Development of an Online Dynamic Noise Mapping Application

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Abstract

This paper presents the development of an online dynamic noise mapping application that provides real-time monitoring of road traffic noise using strategically placed microphones along a road. The continuously transmitted noise level data is postprocessed, enabling near real-time tracking of sound levels in the surrounding areas. Additionally, an auralization feature simulates simplified traffic noise, assisting the public in understanding the relationship between sound levels and noise-related annoyance. Long-term data collection further allows for predicting traffic noise-induced health effects, such as sleep disturbance and ischemic heart disease. This innovative approach provides valuable insights into environmental noise impacts, contributing to improved awareness and management of urban traffic noise issues.

Introduction

Environmental noise pollution is a growing concern, particularly in urban areas with high road traffic volumes. Traditional noise mapping methods rely on calculations based on average traffic conditions or monitoring at discrete points, providing limited insight into short-term variations. This paper introduces an online dynamic noise mapping system that continuously monitors noise levels, accounts for changing conditions such as weather and traffic patterns and provides both real-time and historical analysis.

Traditional Noise Monitoring and Its Limitations

Current noise monitoring practices involve either:

1. Single-point monitoring – Using a microphone to measure and report noise levels at a single location over time. While this method provides accurate values at a given position, it does not illustrate the spatial variation of noise.

2. Static noise maps – Large-scale noise models that visualize noise exposure across broad areas, usually categorized into periods (day, evening, and night). These maps are useful for planning but do not capture real-time variations and often neglect factors like weather and local infrastructure changes.

Although static noise level values are objective and easy to standardize, they do not reflect real-time fluctuations or the instantaneous variability that road users and residents experience.

Dynamic Noise Mapping: Objectives and Approach

The dynamic noise mapping application developed by FORCE Technology aims to:

- Provide real-time visualization of noise variations due to traffic fluctuations (daily, weekly, and yearly trends) and weather conditions (wind speed and direction).
- Store measured values for long-term analysis of noise-related health effects.
- Enable studies on mitigation strategies such as speed regulations and noise reducing pavements.
- Assist in public awareness by illustrating noise impact in an intuitive manner, including through auralization.

System Architecture

The dynamic noise mapping system comprises:

1. Data Collection
   a. Strategically placed microphones continuously capture noise levels.
   b. Weather data is integrated to understand noise propagation effects.
   c. Traffic composition (percentage of heavy vehicles) is considered.
2. Data Processing
   a. A sound propagation model (Nord2000) is used to compute noise levels at different locations.
   b. Transfer functions are precomputed and stored in a database for efficient mapping.
3. Data Storage and Visualization
   a. Noise levels and transfer functions are stored in a cloud-based database.
   b. A web-based client dynamically generates noise maps and time plots.
   c. Users can access real-time noise maps and playback a simple version of auralized sound simulations that follows the monitored levels.

Case Study: Nyborg E20

During development a setup was deployed along the E20 highway near Nyborg in Denmark that has now been running continuously for 5 years [1]. Measurements over different times of the day and varying weather conditions demonstrates how:

- Rush hour noise levels are significantly higher than nighttime levels, an example is illustrated in Figure 1.

- Wind direction has a strong influence on noise propagation, with differences between downwind and upwind conditions greater than 20 dB.
- The system provides clear, real-time insights into how traffic and weather conditions impact urban noise pollution.

Figure 1: Screenshot of the Dynamic Noise Map illustrating the difference between day (left) and night (right) hours.

6. Public Awareness and Health Implications

Public exposure to road traffic noise is a significant health concern. According to the European Environment Agency, approximately 100 million EU citizens are exposed to unhealthy levels of road traffic noise [6]. The World Health Organization (WHO) [2] and many other studies (e.g. [3]-[5]) has linked noise pollution to conditions such as:

- Ischemic Heart Disease (IHD)
- Sleep disturbances (SD)
- Highly annoyed (HA)

With the dynamic noise mapping system it is also possible to view the relative (IHD, HA) or absolute (SD) risk of these conditions. User can select any location on the map to observe the relative risk for the aforementioned health issues. The dynamic mapping aims hereby to enhance the public awareness around health problems associated with high noise exposure.

7. Conclusion

The developed online dynamic noise mapping system represents a significant step forward in real-time noise monitoring. By integrating continuous measurements, advanced sound propagation modeling, and auralization, the system provides a more accurate and intuitive representation of environmental noise pollution. Future work will focus on expanding the system's geographic coverage, improving predictive models for long-term health effects, and introducing methods for simulating geometrical changes like noise berms or walls.

References

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