



## **The SWEET-HOME Project: Audio Technology in Smart Homes to improve Well-being and Reliance**

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# The SWEET-HOME Project: Audio Technology in Smart Homes to improve Well-being and Reliance

M. Vacher<sup>1</sup>, Dan Istrate<sup>2</sup>, François Portet<sup>1</sup>, Thierry Joubert<sup>3</sup>, Thierry Chevalier<sup>4</sup>, Serge Smidtas<sup>5</sup>, Brigitte Meillon<sup>1</sup>, Benjamin Lecouteux<sup>1</sup>, Mohamed Sehili<sup>2</sup>, Pedro Chahuara<sup>1</sup> and Sylvain Méniard<sup>1</sup>



<sup>1</sup>LIG UMR CNRS/UJF 5217

<sup>2</sup>ESIGETEL, ANASON Team

<sup>3</sup>THEORIS

<sup>4</sup>TECHNOSENS

<sup>5</sup>CAMERA-CONTACT

- GETALP Team

- MULTICOM Team

<http://getalp.imag.fr>

<http://multicom.imag.fr>

- <http://www.esigetel.fr>

- <http://www.theoris.fr>

- <http://www.technosens.fr>

- <http://camera-contact.com>



## The SWEET-HOME Project Context and Goals

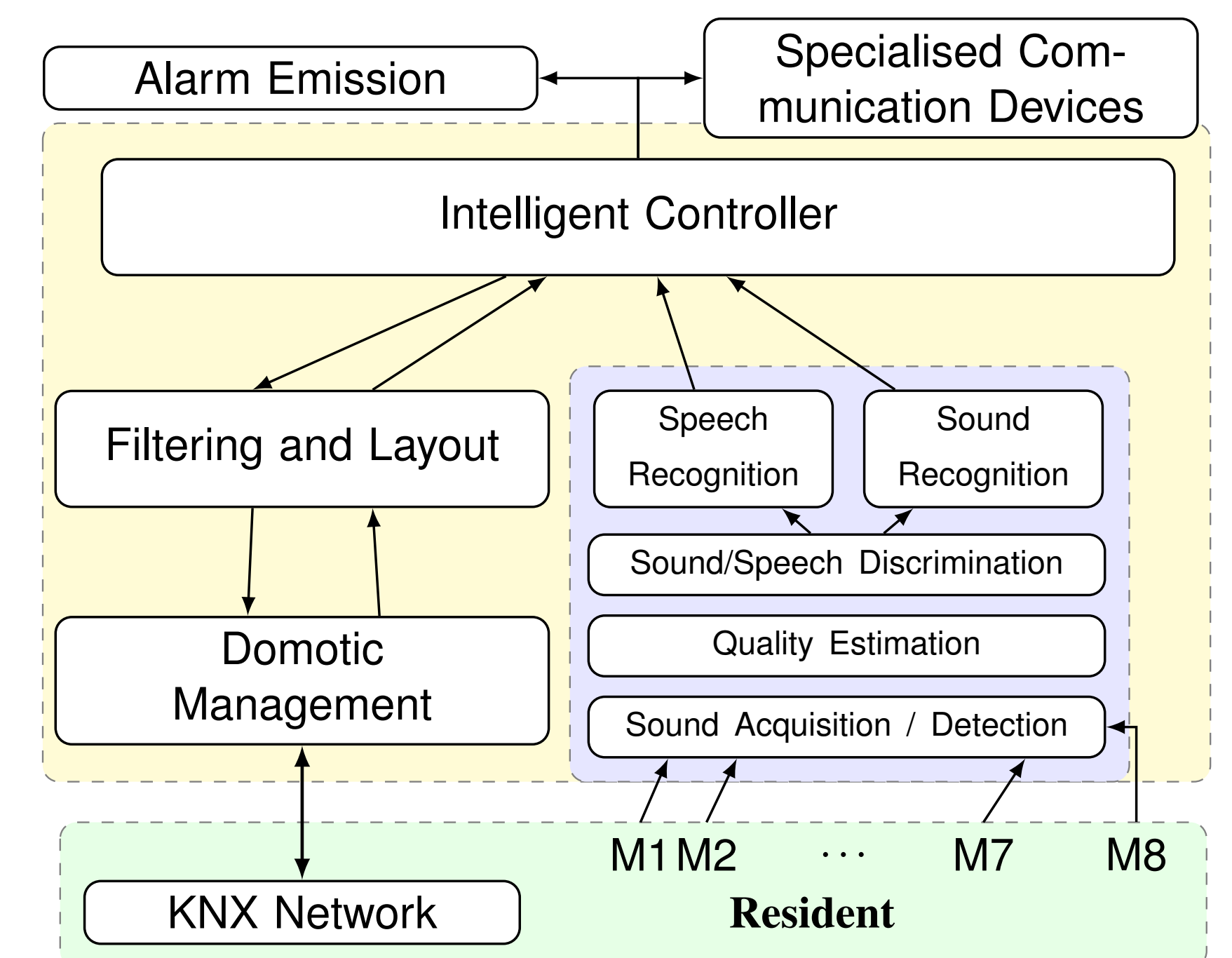
### Audio-based interaction technology :

- ▶ to provide assistance by **natural man machine interaction** (voice and tactile command)
- ▶ to ease **social inclusion**
- ▶ to provide **security reassurance** by detecting situation of distress

**Targeted users :** elderly people who are frail but still autonomous

### Qualitative user evaluation for acceptance assessment :

- ▶ 8 healthy persons,  $71 \leq \text{age} \leq 88$
- ▶ 7 relatives and 3 professional carers
- ▶ interviews and wizard of Oz tests in the DOMUS smart home
- ▶ 4 aspects considered : voice command, communication with the outside world, domotic system interrupting a person's activity and electronic agenda
- ▶ Conclusions : **Great potential of audio technology to ease daily living for elderly and frail persons**



Block diagram of the SWEET-HOME system architecture

## Smart Home Corpus Acquisition

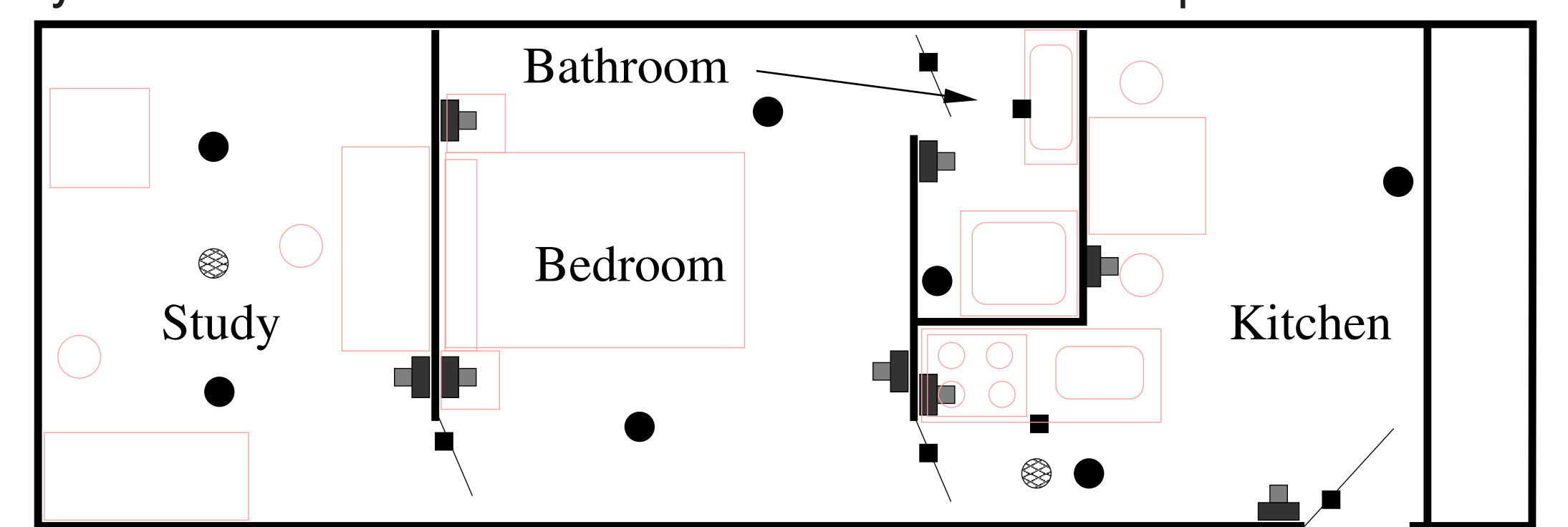
### Technical architecture of the flat

- ▶ DOMUS smart home, 30 m<sup>2</sup>
- ▶ 150 sensors, 7 microphones
- ▶ virtual KNX layer seen as an OSGI (Open Service Gateway Initiative) service (KNX : ISO/IEC 14543-3)

### Experiment

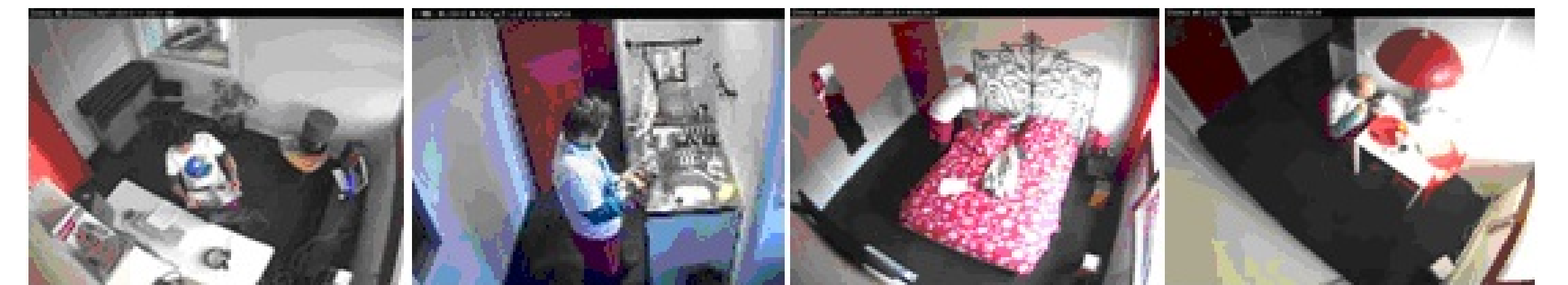
- ▶ 21 persons (7 women, 14 men) -  $38.5 \pm 13$  years old (22-63, min-max)
- ▶ Activities of Daily Living in the flat
- ▶ Total corpus duration : 36 hours
  - ▶ video data (for annotation purpose only)
  - ▶ audio data (7 channels)
  - ▶ KNX events
- ▶ Sound annotation : **ADVENE** software
- ▶ Activities annotation : **Transcriber** software

### Layout of the DOMUS Smart Home and sensor position



■ Switch ■ Contact sensor ● Passive Infrared Detector ● Microphone

### Images captured during the experiment



## Sound Classification

- ▶ Direct information about the resident's status : cry, snoring
- ▶ Situation disambiguation : textile handling during a wearing activity inference
- ▶ Identification of the most useful sound classes according to the project objectives
- ▶ Generic classes : water, human, electrical engine, object falls, etc.

- ▶ 14 sound classes
- ▶ GMM classifier, 16 MFCC
- ▶ SVM, Gaussian RBF kernel

### Results

GMM : 92% of correct classifications, SVM : 87%

## Speech Recognition

### Distant Speech Corpus

- ▶ extracted from the multimodal corpus (7 channels) - 21 speakers
- ▶ Phase 1 (training) : 862 sentences (total : 38 minutes 46s/channel)
- ▶ Phase 2 (test) : 917 sentences (total : 40 minutes 27s)

### ASR Techniques

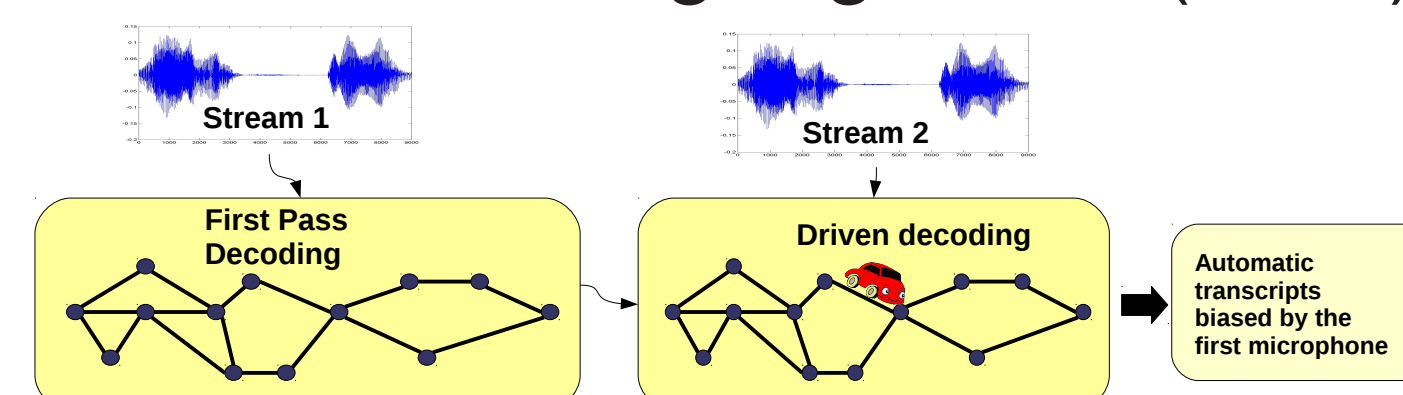
#### 1. Speaker Adaptation

- ▶ Maximum Likelihood Linear Regression (**MLLR**)

#### 2. Multichannel Analysis

- Signal to Noise Ratio for each channel  $\Rightarrow$
- ▶ BEAM-FORMING

- ▶ Recognizer Output Voting Error Reduction (**ROVER**)
- ▶ Driven Decoding Algorithm (**DDA**)



### Results

Method	WER $\pm SD$
Baseline	18.3 $\pm 12.1$
Beam Forming	16.8 $\pm 8.3$
DDA + SNR	11.4 $\pm 5.6$
ROVER	20.6 $\pm 8.5$
ROVER 2c+SNR	13.0 $\pm 6.6$
ROVER +SNR	12.2 $\pm 6.1$

TABLE: Mean WER (7 channels)

## Conclusion and Future Works

### New Smart Home System based on Audio Technology

### Current developments :

- ▶ Audio Algorithms
- ▶ Intelligent Controller

### Future Evaluation of the resulting system :

- ▶ Tests planned in different homes from **fully equipped** with domotic devices to **poorly equipped**
- ▶ With **elderly people**

