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



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The SWEET-HOME Project Context and Goals

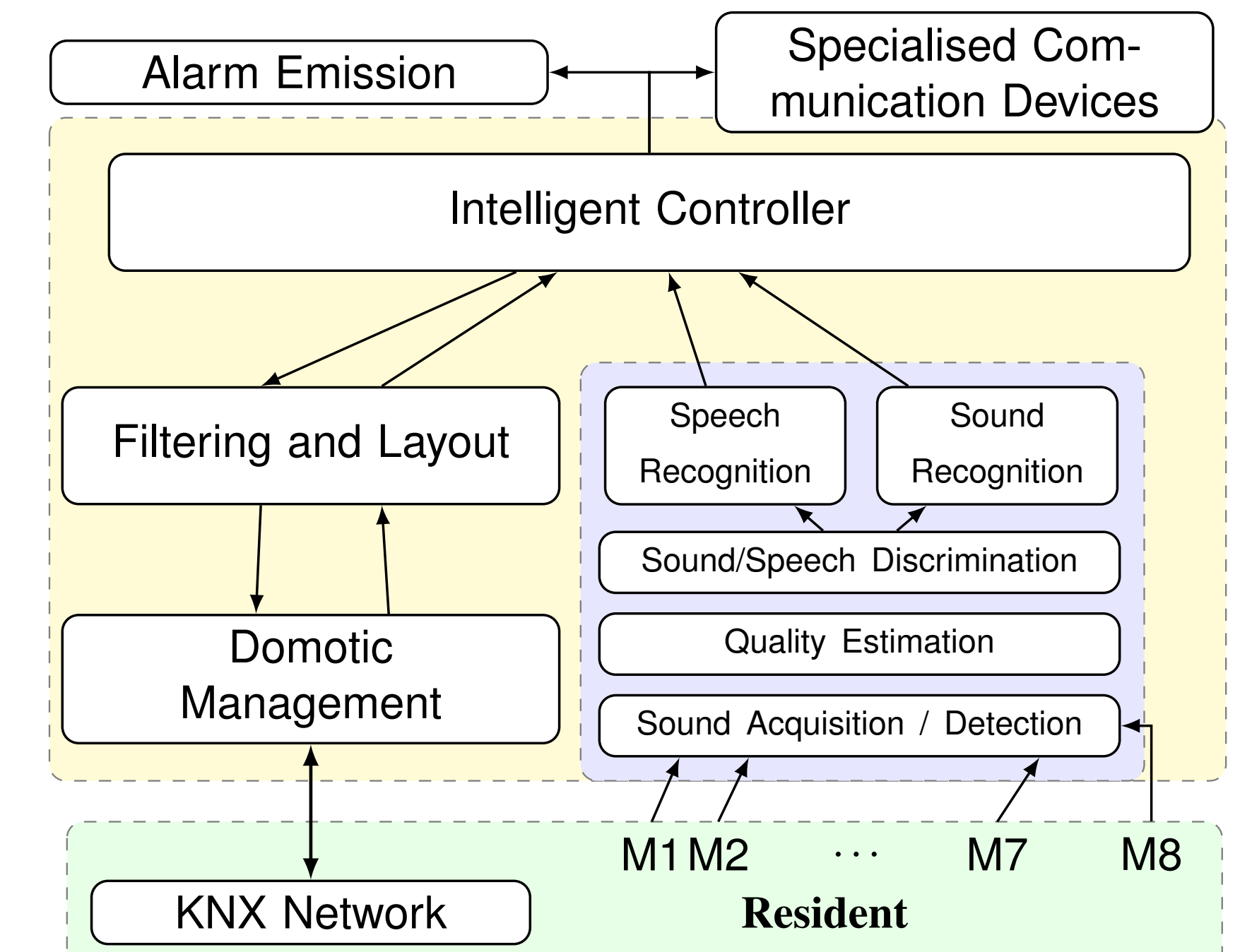
Audio-based interaction technology :

- ▶ 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

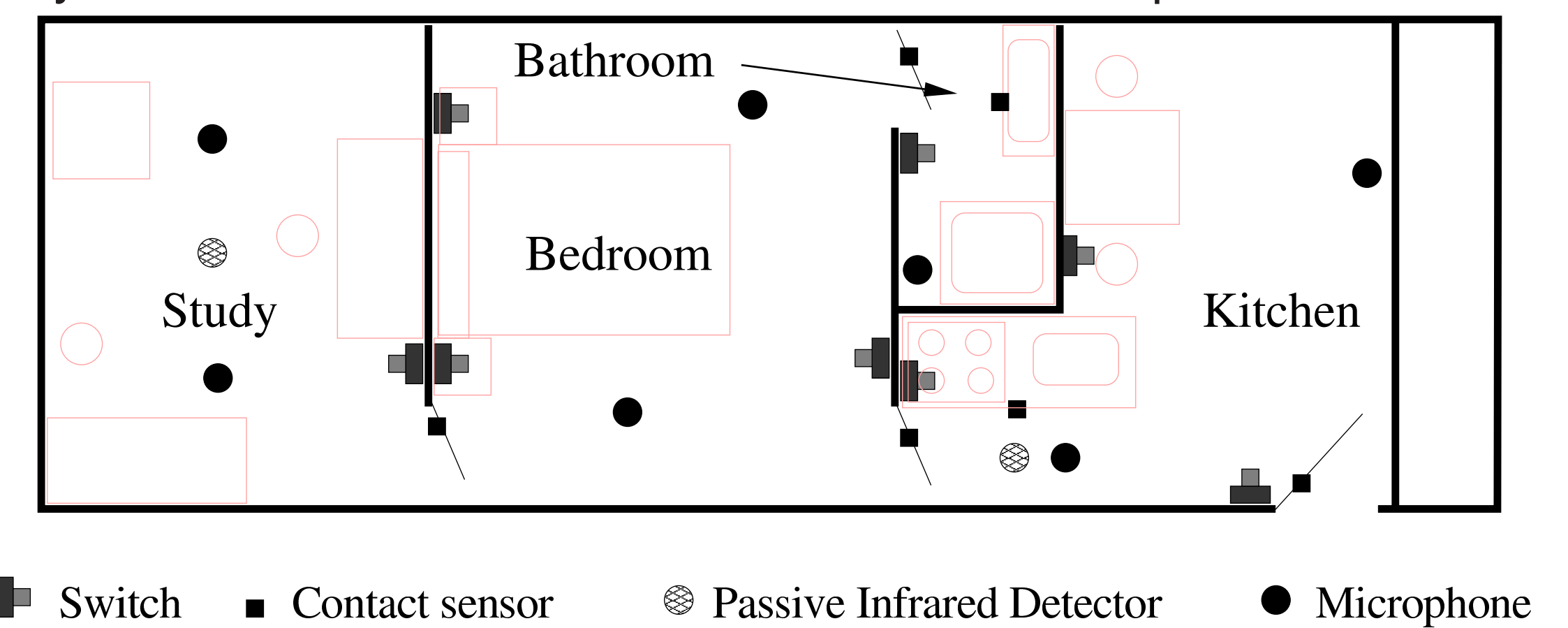
Technical architecture of the flat

- ▶ DOMUS smart home, 30 m²
- ▶ 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 ± 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

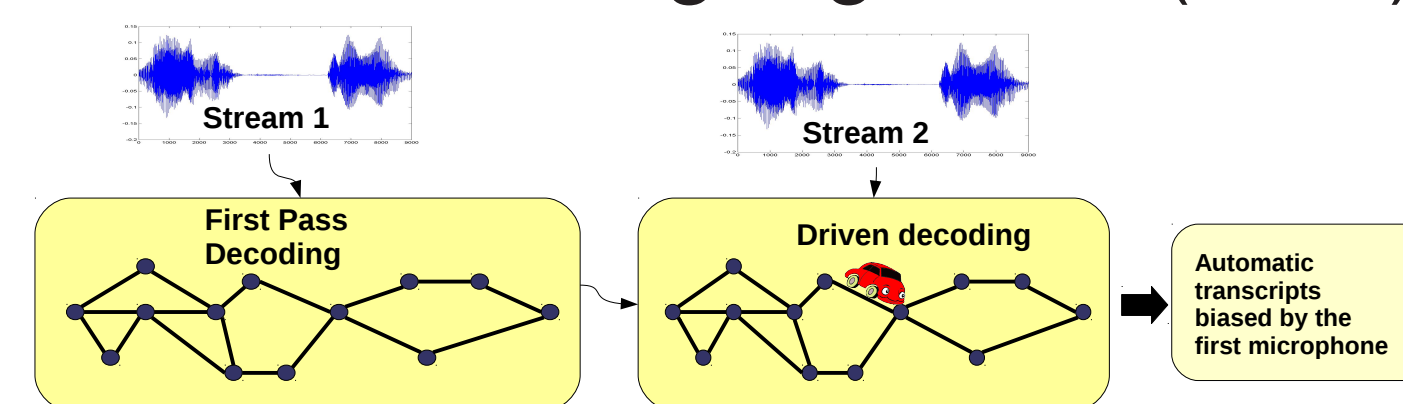
Distant Speech Corpus

- ▶ 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 ⇒
 - ▶ BEAM-FORMING

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



Results

Method	WER ^{±SD}
Baseline	18.3 ^{±12.1}
Beam Forming	16.8 ^{±8.3}
DDA +SNR	11.4 ^{±5.6}
ROVER	20.6 ^{±8.5}
ROVER 2c+SNR	13.0 ^{±6.6}
ROVER +SNR	12.2 ^{±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**

