Evaluating the Effectiveness of Ground Forming for Urban Noise Reduction: Bridging Simulation and Reality

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Noise pollution is the second most significant environmental health risk in Europe [1], with urbanization increasing the exposure of people to harmful noise levels, particularly near airports and large infrastructure. Despite extensive efforts to manage indoor noise through digital design tools, there is a notable research gap in outdoor noise mitigation and strategies. Preliminary research shows promising results for using ground forming to reduce noise levels in simulation [2], [3], but this approach requires further investigation and experimental validation.

The objective of this study is to investigate whether and how ground forming can reduce noise levels in urban areas. Ground forming involves shaping terrain to influence environmental factors such as water drainage or wind flow. The innovation of this research is employing ground forming to reduce outdoor noise. This approach contrasts with standard solutions that use vertical walls, which create barriers and interfere with the landscape, animal habitats, and human activities.

This research aims to bridge the gap between simulation and reality by performing experiments to test and evaluate the performance of different designs. The ground forming will be performed using robots based on previously developed capacity, allowing precision and repeatability [4], [5]. The methodology involves:

1. **Design Phase**: Creating prototype ground shapes optimized for noise reduction based on parametric design principles and preliminary research.
2. **Robotic Setup**: Developing a robotic setup to shape the ground according to the designed prototypes.
3. **Noise Simulation**: Simulating urban noise conditions using a surround sound system connected to audiology sound sources.
4. **Measurement and Analysis**: Measuring noise levels and evaluating the effectiveness of each design pattern using precision microphones.

The significance of this research includes providing empirical evidence supporting the use of ground forming for noise reduction, identifying the most effective designs, and offering insights for architects, urban planners, and landscape designers. The expected contribution of this study is shifting the paradigm by introducing ground forming as a viable mitigation strategy to minimize noise pollution, thus creating quieter urban environments and enhancing the quality of urban life.

[1] W. H. Organization and others, “Compendium of WHO and other UN guidance on health and environment,” World Health Organization, 2022.
[2] K. L. Bar-Sinai, T. Shaked, and E. S. Fettahoglu, *Toward Acoustic Landscapes: A Digital Design Workflow for Embedding Noise Reduction in Ground-forming*. DE: Wichmann Verlag, 2023. Accessed: May 28, 2024. [Online]. Available: https://doi.org/10.14627/537740029
[3] K. L. Bar-Sinai, T. Shaked, E. S. Fettahoglu, J. Krimm, and B. Boucsein, “Embedding Acoustic Analysis in Landscape Architecture Design Processes: A Case Study of Munich Airport,” *Buildings*, vol. 13, no. 1, p. 143, 2023.
[4] T. Shaked, K. L. Bar-Sinai, A. Meles-Braverman, O. Elmakis, and A. Degani, “Aggregate-Forming Planner for Autonomous Earth-Moving,” *IEEE Access*, vol. 11, pp. 118841–118848, 2023.
[5] T. Shaked and A. Degani, “Shepherd: A fabrication-oriented tool for simulation and control of mobile robotic platforms for collaborative earthworks,” in *41th Annual Conference of the Association for Computer Aided Design in Architecture: Realignments: Toward critical computation (ACADIA 2021)*, 2021.