

“Age Sensitive ICT Systems for Intelligent City For All” I’CityForAll



AAL 2011-4-056



www.icityforall.eu

2012-2015

Coordinated by CEA



CALL 4 ICT-based solutions for advancement of older persons' mobility



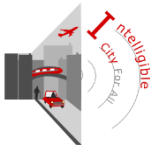
Europe- National Agencies' program to help older persons to sustain their optimal level of mobility for as long as possible, as well as enhance their individual sense of confidence, autonomy, competence, security and safety.

Aims at ICT-based solutions to identified user needs:

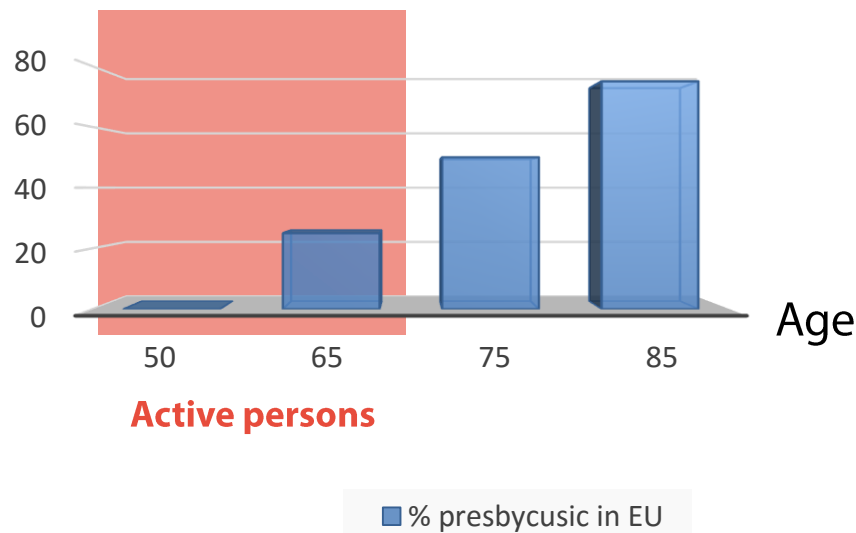
- Time-to-market perspective of 2 to 3 years after end of the projet
- Realistic trial set-up at the end of the projet
- Proactive end-user involvement throughout the life of the projet

Starting point

Presbycusis is the 3rd impairment of the elderly after arthritis & hypertension before presbyopia



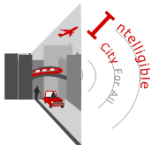
“Presbycusis: Hearing impairment of older persons impacting the **intelligibility perception** and the **ability to localize sound source** and therefore physical and social well being”



Hearing-impaired persons

- **14%** only wear hearing aids
- **2/3** do not think or refuse hearing-aids

Two main situations



Mobility in public confined spaces



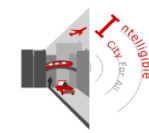
For **better attractiveness/intelligibility/mobility in confined public spaces**: Supermarket, railway stations, museum, theater, cinema...

Mobility in the urban space



To **reduce urban-related accidents of elderly in urban settings**: Elderly are involved in 40% of fatal injuries (105,000 deaths/year), by walking/car 1500/day accidents requiring medical assistance

ICT solutions: “Bring back normal hearing experience to presbycusis elderly”



End users field trials

- Psycho-sociology ORL



- In Architectural and Urban Ambiances

- With ENEA subcontractor



Solutions

- ICT-solutions



- Acoustic quality



- With subcontractors



- Audio expertise | Prototypes



Age Sensitive Users – Products

I'City – Car

Individual cars, professional vehicles, individual public transport

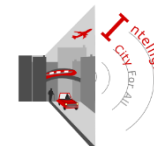


I'City - Loudspeaker

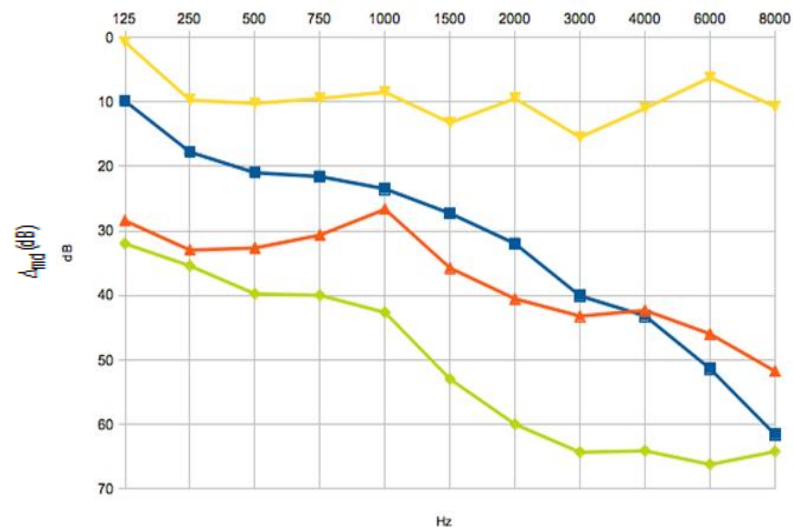
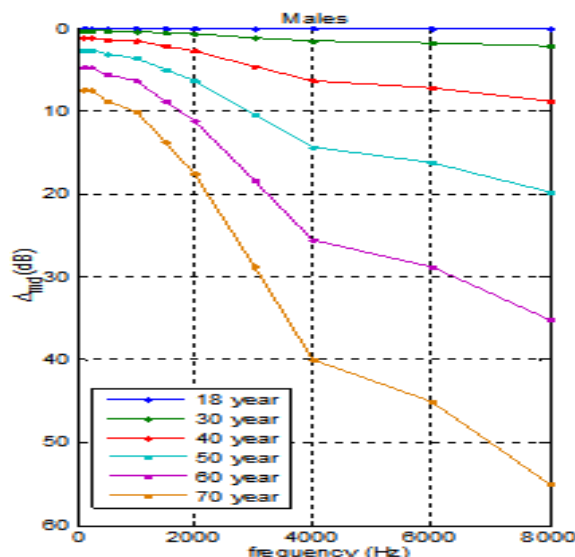
In railway station, airport, museum, supermarket



Surveys for Mobility in public confined spaces and in the urban space



Age related hearing loss:
(Example Male losses)
ISO 7029



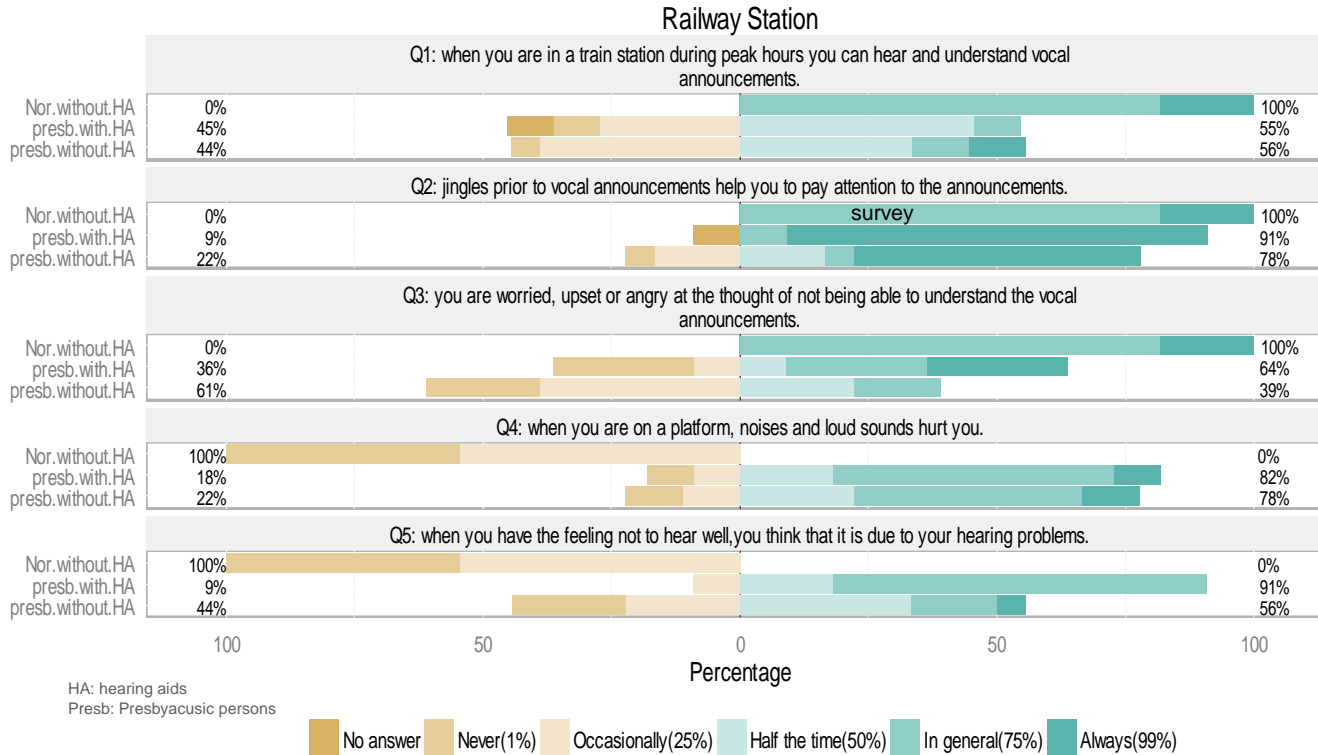
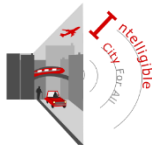
Average cohort audiograms

Cohort of the I'City survey
older than 50 years

Survey population: 38 persons*
50% Male, 50% Female.
20% Normal hearing.
30% Presby with hearing aid.
50% Persby without hearing aid.

*Centich-France & Escoop-Italy 2013

Surveys for Mobility in public confined spaces



- Intelligibility **decreases** for **all Presb.** at **peak hours**
- **Jingles** help **paying attention** to the vocal announces for **all**
- Feeling of **stress and discomfort** is **more** noticeable for **Normal hearing**
- Presb. are the **most hurt** by loud sounds and noise
- **Presb. with HA** are **more aware** about their problems **than without HA**

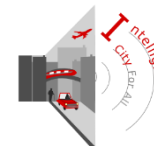


Smart Loudspeaker in public confined spaces

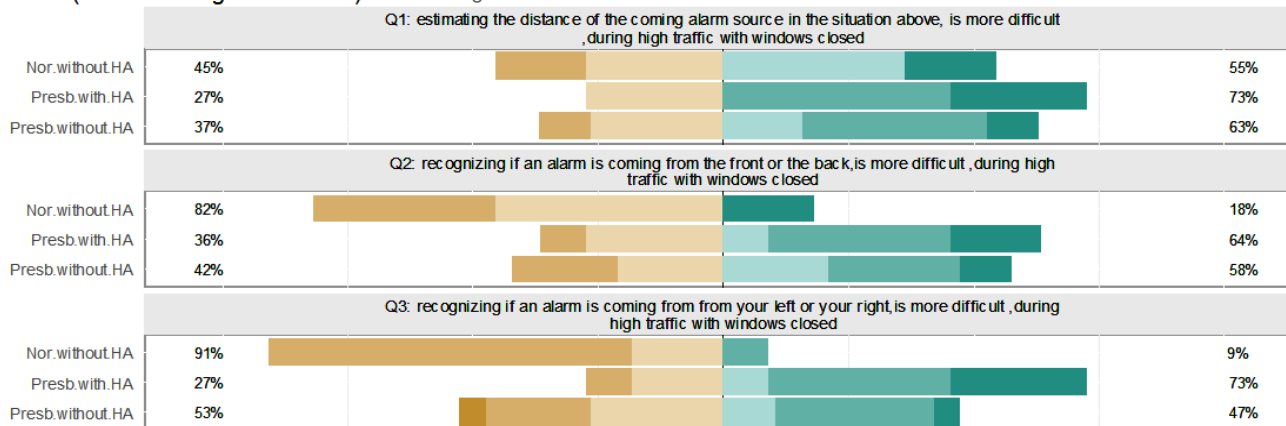
For **better intelligibility** of vocal messages and jingles for all

Products : PERCEIVALL, SpeechConformer, SIMforALL

Surveys for Mobility in the urban space



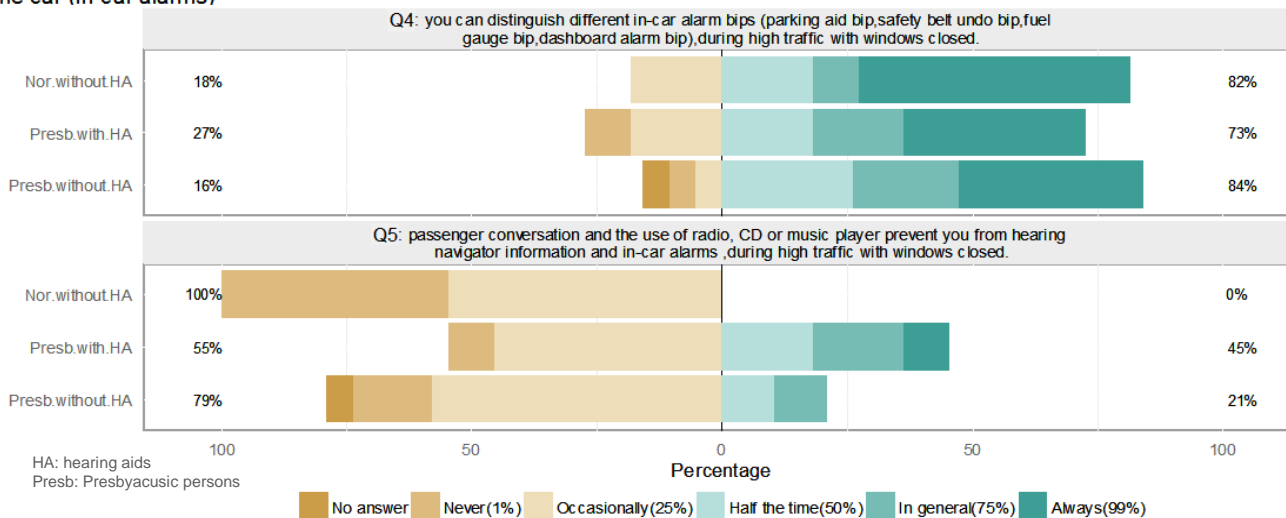
In the car (alarms coming from outside) : case of high traffic with closed windows



→ All persons have difficulties to estimate alarm distance estimation, with higher frequency for Presb. with HA.

→ Front/back and left/right confusion is a common difficulty for Presb. For left/right localization, Presb-HA have more difficulty to localize the alarm source than Presb. without HA.

In the car (in-car alarms)



→ During high traffic, All persons have few difficulties to distinguish the different in-car alarms.

→ Presb. have difficulties to hear in-car alarms or on-board navigator in noisy environment. This occurs occasionally for Normal hearing and more often for Presb. in particular with HA.



Smart loudspeaker for vehicles for better localization of alarm sounds*
 and an appropriate **enhancement of in-car alarms****
Products : PERCEIVALL, AlarmSniffer

*e.g. ambulances, police cars

**e.g. safety belt warning, lane change warning



Lack of intelligibility of vocal announces & Confusion in localizing alarm sources affect differently Normal and Presbycusic

The survey confirms that

“For All” solutions

are necessary for

better intelligibility

in public confined spaces

and

better localization in the urban space

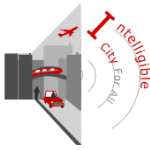


“Intelligibility” Objective

**I’City – Loudspeaker in public confined spaces
for better intelligibility
of vocal messages and jingles**

I'City – Loudspeaker for better intelligibility

In railway station, airport, museum, supermarket...




I'City – Loudspeaker for better intelligibility PRODUCTS

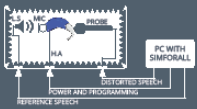
SIM^{ForAll} NO ONE LEFT BEHIND

Know your customer audio experience with the new generation of intelligibility assessment algorithm

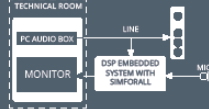
The SIMforall algorithm provides a Speech Intelligibility Measure for a variety of hearing abilities. It provides a for all score of perceived intelligibility for a specified population or for a specific sensorial hearing loss.




Hearing Aid Assessment



PA System Monitoring



SIM^{ForAll} Mobile solutions



Specifications

Speech Intelligibility Measure "for all" (based on ISO 60268-16)

- Inputs: reference speech, distorted speech and audiogram or age
- Can use live broadcasted vocal announce to measure intelligibility
- Provide an intelligibility score that is audiogram dependent
- Can be used as an assessment criteria for public address system or hearing aids
- Decrease the testing cost of speech processing algorithms assessment.

Speech intelligibility

0% to 100% comprehension score:

- Real time
- Time average
- In multiple rooms

EXTRA MEASURES

- Noise level
- Noise spectrum
- Reverberation

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PERCEI^VALL AUDIO FOR EVERYONE, ANYWHERE

For better intelligibility and localization of audio signals

PerceiVAll pre-adjusts audio signal to the target user of diverse spaces taking into account the acoustic environment and the variability of sound ambiances. Its parameter setting allows an application in confined spaces such as railway station and airport or vehicles.

1 "ForAll" user oriented processing

PerceiVAll system includes:

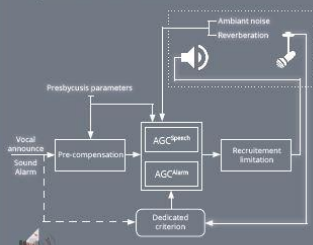
- A frequency pre-compensation for age related hearing loss according to the personal user profile or a "for all" profile based on the ISO 7029 standard
- A gain limiter module for presbycusis/auditory recruitment phenomenon
- dedicated AGC module based on adaptive ambient noise estimation robust to sound events

2 Acoustic environment oriented processing

Public address systems
Automatic adjustment of the public address systems sound level with regards to the variation of ambient noise and reverberation amounts.

Car Auditory display
Adaptation of auditory display according to the driver auditory profile and urban ambient noise masking threshold

System overview



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SPEECH CONFORMER

Easily homogenizes the timbre of voices

The Speech conformer homogenizes the timbre of different voices. The algorithm analyses the spectrum of the input signal and applies the necessary gains so that the spectrum of the output signal meets the target spectrum chosen by the user.

Two steps to homogenize voice spectra

1 Specify the target spectrum

- Standard: IEC60268-16 female
- Broadcast: with emphasis on warmth
- Max intelligibility: with emphasis on presence
- Free user: specification with cursors

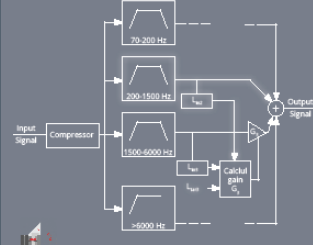
2 Visualize and tweak the Gain in bands warmth, Presence and Brightness

Principle

The Speech Conformer algorithm :

- 4 band analysis (warmth : 70-200Hz ; reference 200-1500Hz ; Presence : 1.5-6kHz ; Brightness : >6kHz).
- user specifies a target spectrum (Female voice as per IEC60268-16 in Icity).
- Level is computed in the 4 bands.
- Gain in bands warmth, Presence and Brightness are computed using a dual rate scheme.

Speech Conformer Diagram



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“Localization” Objective

I'City – Car in vehicles

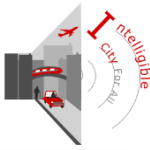
for **better localization of alarm** sounds

(e.g. ambulances, police cars)

and appropriate **enhancement of in-car alarms**

(e.g. safety belt warning, lane change warning)

I'City – Car for enhancing alarm localization



Alarm Sniffer



Audio-Visual HMI

In **individual cars** **Professional vehicles:**

taxi bus, truck,...

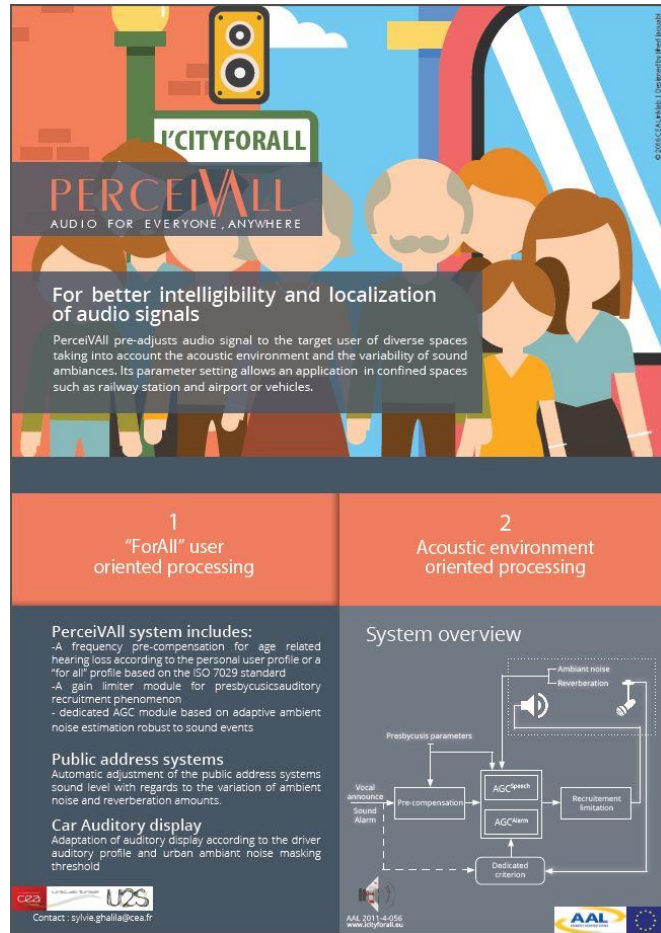
for companies of **individual public transport:** autolib...

PerceivALL
In-car
alarm



I'City – Car for enhancing alarm localization

PRODUCTS



PERCEI Vall
AUDIO FOR EVERYONE, ANYWHERE

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PerceiVAll system includes:

- A frequency pre-compensation for age related hearing loss according to the personal user profile or a "for all" profile based on the ISO 7029 standard
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Adaptation of auditory display according to the driver auditory profile and urban ambient noise masking threshold.

System overview

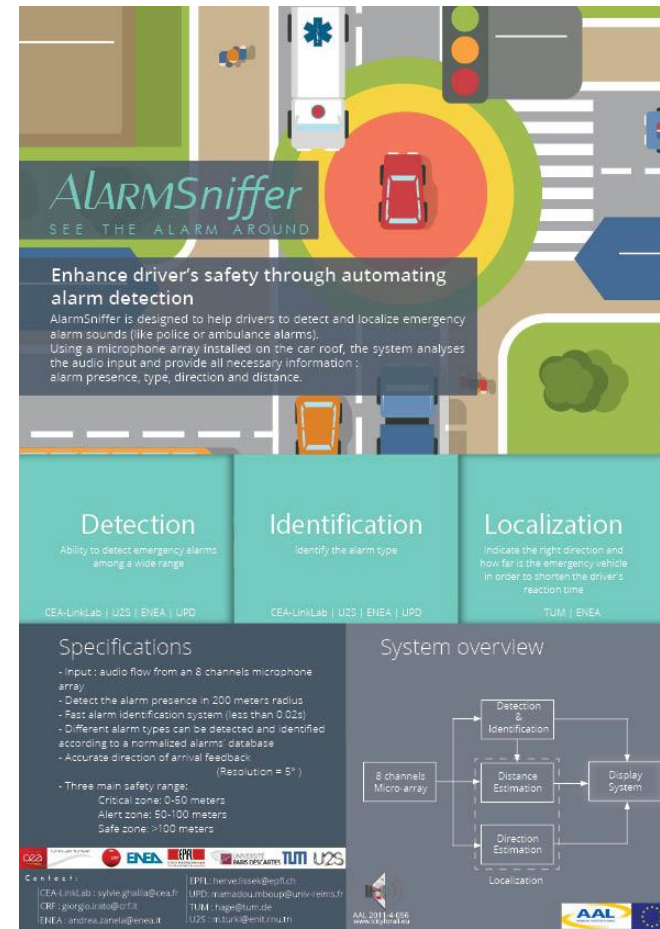
```

    graph TD
        Input[Vocal audiotext / Sound Alarm] --> Pre[Pre-compensation]
        Pre --> AGC[AGC]
        AGC --> Recruitment[Recruitment limitation]
        Recruitment --> Output[Output]
        
        Ambient[Ambient noise / Reverberation] --> AGC
        Ambient --> Recruitment
        
        Parameters[Presbycusis parameters] --> AGC
        Parameters --> Recruitment
        
        Criterion[Dedicated criterion] --> Recruitment
    
```

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ALARM Sniffer
SEE THE ALARM AROUND

Enhance driver's safety through automating alarm detection

AlarmSniffer is designed to help drivers to detect and localize emergency alarm sounds (like police or ambulance alarms). Using a microphone array installed on the car roof, the system analyses the audio input and provide all necessary information : alarm presence, type, direction and distance.

Detection
Ability to detect emergency alarms among a wide range

Identification
Identify the alarm type

Localization
Indicate the right direction and how far is the emergency vehicle in order to shorten the drivers' reaction time

CEA-LinkLab | UZS | ENEA | UPD

Specifications

- Input: audio flow from an 8 channels microphone array
- Detect the alarm presence in 200 meters radius
- Fast alarm identification system (less than 0.02s)
- Different alarm types can be detected and identified according to a normalized alarms' database
- Accurate direction of arrival feedback (Resolution = 5°)
- Three main safety range:
 - Critical zone: 0-50 meters
 - Alert zone: 50-100 meters
 - Safe zone: >100 meters

System overview

```

    graph LR
        Input[8 channels Micro array] --> Detection[Detection & Identification]
        Detection --> Distance[Distance Estimation]
        Detection --> Direction[Direction Estimation]
        Distance --> Display[Display System]
        Direction --> Display
    
```

CEA | UZS | ENEA | UPD

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End User Assessments

In car & in public space solutions

in lab & in vivo validation of I'City products



End User Assessments

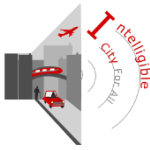
Public space solutions

in lab & in vivo validation of I'City products

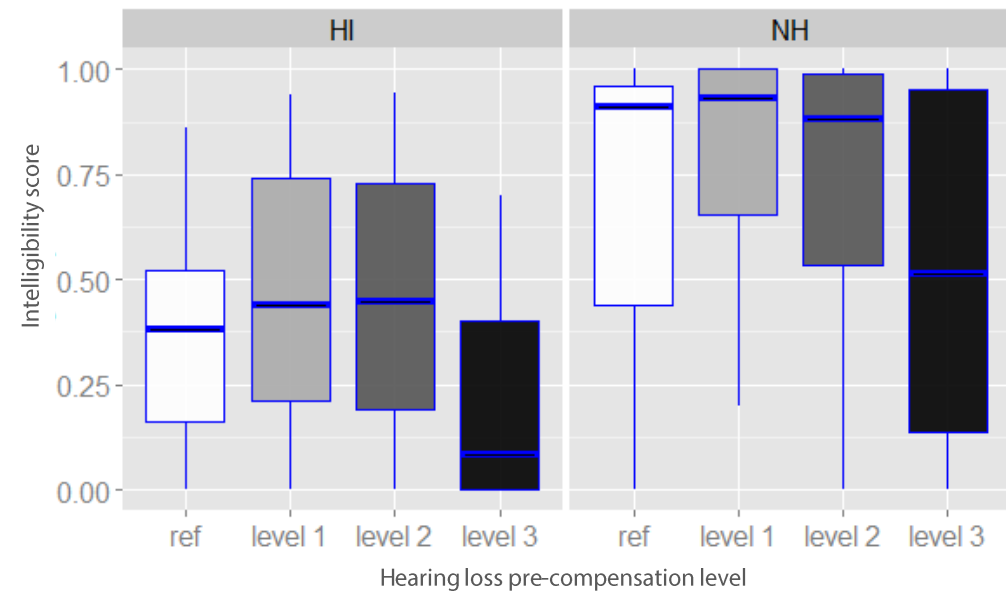
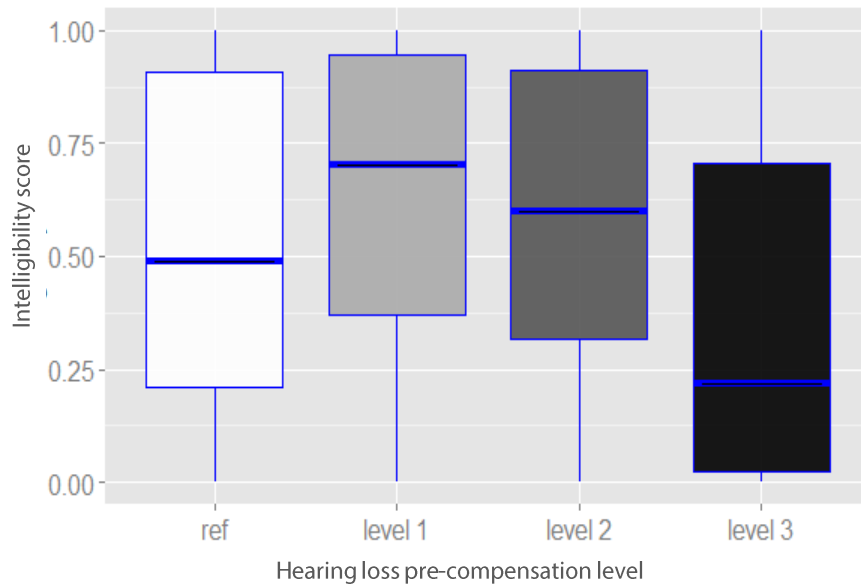


Mobility in public confined spaces

Pre-compensation module of PerceivALL



In lab tests at EPFL LEMA, 10 Normal Hearing, 10 Persbyacusic without hearing aid

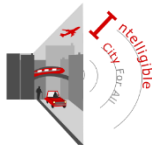


Without increasing the overall loudness of the vocal announcement, Levels 1 and 2 of Perceivall pre-compensation enhance the intelligibility for both normal and impaired hearing persons

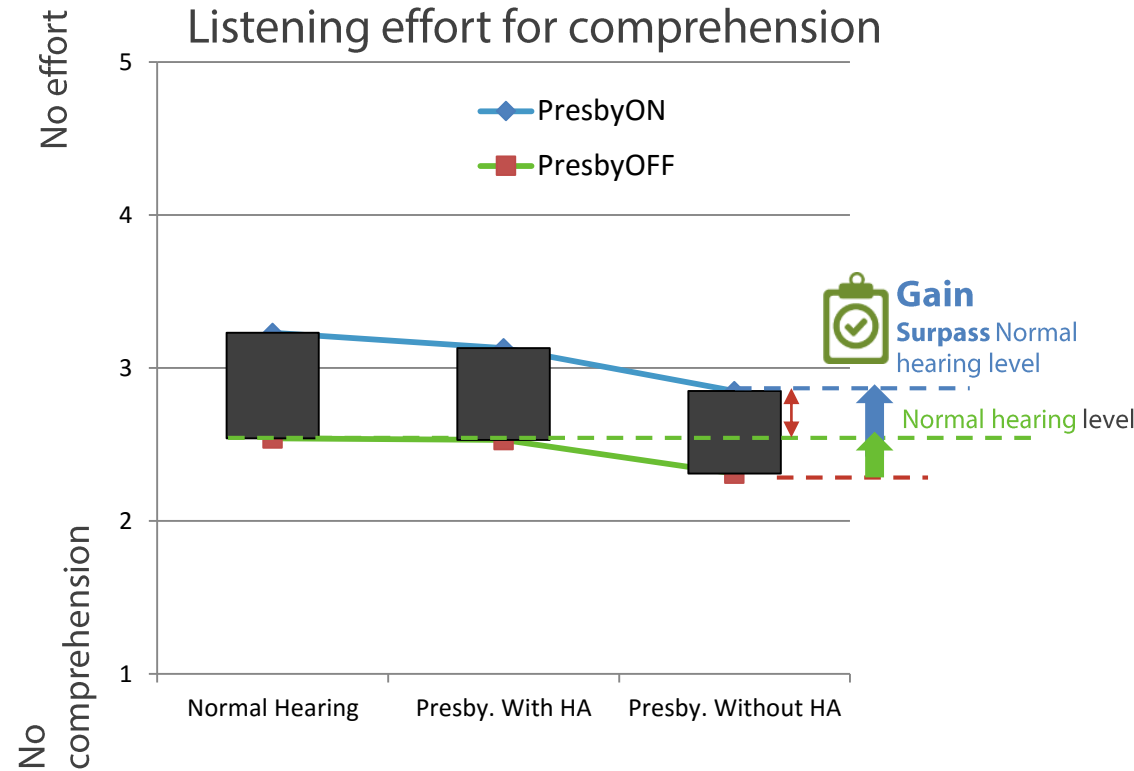
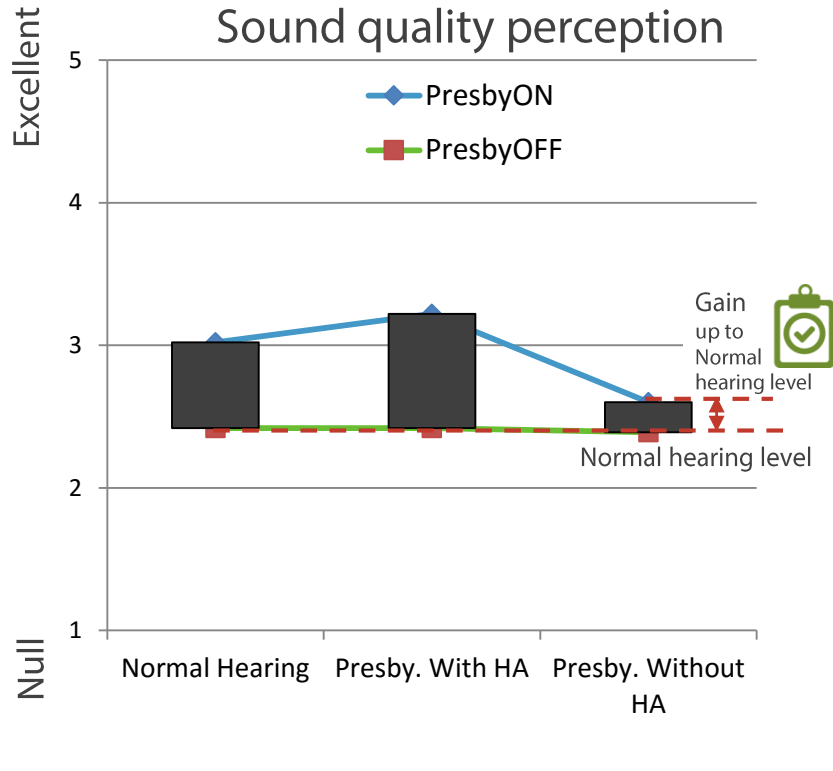


Mobility in public confined spaces

Pre-compensation module of perceivALL



Foggia railway station Italy, 13 Normal Hearing, 15 Presbycusis without hearing aid and 10 with hearing aid



1 Raise intelligibility for Presbycusis to -at least- a normal hearing level

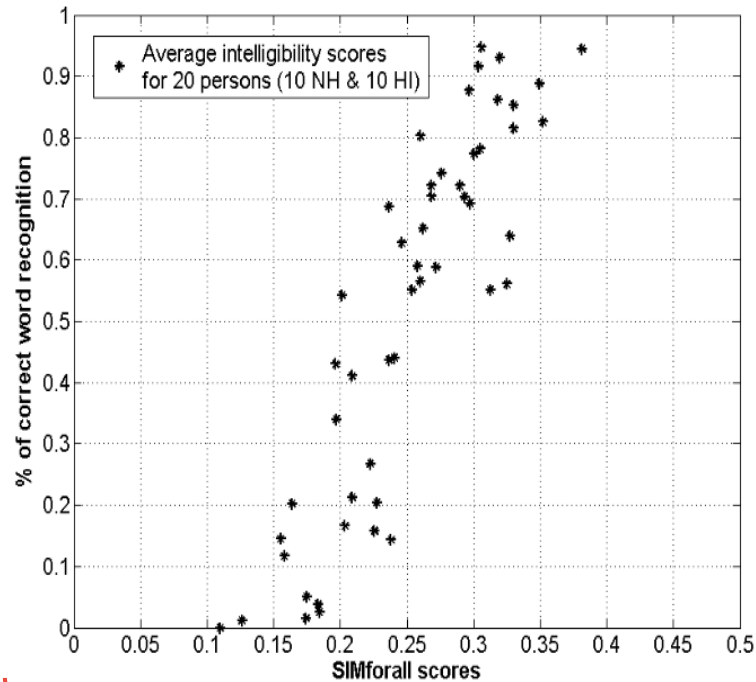
2 Better hearing for both normal and presbycusic persons

Mobility in public confined spaces

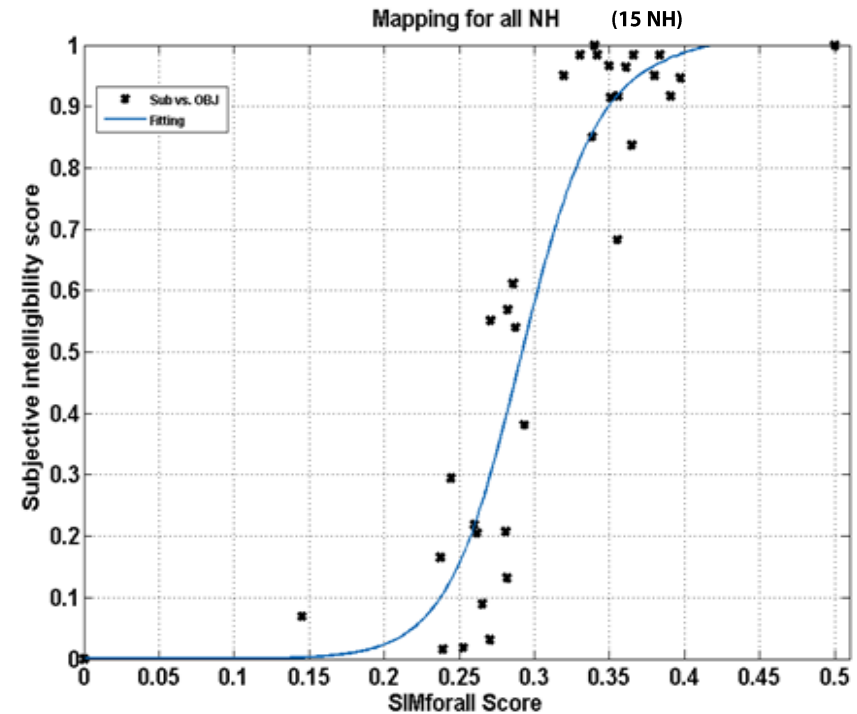
SIMforAll Objective intelligibility measurement tool



EPFL tests



ActiveAudio tests



- Presbycusis behavior is **correctly modeled** by the **SIMforAll** algorithm
- **Good correlation** between **subjective** and **objective** scores for NH, HI and “For All”



End User Assessments

In car solutions

in lab & in vivo validation of I'City products

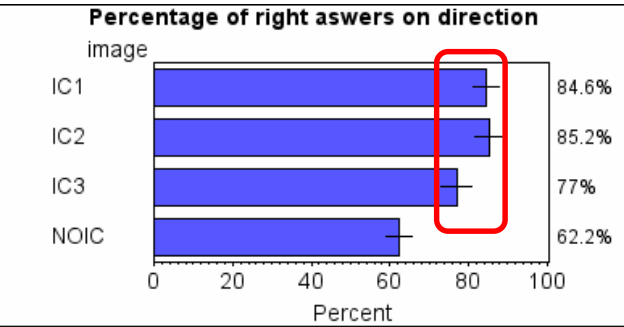
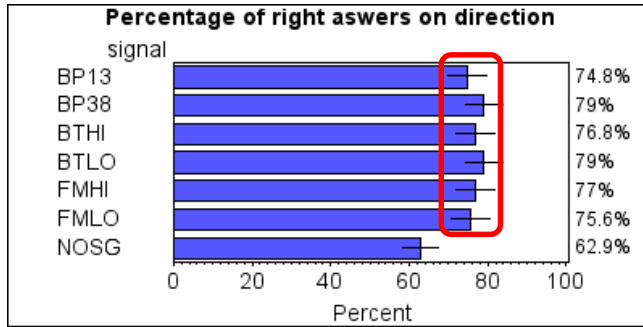


Mobility in the urban space Driver assessments



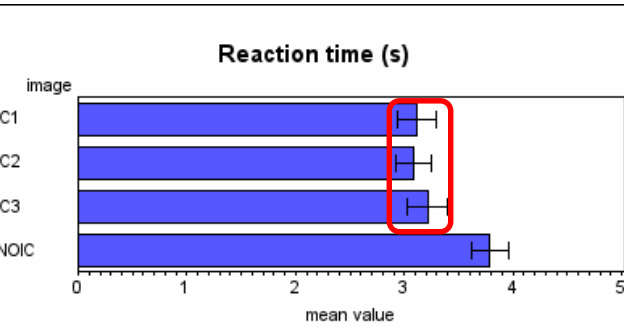
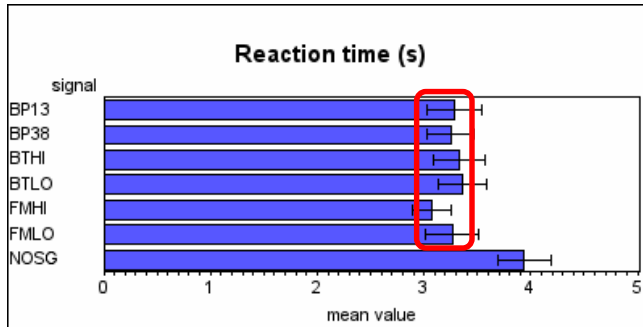
CRF in lab tests: HMI simulation using Perceivall as Auditory Display and AlarmSniffer visual module as Visual Display

+12% (or more)
improvement of
right localization
of DOA*



+15% (or more)
improvement of
right localization
of DOA*

+15% (or more)
improvement of
reaction time



+18% (or more)
improvement of
reaction time

Audio and visual HMI

improve the “siren direction detection” ability and reduce reaction time

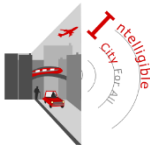
*DOA: Direction of arrival



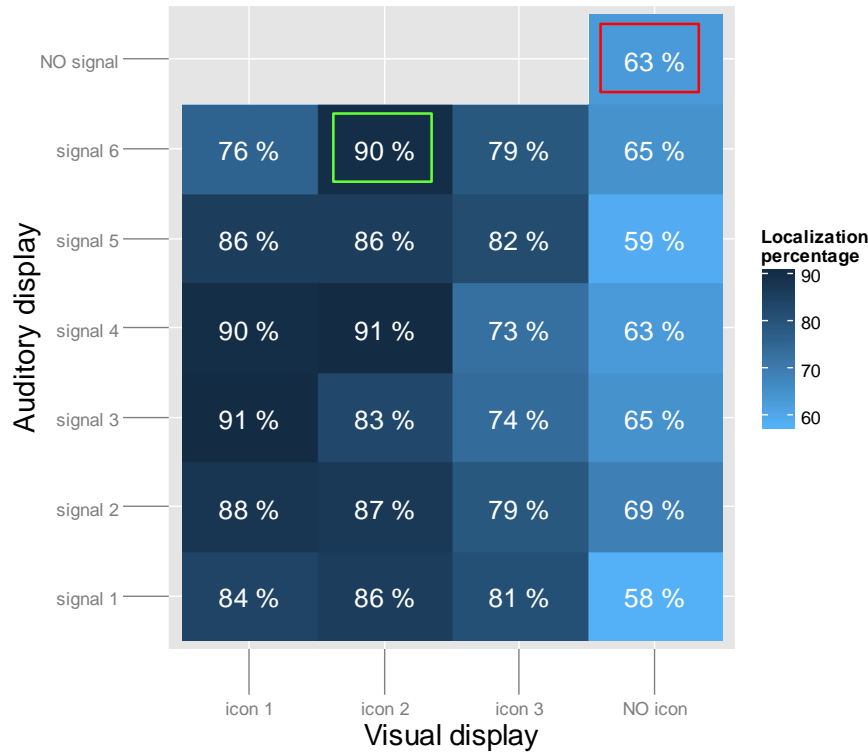
Mobility in the urban space Driver assessments

CRF in lab tests

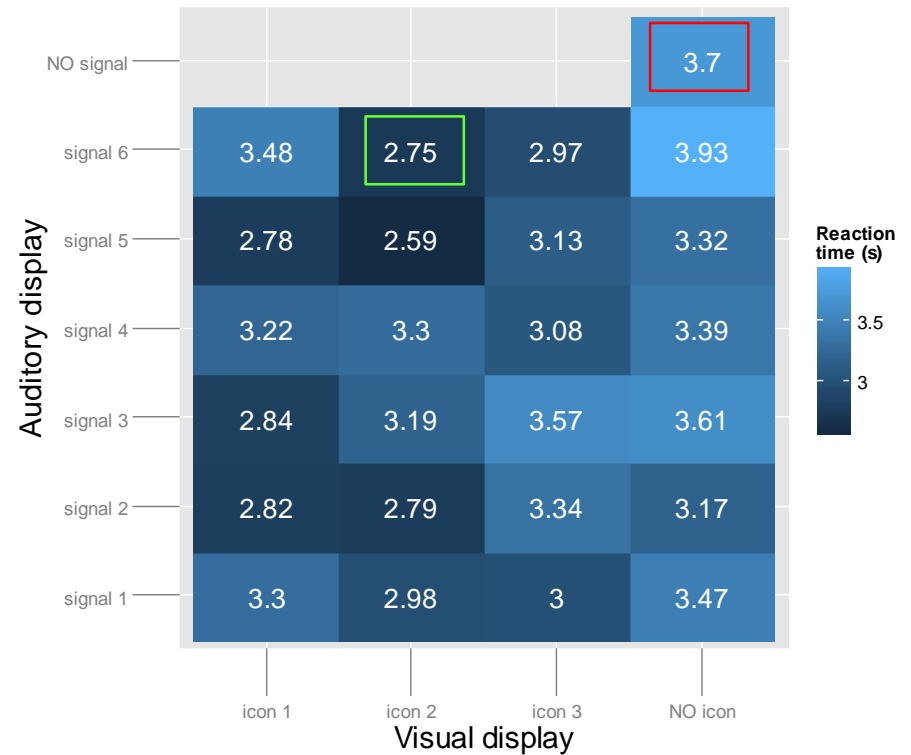
40 people (1/3 females, 2/3 males), with ages ranging from 20 to 65, with normal hearing^(*)



Percentage of sound localization of the DOA^(**) of siren



Reaction time average for right localization of the DOA of siren



Up to **42 % increase** of sound localization with **1s reduction** in reaction time

^(*)The effects of Presbycusis are simulated by appropriate processing of the sound signals into 4 groups of "virtual" hearing impairment: normal hearing and 3 levels of hearing loss

^(**)Direction of arrival



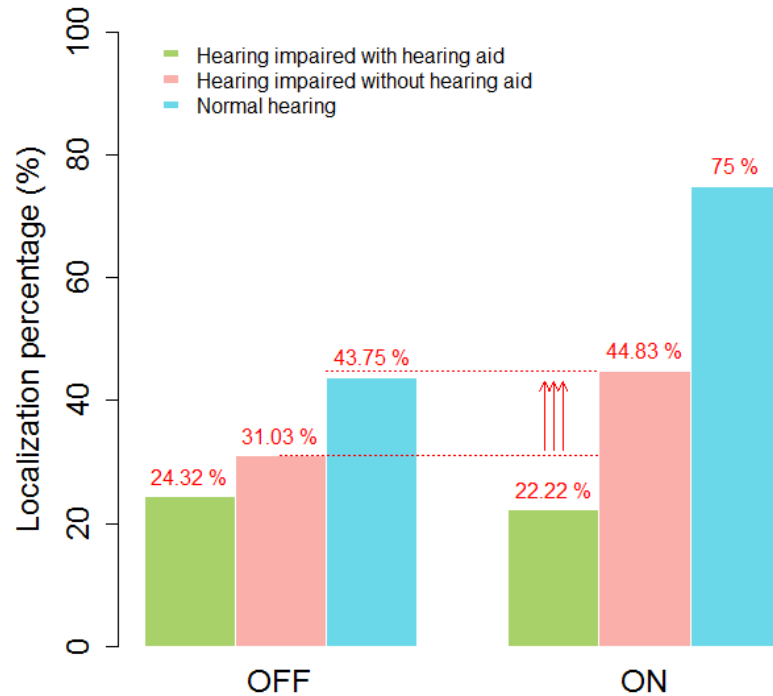
Mobility in the urban space Driver assessments

CENTICH *in vivo* tests

2 normal hearing drivers , 4 presbycusic drivers without hearing aid, 5 presbycusic driver with hearing aids

AlarmSniffer and Perceivall: Auditory display module

Percentage of localization of the direction of arrival of the external alarm:



I'CityForAll solutions improve the **sound localization** for drivers including presbycusis drivers

Thank you for your attention



Age Sensitive ICT Systems
for **Intelligent City For All**
ICFA

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Contact project coordinator:
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