SOUND ENVIRONMENT ANALYSIS IN MEDICAL NURSING HOMES

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Quick Overview

- The E-monitor'âge project
- Sound environment analysis procedure
- Sound database sources / composition
- Data evaluation:
  - Laboratory data evaluation
  - Living Lab data evaluation
  - Real data evaluation
- Conclusions

The E-monitor'âge project

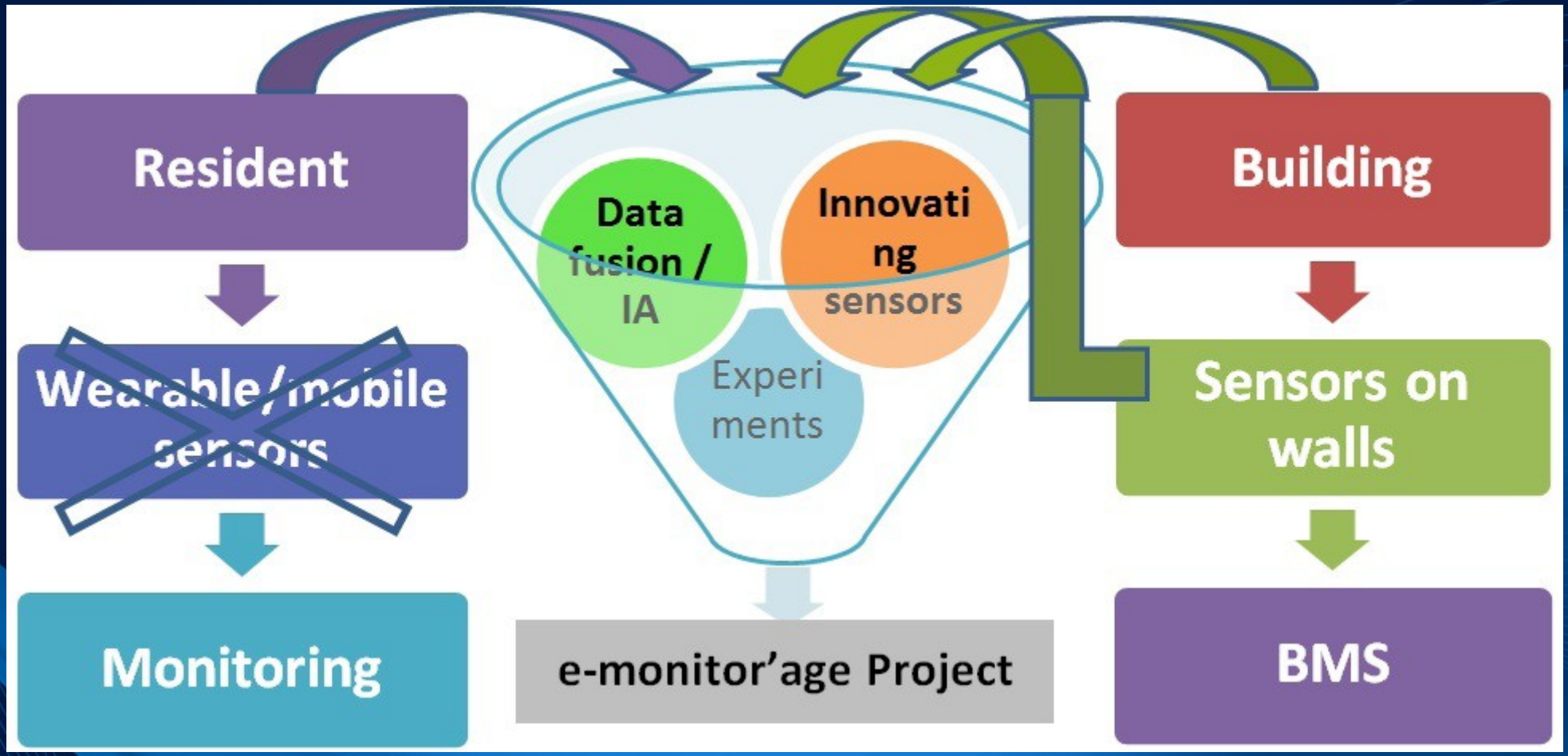
Goal

- providing a monitoring system based on different types of sensors and a self-learning decision process for inhabitants of medicalized retirement homes.
- improving comfort and safety while increasing the availability of nursing staff.

Framework

- The concept of E-monitor'âge project is based on the fact that wearable devices or wearable sensors are an issue when used for monitoring of elderly and dependent people.
- is meant for Smart Homes already equipped with a Building Management System (BMS)

The E-monitor'âge project



E-monitor'âge project concept

Sound environment analysis

Difficulties encountered:

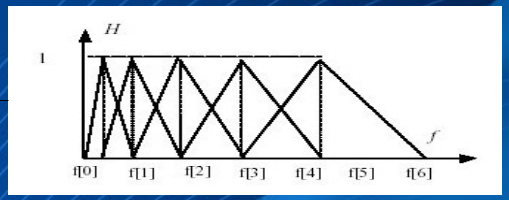
- a very large number of sound classes
- distant analysis using omnidirectional microphones
- noise presence
- large variability of the same sound

Sound environment analysis

Sound acquisition

Sound detection

Feature extraction



MFCC/LFCC

Feature normalization

Initial differentiation

Speech

Other sounds

HMM

Speech recognition

Sound secondary classification

GMM, SVM

Sound environment analysis architecture

Sound database

Step one:

- Source: sound effects CDs, Internet, Lab recordings
- 1049 files / one hour / 18 sound classes

Step two:

- Source: Living Lab in Grenoble
- 21 persons, each scenario contains 2 hours of recordings using 7 microphones

Step three:

- Real recordings in a nursing home, three consecutive days – in the framework of E-monitor'âge project

Sound database

Coughing	Water	Object_Drop
Snoring	Ring	Radio_TV
Yawning	Paper	Vacuum_Cleaner
Hands_Clapping	Keys	Kitchenware
Door_Clapping	Person_Fall	Window_Shutters
Door_Opening	Brushing Teeth	Speech

List of sound classes used for laboratory and living lab recordings

Class no.	Sount class	Occurences	Class no.	Sount class	Occurences
1	Cough	22	8	Water flow	36
2	Snoring	4065	9	**Object hit**	376
3	Yawn	24	10	Kitchenware	171
4	Door clapping	92	11	**Electric Razor**	66
5	Door opening	50	12	Speech	709
6	**Door knock**	3	13	**Sigh**	52
7	**Steps**	16	14	Unknown	328

List of detected sound classes

Data evaluation

Laboratory evaluation

- average sound recognition rate using GMM: about **71%**
- average sound recognition rate using SVM/GSL: about **75%**

Living Lab evaluation

- average sound recognition rate, using SVM/GSL method: about **70%**

Real Data evaluation

Leave-one-out method, GMM, MFCC, E-monitor'âge only sounds	56.147%
Leave-one-out method, GMM, LFCC, E-monitor'âge only sounds	73.042%
TrainWorld on living lab sounds, TrainTarget on 80% Emonitor'age sounds, Tests on 20% E-monitor'âge sounds, GMM, MFCC	68.596%
TrainWorld on living lab sounds, TrainTarget on 80% Emonitor'age sounds, Tests on 20% E-monitor'âge sounds, GMM, LFCC	74.128%

Good Recognition rates for different tests

Real Data evaluation

Rec. class / *Class*	*01*	*03*	*04*	*05*	*08*	*10*	*11*	*12*
01	**36.36**	9.09	0	4.55	27.27	0	9.09	13.64
03	0	**17.39**	0	8.7	47.83	0	21.74	4.35
04	2.17	4.35	**47.83**	11.96	18.48	2.17	10.87	2.17
05	2	4	26	**38**	20	6	2	2
08	0	0	0	8.33	**50**	0	38.89	2.78
10	0	0	5.85	14.62	1.17	**78.36**	0	0
11	1.52	0	0	0	22.73	0	**72.73**	3.03
12	1.68	4.9	2.52	2.24	8.81	0.98	4.62	**74.27**

Overall Good Recognition Percentage: **68.596%**

Confusion matrix for TrainWorld on living lab sounds, TrainTarget on 80% Emonitor'age sounds, Tests on 20% EMonitor'age sounds, GMM, MFCC

Conclusions

- The sound environment is very rich in information, but the noise presence and the distant recording create difficulties for the analysis.
- The best results so far have been obtained by creating the models from laboratory sound data base, by adapting all models using 80% of the sounds recorded in the nursing home (E-monitor'âge project), all with LFCC coefficients.
- The recognition rate is comparable with the one obtained using only sounds recorded in controlled conditions.
- The work is in progress in order to obtain a more reliable system.

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