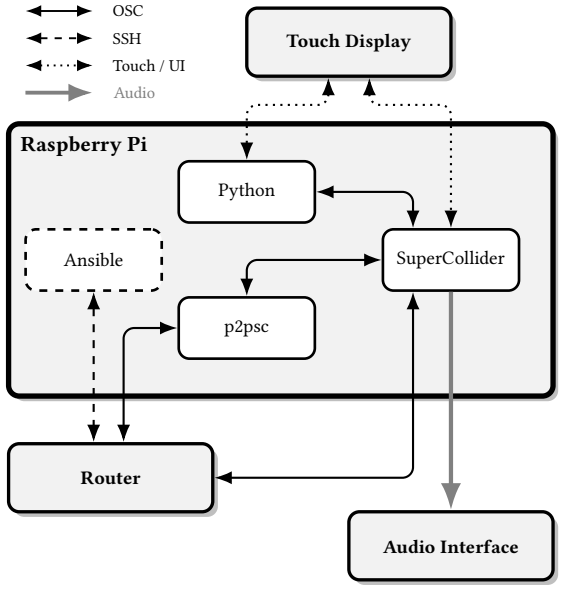

Figure 4: Hard- and software components on a single bike.

SuperCollider is used as the default audio synthesis and processing environment, given its ability to run headless and to be configured during runtime via OSC. Communication between nodes is largely realized through OSC within SuperCollider. In addition, the *Ableton Link* implementation in SuperCollider is used to synchronize rhythmic sequences across the bikes. The GUI capabilities of SuperCollider are used to create minimal user interfaces for riders.

p2psc[4] is used to facilitate inter-node communication. This Python-based network overlay implements auto-discovery for all nodes in the mesh via OSC and is integrated into SuperCollider through custom classes. Lower-level concepts such as addresses and ports are handled by p2psc, exposing only node names to the user.

Python is at this stage mainly used for the design of graphical user interfaces, based on PyGame[5] and OpenCV[6]. It communicates directly with SuperCollider via OSC to translate touch input into control data for the sound system and to visualize the system's status.

Ansible is used as the backbone for system management and configuration [23]. This system administration tool enables the orchestrated execution of SSH commands on a server cluster, organized in so-called playbooks. For each concept or composition, a dedicated playbook launches all software components in the appropriate configuration and sets system parameters accordingly.

4 Urban Activation: Group Ride

4.1 Urban Context

US metropolitan areas have a reputation for being unwalkable and unbikeable. This condition results from car-centered urban planning associated with sprawling neighborhoods. On a larger scale, this also applies to Atlanta. With a metro area population of about 5 million, the car is the primary, and sometimes only, mode of transportation. The inner-city area of Atlanta, however, is more bike-friendly than commonly assumed. This push toward a more bike-friendly city, despite its shortcomings, is not uncommon for US cities in the 21st century, making bike-based situated urban practices both relevant and possible. There is sufficient cycling activity to make it a viable topic, and enough challenges related to inner-city mobility to justify intervention.

4.2 Concept and Organization

While BIKES had previously been deployed in various contexts [2, 11], the public group ride presented in this paper was the first attempt to explore the transformative potential of the instrument. Earlier presentations, such as interactive installations at art events and participation in larger group rides, provided only proof of concept for isolated use cases. With the organized group ride, we aimed at immediate interaction with the urban surroundings, delivering on the promise of an *in-the-wild* approach. The system was used in all three intended scenarios:

(1) Moving PA system for music playback along the route.
(2) Soundscapes performed by the artists.
(3) Interactive installations for audience participation.

The ride was intended to focus directly on the idiosyncrasies of Atlanta, in terms of its culture, iconic places, and infamous traffic conditions. The event was organized in collaboration with several community partners to allow for a deeper connection. Fulton County Arts & Culture[7] was the main partner in organizing the ride, providing a location for a pre-ride gathering and facilitating connections to other community partners. Two local cycling communities, MOBB ATL[8] and Red, Bike and Green-Atlanta[9], helped organize the ride. With over 30 participants, the group could leverage the dynamics of a critical mass. While riding, the group occupied all lanes in one direction, resulting in a safer trip.

4.3 Route Planning

Planning the route is a crucial step in designing the group ride as a site-specific sonic interaction. The route defines the nature of the situated urban practice as much as the sound and interaction design. In the first stage, desirable stops and paths were selected by the BIKES team. These were chosen to highlight both favorable and unfavorable aspects of the urban surroundings, including:

- Sites characterized by significant noise and air pollution.
- Sites with increased risk for pedestrians and cyclists.

[4] https://github.com/L42i/p2psc
[5] https://www.pygame.org/
[6] https://opencv.org/
[7] https://www.fultonarts.org/
[8] https://www.mobbcycling.com/
[9] https://www.redbikegreenatl.com/

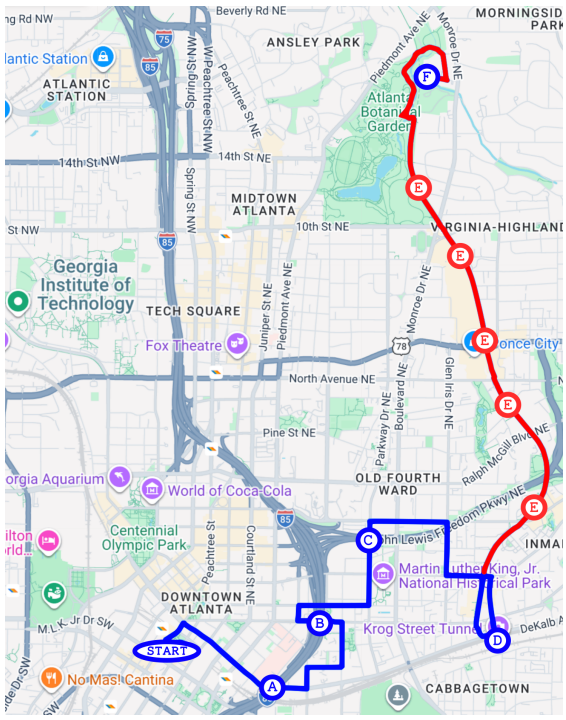

Figure 5: Route through downtown and midtown Atlanta.

- Iconic sites representative of the city's identity.
- Sites with favorable acoustic conditions and spatial qualities.

Together, these elements contribute to the character of a city and its perceived quality for its inhabitants. Each of the above-mentioned scenarios calls for a different form of sonic interaction and sound design.

The list of locations was shared with our partners in the cycling communities, who created a route based on it. It had to be shortened to keep the ride to a reasonable duration, especially since frequent stops along the route significantly extend the overall event. The resulting route, shown in Figure 5, includes six locations over a total distance of 11 km. A conventional ride without additional stops would take approximately 44 minutes. The group ride lasted a total of three hours, including all stops. In the remainder of this section, each relevant stop or segment is introduced in order along the route, focusing on its affordances for the activation and the way it was integrated into the ride.

4.4 Locations and Interactions

A Freeway Bridge: Challenging Noise Pollution. With two major interstate freeways running through the center of Atlanta, the *Downtown Connector* exemplifies 20th-century urban planning that divides the city and introduces significant air and noise pollution. Especially for pedestrians and cyclists, this inner-city freeway presents a major obstacle. Bridges over it, some not designed for anything but cars, pose significant safety risks.

The *Decatur Street* freeway bridge presents a highly exposed acoustic environment. Without noise barriers, it exhibits high noise levels, particularly during commute times. In this scenario, we intervened by creating a quadraphonic soundscape spanning the bridge, as shown in Figure 1 on the first page. A maritime soundscape was chosen to complement the near-white noise from the cars underneath. This approach combines two soundscapes with similar timbral characteristics but contrasting affective associations. Following R. Murray Schafer's soundscape theory, the installation consisted of layered elements corresponding to Soundmarks, Signals, and Keynotes [21]. The sound of waves formed a continuous background layer, while performers triggered events such as flocks of seagulls and ship horns via the touch display.

The designated riders controlled the soundscape, as traffic conditions between the bikes did not allow the other participants to cross the street. The group ride was the only audience during this stop.

B Freeway Underpass: Engaging with Urban Acoustics. As with the freeway bridge, the underpass is characterized by high noise levels and initially appears as an unfavorable environment. However, as a fully roofed structure, it exhibits acoustic and spatial properties that distinguish it from the open bridge context. Street art projects cover the walls. The underpass offers shelter, and its concrete surfaces produce pronounced reverberation.

An industrial soundscape was chosen, since its high-density layers articulated the acoustics of the space while resonating with its industrial appearance. Given the traffic situation, the underpass stop was again controlled by the designated riders, with the group ride as the only audience.

C Scenic View: Connecting to the City. *Jackson Street* bridge provides a well-known view of Atlanta's downtown skyline. This overlook attracts visitors who take photographs for weddings, graduations, and other occasions. The site was included in the ride as an iconic landmark to engage with the city and document the event. Figure 6 shows a photograph taken at this stop with participants of the group ride.

Figure 6: The group ride at Jackson Street overlook.

At stops such as this overlook, and while moving through the city, BIKES played music by local artists synchronously across all four bicycles, prompting recognition and noticeable appreciation among passersby familiar with Atlanta's music culture.

D Neighborhood Tunnel: Competing with Traffic. The *Krog Street Tunnel* is part of the Beltline, connecting two neighborhoods in Atlanta's urban core. It is well known for its street art and serves as a frequent location for photo and video shoots, music videos, and social media content. At the same time, it functions as a traffic bottleneck with severe noise conditions for pedestrians and cyclists. Its reverberant acoustics have also made it a site for several music performances in the past. This contrast made the tunnel a compelling part of the route. Figure 7 shows the group passing through the tunnel while playing a synchronized music playlist. By fully occupying the tunnel, this activity drew immediate attention and reached audiences in passing cars.

Figure 7: Riding through Krog Street Tunnel.

E The Beltline: Connecting to Incidental Audiences. The Beltline is a 21st-century urban planning project aimed at enabling alternative means of transportation [12] and outdoor activities. Now nearing completion, this 35 km-long former railway corridor encircles the inner city and is designed to be shared by pedestrians, cyclists, and other users for commuting and leisure. While often cited as a model project for sustainable urban development, it has also been criticized as a catalyst for environmental gentrification [8].

Regardless of its political dimension, it is the most popular urban corridor in the metropolitan area, attracting visitors for strolling and activities such as roller skating and jogging. While playing synchronized popular music, the ride followed the busiest section, the Eastside Trail, which attracts 3,000 users on weekdays and over 10,000 on weekend days, thereby reaching a large incidental audience.[10]

Figure 8: Experiencing a quieter acoustic environment along the Beltline.

F The Park: Engaging Natural Soundscapes. The ride concluded in a secluded section of the Beltline featuring an interactive sound installation that could be controlled by all participants. This site was chosen as a contrasting example: only a few minutes from a busy freeway, it offers a quiet, green environment. This part of the Beltline is less developed than other sections, meandering through a more overgrown area near the city center. The section shown in Figure 8 is approximately 20 m long and bounded by natural stone walls on both sides. These surfaces provided acoustic reinforcement during the activation. The site also features a sculpture by local artist JD Koth[11].

At this location, the instrument was used to create a rainforest soundscape, extending the existing natural sound environment. Keynote sounds such as wind in branches and distant birdsong were played continuously across all systems. Participants could approach the touch displays, as shown in Figure 9, to trigger foreground sounds such as animal calls.

Figure 9: Group ride participant interacting with BIKES during an installation along the route.

5 Discussion

BIKES is situated within artistic and research practices that treat the city as an acoustic, social, and performative environment. Observations by the artists and development team informed successive design iterations and revealed recurring patterns in how riders perceived spatial relationships, coordination, and agency within the distributed sound environment. Through its networked structure, instrumentality was distributed across riders, system, and city, making urban space an active musical agent. By directly engaging with the environmental and social idiosyncrasies of the city, sound art becomes a form of situated urban practice.

5.1 Route and Ride

Although the group ride was considered a success by riders and participants, this activation also revealed several areas for improvement. Selecting relevant locations for the project and planning the route with experienced partners helped shape the experience. However, the ride was still too long, especially given the challenges of navigating the inner city.

In terms of safety and organization, it must be emphasized that such a group ride, even at a manageable size of 30 riders, should not be planned without expert support. This is also reflected in Kagel's score for *Eine Brise* [9], which provides clear safety instructions for the riders. The support of our community partners, who directed the convoy and gave instructions throughout the ride, was essential in ensuring a safe event.

The concept of the ride demonstrated the value of the bicycle as an interface and instrument for situated urban practice. One noticeable aspect of Atlanta is the abrupt transition between contrasting sites. This rapid change in the urban surroundings is a central feature of many metropolitan areas, particularly in US cities. A bike ride is well suited to highlighting this dynamic, revealing rapid shifts in context while remaining embedded within them. These transitions also produce shifts in the scope of acoustic interaction, moving between individual listening, group-oriented situations, and engagement with the

[10] https://www.landscapeperformance.org/case-study-briefs/atlanta-beltline-eastside-trail
[11] https://beltline.org/art/rakshasa/

surrounding urban environment. This mode of interaction increases awareness of the urban setting as a whole and enables a range of different interactions.

5.2 Sonic Interaction Design

The sonic interactions presented during the ride represent initial explorations within this approach. Playing recognizable music proved effective in engaging incidental audiences, as reflected in positive reactions from passersby. This strategy created a meaningful point of connection, as people in public space are often more receptive to familiar music than to experimental sound art.

The soundscape concept was particularly effective at the freeway bridge, based on participant feedback and observational reflection. Its effectiveness lay in the ability of the sound material to merge with the existing freeway noise below, producing a coherent soundscape rather than masking or opposing the urban environment. Such moments illustrate how the instrument can incorporate environmental sound as a compositional element, establishing a direct dialogue with the site.

Although the interactive soundscape in the park setting was used and appreciated by participants, it was less effective than the intervention on the bridge. This observation points to a recurring tension in sound-based urban practice. Sites with favorable acoustic conditions may not require additional sound to be perceived as meaningful or effective. This applies more broadly to other interventions, including the one on the Beltline. While responses were generally curious and supportive, not all passersby may welcome amplified music in public space.

6 Conclusion and Future Directions

As an instrument and interface to the urban surroundings, BIKES enabled situated urban practices and differentiated modes of sonic interaction across multiple contexts. Through route planning and tailored sonic interventions, the activation remained closely connected to the affordances of the city, revealing shifts between individual, collective, and environmental modes of listening. This approach can be translated to other cities and urban environments.

While the technology requires improvements for long-term durability, it did not hinder the activities during the ride. A next-phase prototype has been designed [2] and may be fabricated in the near future, while the current iteration remains suitable for continued exploration. We are currently integrating UWB distance tracking and geolocation capabilities to incorporate the relative positions of the bikes into future compositions and interaction concepts.

Future work will focus on the systematic exploration of acoustic strategies that leverage the distributed and moving nature of the instrument. This includes reverberation patterns of urban structures, Doppler effects, latency-related phenomena, and other spatial-temporal characteristics of sound in motion.

7 Ethical Standards

The activation was an open public artistic event and not a controlled experiment. Photo and video documentation were created in public space for artistic and reporting purposes. No personally identifiable information was collected for research analysis. The project did not require formal IRB review under institutional guidelines.

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