

DESIGNING AUDITORY EXPERIENCES: EXPLORING THE MIGRATION OF BEIJING SWIFTS THROUGH SOUNDSCAPES.

Fangxia Wei^a, Zhigang Wang^{*a}

^a Academy of Arts & Design, Tsinghua University, China

^{*} wangzhigang@mail.tsinghua.edu.cn

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ABSTRACT | “The Voice of Swifts” is an ongoing sonification installation project that transforms the migration data of Beijing Swifts into an immersive soundscape. Utilizing beamforming speakers and spatial audio techniques, the project recreates the swifts’ 30,000-km journey from Beijing to South Africa. It blends swift flocks’ sounds with environmental elements, reflecting geographical stopovers. The installation’s design symbolizes the swifts’ flight, using a “one month per minute” scale for sonification and aligning speaker placement with migratory waypoints. This approach bridges science and public engagement, deepening the understanding of swifts’ ecological significance and the impact of environmental changes. The project exemplifies how art can communicate scientific concepts, enhancing environmental awareness and education.

1. Introduction

The Beijing Swift (*Apus apus pekinensis*), renowned for its remarkable speed, serves as a key model for one of biology's most intriguing puzzles: the mechanism of long-distance migration. Highlighted by "Science" magazine as one of the 125 most challenging scientific questions, it remains at the forefront of ecological research. The migratory journey of Beijing Swifts, spanning nearly 30,000 kilometers between Beijing and South Africa, offers a unique perspective on this complex biological phenomenon. However, this species faces severe threats in its native habitat of Beijing. Urban redevelopment and pesticide use have reduced their numbers from a peak of 50,000 in the early 20th century to just 3,700 in 2021 (National Forestry and Grassland Administration, 2021). This drastic decline not only signals an ecological crisis but also underscores the urgency of understanding and protecting these swifts. Their transcontinental migration is more than a biological phenomenon; it serves as a window into complex ecological interdependencies and the consequences of human activities. Studying their migratory patterns provides insights into ecosystem health, species adaptability, and the broader impacts of human-induced environmental changes.

Sonification is the process of translating data into sound, forming a core component of auditory display systems. By systematically transforming sound parameters, it represents changes and structures in data, leveraging human auditory abilities to enhance data understanding and exploration (Hermann, T., Hunt, A., Neuhoff, J. G., 2011). A study by Supper (2014) emphasizes how sonification in ecological research can turn abstract data into an experiential format, revealing patterns and dynamics that might otherwise remain obscured. In the context of Beijing Swift migration, sonification extends beyond mere data representation. It evolves into a storytelling medium, effectively bridging the gap between scientific understanding and public awareness. By transforming abstract ecological data into auditory forms, sonification provides experiencers with a new sensory dimension, thereby enhancing their intuitive and immersive understanding of these data, and deepening their appreciation of complex natural phenomena (Foteinou, Kokla, Tomai, & Kavouras, 2022).

In an endeavor to accentuate active listening and foster a heightened sense of embodiment among participants, beamforming loudspeakers are utilized. These speakers are notable for their pronounced directivity, creating an immersive soundscape that is perceptible only within a specific listening radius. This characteristic compels participants to physically follow the path of the swifts to fully engage with and appreciate the auditory representation of their migration. The use of beamforming technology aligns with contemporary auditory display research, which emphasizes the importance of listener engagement and interaction in spatial sound experiences. Brownell (2017) thoroughly explores the importance of active listening in his comprehensive work, defining it as "a deliberate and conscious endeavor directed toward achieving understanding." Active listening is not a passive occurrence; rather, it requires awareness and conscious effort, demanding high levels of concentration and engagement. Moreover, the goal of active listening is to achieve understanding, not merely to hear sounds superficially. This necessitates proactive decoding, analysis, and internalization of the information heard.

2. Installation Design

"The Voice of Swifts" is a multi-channel immersive audio installation that skillfully employs beamforming speakers suspended from the ceiling for a unique auditory transmutation of data on the migration of Beijing swifts. This design draws inspiration from the swift as an emblem of Beijing and its characteristic of nearly uninterrupted flight, symbolizing the continuity and omnipresence of sound reverberating through the air. This piece integrates sound materials from Beijing swift flocks and, based on the geological features of the stopover locations, skillfully incorporates marine and wind sounds to reflect the topographical characteristics of the migration stopovers. In alignment with key waypoints on the swifts' migratory route, eight speakers are meticulously arranged. I used Python to create a simple map of spring and winter migration paths based on the description of Swifts migration in (Zhao, Zhao, Wu, et al., 2022), as shown in Figure 1. A projector is utilized to cast a mapping of the area onto the floor, providing a visual reference for spatial orientation. Subsequently, specific coordinate points are meticulously marked on the surface, delineating precise locations based on the projected map. Following this, loudspeakers are strategically positioned in

accordance with these demarcated coordinates. This methodical approach ensures accurate spatial distribution of sound, adhering to the predefined mapping for optimal auditory experience.

The distance between each speaker mirrors the kilometers spanned between nations traversed by the swifts. For example, the distance from Beijing to Mongolia, approximately 1273 kilometers, is represented by a spatial interval of 636.5 millimeters between two speakers. Additionally, each speaker serves as an independent auditory channel, facilitating sound movement within the space. By representing geographical distances through proportional spatial intervals between speakers, the installation transforms the abstract concept of migration into a tangible auditory experience. This innovative approach brings the audience closer to the swifts' epic journey, spanning thousands of kilometers, by translating these vast distances into an intimate, immersive soundscape. The choice of beamforming technology further enhances this experience. These speakers, known for their ability to direct sound with precision, create a focused and intimate auditory environment. As a listener moves through the space, they encounter different segments of the swifts' migratory path, almost as if they are traveling alongside the birds. This dynamic interaction between sound and space invites the audience to actively engage with the installation, fostering a deeper connection to the story being told.

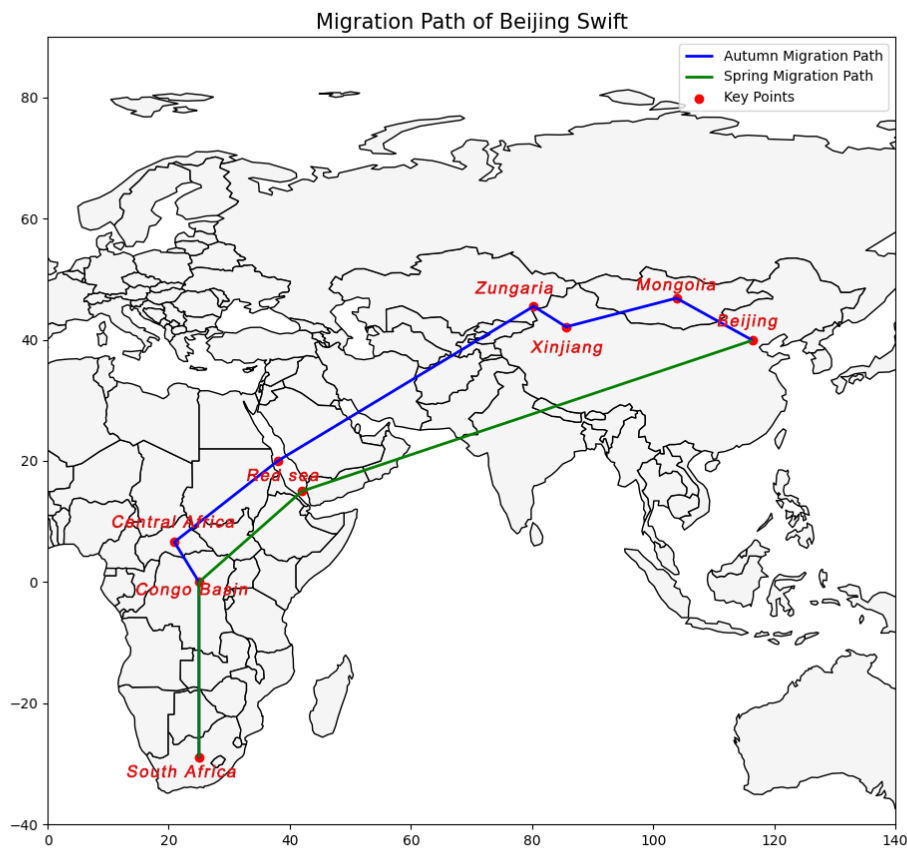


Figure 1. Migration Path of Beijing Swift made by Python.

3. Sonification Method

The 12-minute composition simulates swifts' migratory process through dynamic auditory changes. Aligned with the actual migration timeline, each minute represents one month, starting from mid-July in Beijing. Due to the limitations in the number of speakers, a perfectly smooth transition of sound is not feasible. Currently, this is managed by adjusting the volume between two speakers. For example, if the sound moves from one coordinate to another in one minute, a one-minute fade out is executed on speaker A, while a simultaneous one-minute fade in is implemented on speaker B.

Furthermore, the flying speed of swifts is mapped onto the volume of the sound. The velocity is deduced from the distance between coordinates, which in turn informs the volume adjustments: higher speeds result in louder volumes and slower speeds in quieter volumes. In this study (Zhao, Zhao, Wu, et al., 2022), a total of 66 geographical locators were used, but only 25 provided effective data. This data was then mapped to the complexity of the swifts' sound. Initially, the sound material of swifts was processed to create 66 separate audio tracks, which were reduced to 25 by the end of the journey. This method allows for the creation of a dynamic soundscape in the performance, reflecting the characteristics of the swifts' migration.

From the sound design aspect, the integration of environmental factors affecting the swifts' migration into the auditory experience. As the swifts encounter different environmental conditions – from the urban sounds of Beijing to the natural sounds of the Red Sea and Congo – these changes are reflected in the sound design. This not only adds a layer of realism to the experience but also educates the audience about the diverse challenges faced by the swifts during their journey. Additionally, the use of real-time data processing techniques can be explored to further enhance the dynamic nature of the installation. By incorporating live data feeds, such as current weather conditions along the migratory path or real-time tracking of swifts, the sound composition can evolve continuously, making each performance unique. This approach not only reflects the real-time aspect of migration but also emphasizes the ever-changing nature of ecological systems.

Also, the representation of the swifts' migratory journey through musical elements, infused with the geographical features and cultural contexts of their various locations, is an innovative blend of music, geography, and ecology. This concept, where the swifts' presence in Beijing is signified by the ancient sounds of Bianzhong, aligns with the idea that geography profoundly influences musical styles and instruments, as well as the emotional resonance of melodies ('Musical Landscapes - How Geography Influences Music', 2023.). This traditional music, known for its melodious and resonant tones, linking the swifts' journey to the historical and cultural context of Beijing. Upon reaching Africa, the installation embraces the vibrant and rhythmic music of the continent. African music, known for its complex drumming patterns and lively melodies, reflects the diverse ecosystems and rich wildlife of the continent. As depicted in Figure 2, a basic conceptual illustration includes sound design examples of locations where Beijing swifts dwell.

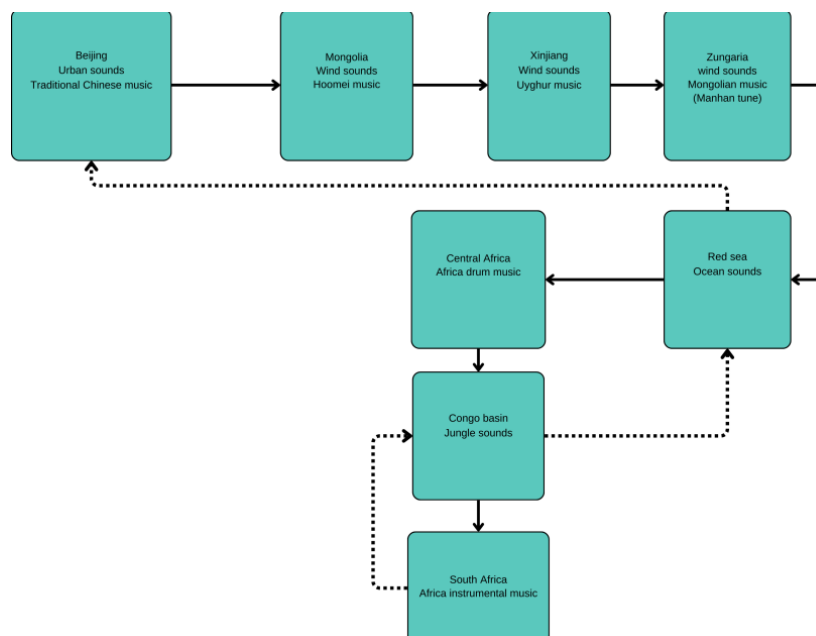


Figure 2. A Basic Conceptual Illustration of Sound Design.

This shift to a more energetic and dynamic musical style symbolizes the swifts' arrival in a land teeming with life and diversity. By incorporating these regional musical elements, "The Voice of Swifts" not only charts the geographical journey of the swifts but also celebrates the cultural diversity of the regions they traverse. This approach enriches the narrative, allowing the audience to experience the migratory path of the swifts not just

as a biological phenomenon but as a journey through diverse cultural landscapes. This method deepens the audience's engagement, making the swifts' migration a journey through sound, culture, and history.

4. Conclusion

“The Voice of Swifts” serves as a pioneering exploration in sonifying ecological data, transforming the intricate migratory patterns of Beijing Swifts into an immersive auditory narrative. This innovative blend of art and science not only deepens our understanding of these birds' journeys and their ecological significance but also highlights the impact of urbanization and climate change on biodiversity. By employing spatial audio techniques and thoughtful speaker placement, the installation invites active listening and fosters a deeper appreciation for nature's complexities. Ultimately, this project stands as a testament to the potential of sonification in bridging the gap between scientific research and public engagement, offering a compelling model for future interdisciplinary endeavors in environmental awareness and education.

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About the Authors:

Fangxia Wei, his research focuses on spatial narrative approaches in sound art, as well as theoretical and practical studies on the intersection of sound, technology, and audience perception.

Prof. Zhigang Wang, his research innovates in merging technology with performing arts, creatively transforming traditional Chinese culture through new media art, and exploring spatial narrative methodologies in this field.

P/REFERENCES OF DESIGN

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