AVAS

AVAS : Approaching Vehicle Audible System

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JASIC
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What is AVAS?

AVAS meets the Japanese Guideline

- **Scope**
  - Electric vehicles and hybrid electric vehicles which are capable of running exclusively on motor power.

- **Activation condition**
  - Automatically generate a sound
  - The minimum range of vehicle speed from starting to 20 km/h forward and backward.
  - May equipe manual pause switch

- **Sound level**
  - Not exceed the sound level of ICE which runs at speed of 20km/h.

- **Type of sound**
  - Siren, chime, bells, melody, horn sound, etc. are not allowed.
  - Continuous sound associating running vehicle
AVAS Logic (example of Nissan)

- The system automatically activate and do not rely on the driver’s decision to manually activate it.
  - No sound while stopped, sound starts when brake released.
  - sound fades-out when vehicle speed is approx. 30kph
  - sound fades-in when vehicle speed is reduced to approx. 25kph
  - system emits sound while reverse gear position engaged

![AVAS Logic Diagram](image)
What is an ideal sound for AVAS?
What is an ideal sound for AVAS?

- Requirement for sound of AVAS?
  - Noticeable & Acceptable Sound associating motor vehicles

- Sound associating vehicles
  - Engine
  - Horn
  - Road Noise

- Ideal Sound for AVAS
  - Natural Sound
  - Voice
  - Clear Sound

- Perception
  - Emergency Bell
  - Wake-Up Sound
  - Abrasive sound

- Acceptance

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What are important factors for sound of AVAS?

- **Associative**
  - Associated with Vehicle running condition
    - Needs to vary according to drive information
  - Sounds like running vehicles
    - Associated with engine or motor behavior

- **Noticeable**
  - Noticeable in City Noise
    - Hard to be masked by background noise
  - Audible for wide age range
    - Sound rich in low ~ mid frequency

- **Acceptable**
  - Immune to frequency / repetition
    - Familiar sound
  - Immune to time length
    - Non-melodic nor non-tonality

Use of "Fluctuation" is a key
Sound associating vehicles #1

- Vehicle’s running condition shall be expressed by sound variation
  - Vehicle’s running condition is judged from real time variation of sound according to the condition of acceleration, brake pedal and gear

- Real time response enables pedestrians to notice ......
  - distance from vehicles
  - speed of vehicles
  - vehicle’s running condition (approaching/in halt/departing)

- Sound reflecting engine condition make pedestrians feel it associated with vehicles

Sound shall change according to vehicles speed
Sound associating Vehicles #2

- Volume and/or Frequency need to vary (should not be constant)

- Quick response is required
  - Pedestrians & drivers feel uncomfortable in failing to respond to speed variation in a real time manner

- Smooth fade out in reaching an upper limit speed is desirable
  - Fade out with break makes an undesirable effect on comfort & quality
    - Smooth cross-fade with Road noise is preferable

With variation similar to engine sound, even Synth sounds like a vehicle
What are important factors for sound of AVAS?

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Use of "Fluctuation" is a key

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Effect of Fluctuation

- Without Fluctuation

- With Fluctuation
Fluctuation

- Fluctuation is important for Sound

- What is fluctuation?
  - Periodical variation of Amplitude and/or Frequency

- Helpful for perception
  - Sound without fluctuation is easy to be masked by background noise
  - More noticeable by variation of sound
    - More sensitive to variation due to human ears’ characteristics
    - Too much fluctuation leads to discomfort

- Sound with fluctuation can be associated with vehicles as conventional engine sound has fluctuation
  - Fluctuation can also express engine rotation
Comfortable

- Needs to be Immune to (frequent & long) hearing
  - Sound strong in pitch is noticeable but is vulnerable to (frequent & long) hearing
  - Horn/Alarm sound is noticeable but likely to stick in the ears or to scare pedestrians

- Non-melodic, natural & noticeable
  - Melodic sound is noticeable but vulnerable to frequent hearing
    (air conditioner sound is not distinguished but immune to frequent hearing)
  - Mixing noise is also effective
Key Point of a Sound for AVAS

Change frequency and/or volume according to vehicle speed

Key components
- Important factors

Wide frequency range
- not only one range

Sound associating vehicles
- Engine
- Horn
- Road Noise

Ideal Sound for AVAS

Comfortable
- need to be immune
- not strong pitch
- non-melodic

Perception
- • Emergency Bell
- • Wake-Up Sound
- • Abrasive sound

Acceptance
- • Natural Sound
- • Voice
- • Clear Sound

Fluctuation
- amplitude and/or frequency
Concept of Sound
Nissan’s Sounds Strategy

**A** Outstanding peak frequency **between 1kHz and 5kHz** is effective for providing good detectability for **all pedestrians but B**.

**B** AVAS needs an outstanding peak **under 1kHz frequency** to ensure good detectability for elderly (suffering from high-frequency hearing loss by aging).

**C** AVAS frequency peaks at the ‘shoulders of the 1 kHz peak’ will allow the lowest sound level possible while maintaining its effectiveness and a quiet environment for **neighborhoods**
Sound for all Pedestrian

For persons with normal hearing, the ear is most sensitive to frequencies between 1 and 5 kHz due to the resonance of the ear canal and the transfer function of the ossicles of the middle ear.

Outstanding peak frequency between 1kHz and 5kHz is effective for providing good detectability for pedestrians.

Sound for elderly suffering from hearing loss by aging (most of visually impaired)

- More than 70% of visually impaired are over 60 years old.
- Elderly persons more than 60 years old have difficulty detecting sounds higher than 2kHz due to age-related hearing loss.

AVAS needs outstanding peak under 1kHz frequency to ensure good detectability for the majority of blind people.

<table>
<thead>
<tr>
<th>Population of Visually Impaired</th>
<th>Impaired over 60 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>1.64 million 72%</td>
</tr>
<tr>
<td>USA</td>
<td>4.15 million* 73%</td>
</tr>
</tbody>
</table>

“Visually Impaired” includes people with “Legal Blindness” and “Low Vision”


US Data: National Eye Institute (NEI) “Prevalence of Blindness Data, *850,000 added to NEI estimate to account for ages <40 years based on Lighthouse International data

Sound for Neighborhood Community

- Ambient noise measurements taken at different locations in Detroit.
  - Ambient noise peaked at approx. 1kHz for each traffic condition

AVAS frequency peaks at the ‘shoulders of the 1 kHz peak’ will allow the lowest sound level possible while maintaining its effectiveness and a quiet environment for neighborhoods.
Cover wide frequency band and focus important frequencies

Continuous chord of 175 Hz and 233 Hz as its base-frequency with sound around 2 kHz in addition.

The sound pressure and scale change in response to the vehicle speed while the sound has moderate fluctuation.
Sound level of AVAS is same as that of ICE
Summary

- Three manufactures in Japan have developed AVAS for EV and Hybrid Vehicle.

  AVAS strategy addresses concerns of three key Stakeholders
  ✓ Pedestrian (especially visually Impaired persons)
    providing good detectability and giving an image of a car behavior(recognizably)
  ✓ Environment for neighborhoods
    maintain a quiet environment
  ✓ Driver
    acceptance of sound so he/she does not turn the sound off

- Detectability and reconizability studies in cooperation with visually impaired persons and elderly persons have been conducted by each manufacturer and the Study committee organized by MLIT.

- It is important to be widely spread and known of the sound.
  New Electrical Vehicle sound!
Demonstration today

Please have an experience of AVAS. To help understanding AVAS for those who could not attend #3 QRTV meeting in Tokyo
Thank you for your attention