“Age Sensitive ICT Systems for Intelligible City For All”

I’CityForAll
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.”

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

I’CityForAll projet 2012-2015
Two main situations

Mobility in public confined spaces

Mobility in the urban space

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

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 presbyacusic 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

ICity – Car
Individual cars, professional vehicles, individual public transport

ICity - Loudspeaker
In railway station, airport, museum, supermarket

I’CityForAll projet 2012-2015
Surveys for Mobility in public confined spaces and in the urban space

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

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

Cohort of the I’City survey
older than 50 years

Average cohort audiograms

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

I’CityForAll projet 2012-2015
Surveys for Mobility in public confined spaces

Q1: when you are in a train station during peak hours you can hear and understand announcements.
- Nor without, 0%
- presb. with HA, 56%
- presb. without HA, 55%

Q2: jingles prior to vocal announcements help you to pay attention to the announcement.
- Nor without, 0%
- presb. with HA, 78%
- presb. without HA, 56%

Q3: you are worried, upset or angry at the thought of not being able to understand the announcements.
- Nor without, 0%
- presb. with HA, 91%
- presb. without HA, 56%

Q4: when you are on a platform, noises and loud sounds hurt you.
- Nor without, 100%
- presb. with HA, 78%
- presb. without HA, 82%

Q5: when you have the feeling not to hear well, you think that it is due to your hearing.
- Nor without, 0%
- presb. with HA, 91%
- presb. without HA, 58%

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
Preb. are the most hurt by loud sounds and noise
Presb. with HA are more aware about their problems than without HA

HA: hearing aids
Presb: Presbyacusic persons

Smart Loudspeaker in public confined spaces
For better intelligibility of vocal messages and jingles for all

Products: PERCEIVALL, SpeechConformer, SIMforALL

I’City solutions

I’CityForAll projet 2012-2015
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.

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.

---

I’City solutions

Smart loudspeaker for vehicles for better localization of alarm sounds*

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 Presbycusis

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**

---

**Specifications**

- **Speech intelligibility**
  - 0% to 100% comprehension score
  - Avg. score
  - Time average
  - In multiple rooms

**EXTRA MEASURES**

- Tonal distortion
- Noise level
- Noise variation

---

**For better intelligibility and localization of audio signals**

The AGC™ system includes:

- A frequency pre-compression for age-related hearing loss according to the personal user profile and the average profile based on the ISO 7029 standards
- 4 Gain level modes for pre/post-confluent auditory recruitment (MVIC)
- Reduced noise based on adaptive ambient noise estimation robust to sound events

---

**Speech Conformer Diagram**

1. **Principle**

   - The Speech Conformer algorithm:
     - 6-band analysis (low - 1000Hz; reference 200 - 1000Hz; Presence 10 - 6000Hz; Brightness 6000Hz)
     - User selects a target spectrum (female voice) per ISO 226:1997
     - Level is computed in the 4 bands
     - Gain in bands warmth, presence and brightness are computed using a dual-rice scheme

2. **Two steps to homogenize voice spectra**

   - Specify the target spectrum
   - Visible and takes the Gain in bands warmth, presence and brightness

---

**I’CityForAll projet 2012-2015**
“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

Audio-Visual HMI
In individual cars Professional vehicles:
taxi bus, truck,…
for companies of individual public transport: autolib…
I’City – Car for enhancing alarm localization

PRODUCTS

1. "ForAll" user oriented processing
2. Acoustic environment oriented processing

The AGC\textsuperscript{\textregistered} system includes:
- A frequency pre-emphasis for age-related hearing loss according to the perception user profile for a
  "ForAll" profile based on the ISO 7029 standard
- An "All user" profile for pre-emphatic sensitivity
- An "Equal" AGC\textsuperscript{\textregistered} profile based on adaptive ambient noise estimation robust to sound events

Public address systems
Automatic adjustment of the public address systems sound level with regards to the variation of ambient
noise and fluctuation phenomena

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

Specifications:
- Input: audio from an 8 channel microphone array
- Output: signal presence in 50 meters radius
- Minimum alarm detection: system detection at 5 m
- Various alarm types can be detected and identified
- According to a predefined alarm database
- Accurate direction of arrival feedback
- Three main safety range:
  - Critical zone: 0-50 meters
  - Alarm zone: 50-100 meters
  - Safey zone: >100 meters

Enhance driver’s safety through automating alarm detection
AlarmSniffer is designed to help drivers detect and localize emergency
alarms (such as police or ambulance alarms).
Using a microphone array installed on the car roof, the system
analyzes the audio input and provides all necessary information:
alarm presence, type, direction and distance.
End User Assessments

In car & in public space solutions

in lab & in vivo validation of l’City products
End User Assessments

Public space solutions

in lab & in vivo validation of l’City products
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 Presbyacusic without hearing aid and 10 with hearing aid

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

2. Better hearing for both normal and presbyacusic persons
Mobility in public confined spaces

**SIMforAll** Objective intelligibility measurement tool

**EPFL tests**

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

**ActiveAudio tests**
End User Assessments

In car solutions

in lab & in vivo validation of l’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 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

CENTICH *in vivo* tests

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

**AlarmSniffer and Perceivall: Auditory display module**

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

- Hearing impaired with hearing aid
- Hearing impaired without hearing aid
- Normal hearing

I’CityForAll solutions improve the *sound localization* for drivers including presbycusis drivers
Thank you for your attention