SafeSonic Shield: Innovative Strategy to Localize Animal Distracting Frequencies on Roads

*Abstract*—Accidents involving stray animals on roads pose significant risks to both human and animal safety, requiring innovative solutions to neutralize these hazards. One promising approach is the use of low-frequency sound emitters to prevent animals from entering roadways. However, the challenge lies in ensuring that these frequencies are localized and do not spill over to the opposite side of the road, causing unintended disturbances. This paper explores directional sound containment strategies, combining advanced technologies like parametric speakers, acoustic barriers, and vegetative sound absorption, along with frequency cancellation techniques to effectively limit sound propagation. Directional sound emitters focus frequencies on targeted areas, while frequency barriers ( reflective and absorptive barriers) prevent lateral sound dispersion.These methods not only enhance road safety by guiding animals away but also maintain a humane, eco-friendly approach with minimal noise pollution.

# Directional Frequency Emitters with Non-Human Frequencies: A Humane Approach to Animal Safety

Directional frequency emitters operating at non-human frequencies represent a technology designed to influence animal behavior while maintaining human comfort. These devices emit sound waves at frequencies outside the audible range for humans but within the hearing spectrum of specific animal species. By focusing sound in targeted areas, these emitters offer a humane, efficient, and non-invasive solution for preventing animals from entering unsafe zones such as roadways, airport runways, or agricultural fields.

## Principle of Operation

The core principle behind directional frequency emitters is the use of frequencies that lie above or below the human auditory range (20 Hz to 20 kHz). Animals, however, have varying hearing ranges, often extending beyond human capabilities. For instance, cattle and deer can perceive frequencies between 23 Hz and 35 kHz, while dogs can detect up to 60 kHz. By leveraging these ranges, sound emitters can be calibrated to emit frequencies that are uncomfortable for animals but inaudible to humans.

Directional sound technology, such as parametric speakers, allows these emitters to project sound waves in highly focused beams. Unlike traditional loudspeakers that disperse sound in all directions, directional emitters use ultrasonic carriers to modulate and deliver sound to specific locations. This ensures that the sound is confined to the target area, preventing it from spreading to unintended zones or causing disturbances to humans or other animals.

### Preventing Sound Spillover to Avoid Attracting Animals from the Other Side: Directional frequency emitters are an innovative solution for deterring animals from unsafe areas such as roads, airports, or agricultural zones by emitting sound waves at non-human frequencies. While effective in guiding animals away from danger, a critical challenge arises when these frequencies spill over to the opposite side of the road, attracting animals from unintended areas. This unintended spillover may inadvertently bring animals closer to the road, counteracting the emitter's purpose and increasing the risk of accidents. The goal of this challenge is to develop an effective solution that ensures the sound emitted by these devices does not spread across the road, attracting animals from the opposite side, but instead remains confined to the targeted area

· Reflective Barriers:

· Design and Implement Reflective Boards: Use materials like acoustic panels, mirrors, or metallic barriers that can reflect sound waves back towards the target zone. These barriers should be positioned on the opposite side of the emitter to prevent sound from crossing the road.

Optimal Placement and Angles: Ensure that the reflective boards are positioned at optimal angles to reflect sound without directing it toward other unintended locations.

· Absorptive Barriers:

· Sound Absorptive Materials: Integrate sound-absorbing materials (e.g., foam, dense vegetation, or specialized acoustic barriers) along the road's edges to absorb excess sound and prevent it from spreading. These materials will effectively trap sound waves and prevent them from leaking into the surrounding environment.

Design of Absorptive Zones: Create absorptive zones at strategic intervals, particularly along the center median of the road, to reduce the sound intensity as it travels toward the edges. This ensures that the sound waves are absorbed before they can spill over to the opposite side, effectively preventing any unintended attraction of animals from the other lane. By strategically placing these absorptive zones, sound containment is maximized without the need for excessive barriers, enhancing both road safety and environmental harmony..

Directional Focused Emitters:

Enhance the precision of the directional frequency emitters by incorporating adaptive focusing technology. This can include ultrasonic or parametric speakers that automatically adjust the frequency range or angle based on real-time monitoring of sound spread, ensuring that the sound is always focused within the target zone

**While the technology behind this project holds great potential, there are a few challenges to overcome:**

**Animal Adaptation:  
Animals may get used to the sound frequencies over time, making them less effective. To tackle this, the system could be designed to randomly change the frequencies or alternate between different sound types, ensuring the animals stay alert and responsive to the deterrents.**

**Environmental Factors:  
The way sound travels can be influenced by things like weather, terrain, and other background noises. For example, heavy rain or strong winds could affect how well the sound reaches its target. To ensure the system works reliably, careful placement of the sound emitters and regular adjustments might be necessary.**

**Deployment Costs:  
The technology needed for this system, like advanced parametric speakers, can be quite expensive to create and install. However, as the technology advances and becomes more widely used, the cost of manufacturing and deploying these systems is likely to go down, making them more affordable over time.**