

# Wearable Video Monitoring of People with Age Dementia: Video Indexing at the Service of Healthcare

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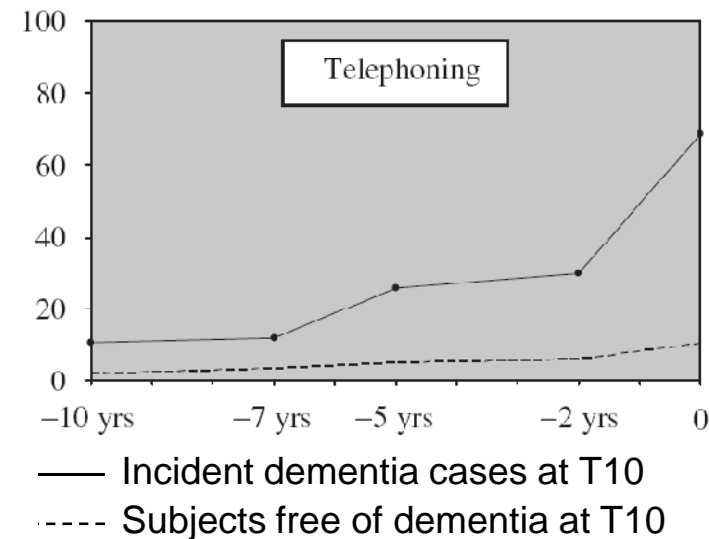
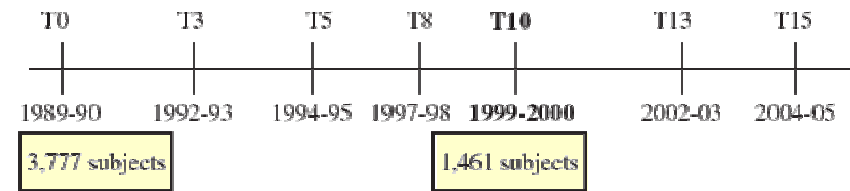
*Work supported by a PEPS S2TI CNRS grant and by a BQR grant of University Bordeaux 1*

# Context

- Global population aging issue in Europe
  - Need for assisting aged people living independently in their home
    - Help people who suffer from impairment
  - Need for a better understanding of aging related phenomena
    - Detect potential future impairment earlier

# Context: Early Diagnosis of Dementia

- PAQUID Study
  - Large scale epidemiological survey on cerebral and functional aging
- IADL assessment [Peres 08]
  - (Instrumental Activities of Daily Living)
  - Telephoning, Transportation, Medications, Finances
- Correlation between IADL restriction and future dementia
  - IADL may be a useful tool for screening subjects at risk



K. Peres, C. Helmer, H. Amieva, J.-M. Orgogozo, I. Rouch, J.-F. Dartigues, P. Barberger-Gateau, Natural history of decline in instrumental activities of daily living performance over the 10 years preceding the clinical diagnosis of dementia: a prospective population-based study. *Journal American Geriatrics Society*, 2008.

# Project motivation

- Early diagnosis of dementia
  - Complement questionnaire based diagnosis
  - Take into account low number of specialists
- Ecological behavioural analysis
  - Objective observation of
    - IADL
    - Social interaction
  - First step for designing remediation therapies

## Related work : ambient sensor monitoring

- Static sensors

- Fixed setup at home
  - Incident detection
  - Trend monitoring
- Adapted for long-term monitoring

- Wearable systems

- More ubiquitous
- Monitoring of
  - Mobility
  - Physiological data

➔ Monitoring of  
behaviour and  
activities ?

C. Scanail, S. Carew, P. Barralon, N. Noury, D. Lyons, G. Lyons. "A Review of Approaches to Mobility Telemonitoring of the Elderly in Their Living Environment", Annals of Biomedical Engineering, 2006.

## Related work : wearable video for healthcare (1)



SenseCam device



Wide-angle image capture

- Wearable camera+micro
  - Embedded recording  
1 frame every 30s on average
- Visual Lifelog / Diary
  - Automatic video structuring  
[O'Conaire 07]
  - Retrospective memory aid  
[Hodges 06]

C. O'Conaire, N. O'Connor, A.F. Smeaton and G. Jones, "Organising a daily Visual Diary Using Multi-Feature Clustering," *SPIE Electronic Imaging*, 2007.

S. Hodges, L. Williams, E. Berry, S. Izadi, J. Srinivasan, A. Butler, G. Smyth, N. Kapur and K. Wood, "SenseCam: a Retrospective Memory Aid," *In UBICOMP* 2006.

## Related work : wearable video for healthcare (2)



WearCam device



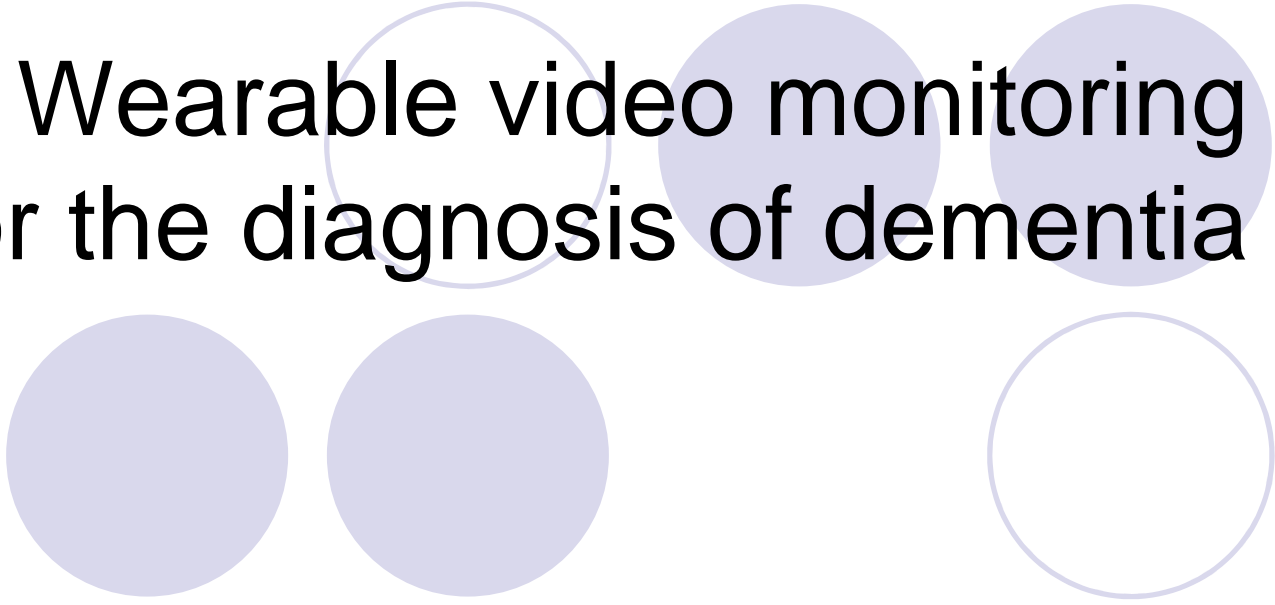
Gaze tracking

- Wearable camera
  - Wireless video transmission
- Behaviour analysis
  - Tracking of the gaze attention
  - Quantification of the time spent looking at persons
- Diagnosis of developmental disorders [Picardi 07]

L. Piccardi et al., WearCam: A head mounted wireless camera for monitoring gaze attention and for the diagnosis of developmental disorders in young children, RO-MAN2007.

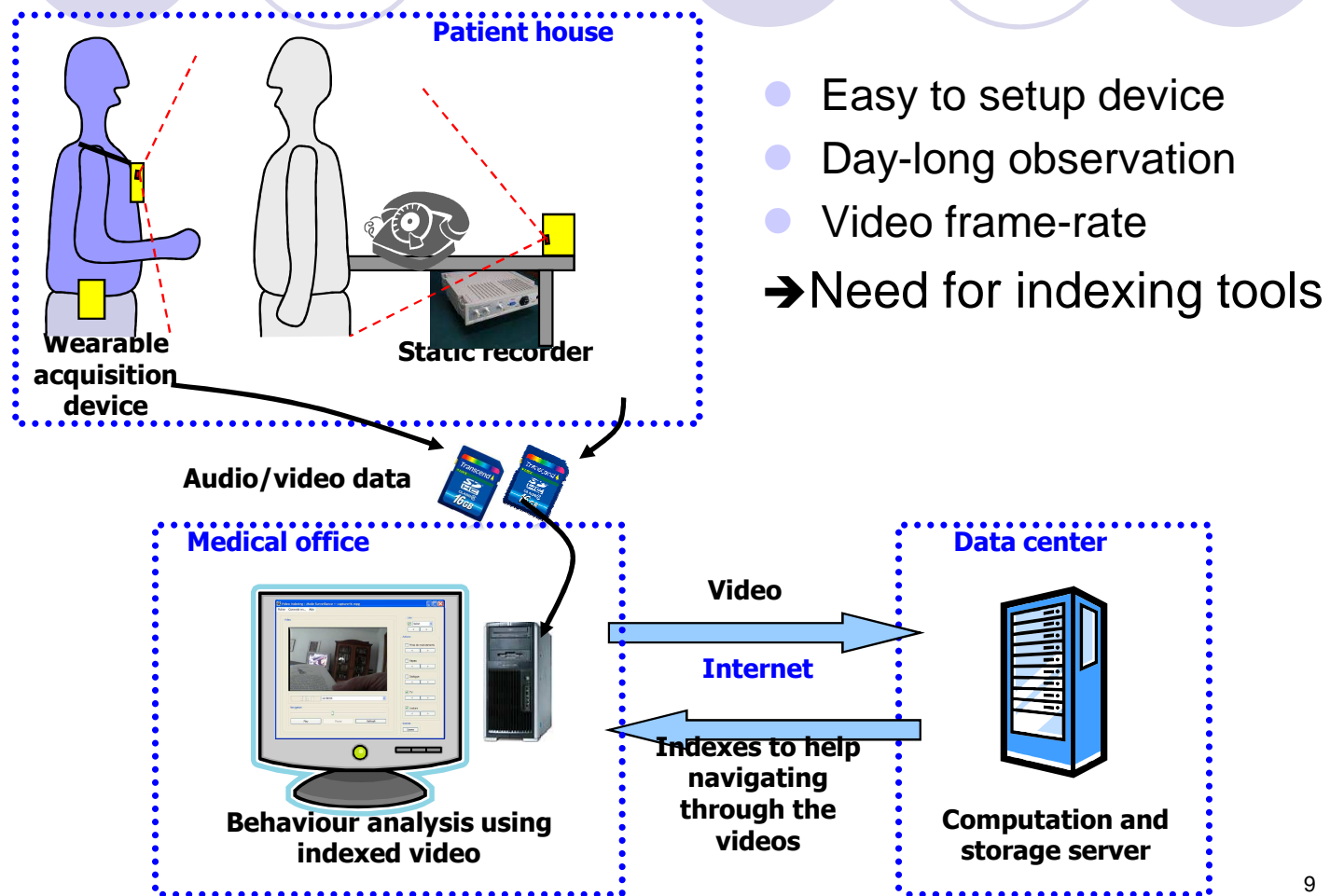
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# Wearable video monitoring for the diagnosis of dementia





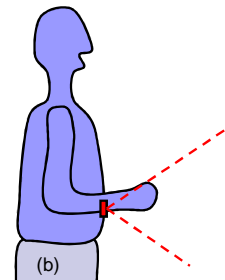
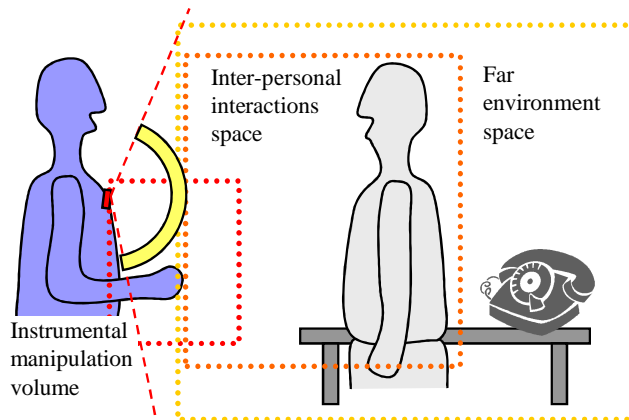
# General principle



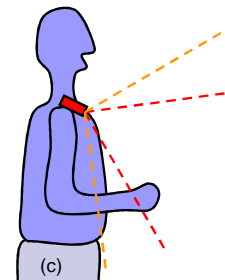
# Capture field of view

- Events of interest

- Instrumental activities
- Conversation abilities
- Task planification



Instrumental activities setup



Shoulder setup + Fisheye

- Stable point of view
- Overall view on both spaces
- Few occlusions
- Farther from liquid projections



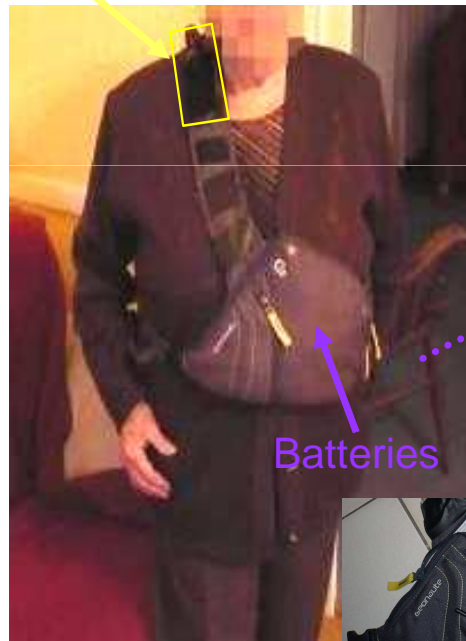
## Example of a scenario based capture



- IADL related scenariii
  - Instrumental Activities of Daily Living
  - Washing, cleaning, answering or giving a phone call, reading, writing, talking to another person...
- 6 minutes of video monitoring (x20 speed)
  - interferences between tasks concerning planning (phone call interrupted by sweeping)

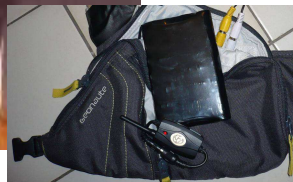
# Wearable audiovisual acquisition device

Camera +  
Microphone



Batteries

RF audio/video  
transmission



First wearable  
acquisition prototype

- Minimal hindering
    - Easy to put/remove
    - Comfortable bag
  - Low weight
    - Total 650g, including 300g bag
  - Day-long autonomy
    - 230g battery
    - 2GB/hour of data
- Good acceptance by volunteers



Receiver and  
recorder

# Video corpus

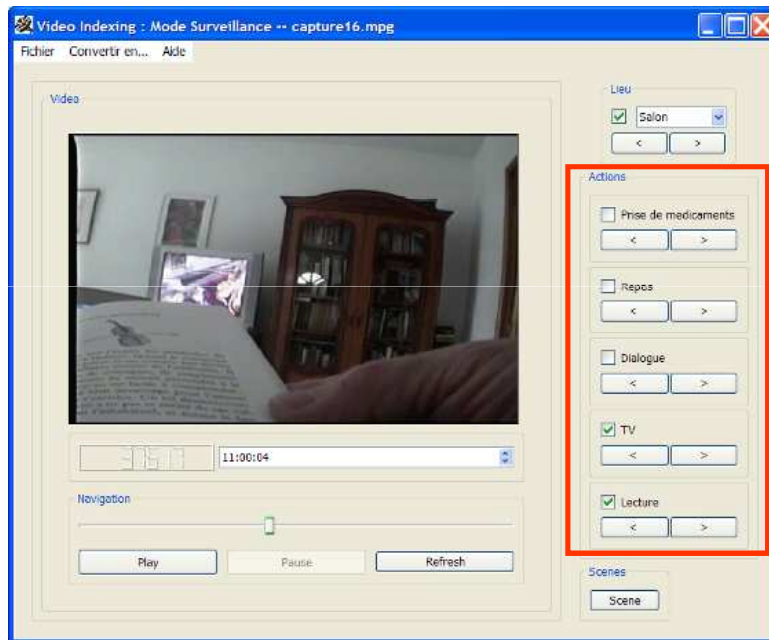
- Tests on 2 aged healthy volunteers
  - Volunteer 1
    - 76 years old
    - Instrumental activities setup
  - Volunteer 2
    - 81 years old
    - Shoulder setup, wide angle lens
- Test on 1 moderately impaired volunteer
  - Volunteer 3
    - Shoulder setup, fish-eye lens



# Video indexing and structuring



# Browsing interface



- Time-based navigation
- Event-based navigation
  - Meal / TV / Reading
  - Speech
  - Location
- Today, manually indexed



# Shot summarization and motion compensation

- In relation with shot detection algorithms
- Challenging data
  - Motion amplitude > 30px
  - Noise, Motion blur
  - Unusable MPEG2 motion vectors
- Hierarchical block-matching
  - Large window search at top level
  - Block based robust motion estimation [Durik 01]

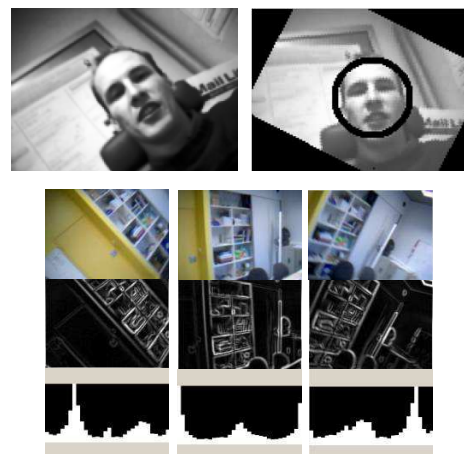
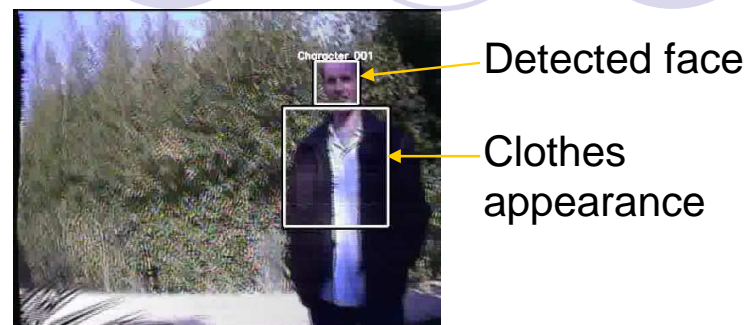


M. Durik, J. Benois-Pineau, "Robust motion characterisation for video indexing based on MPEG2 opticalflow". *In CBMI'01*.



# Person detection

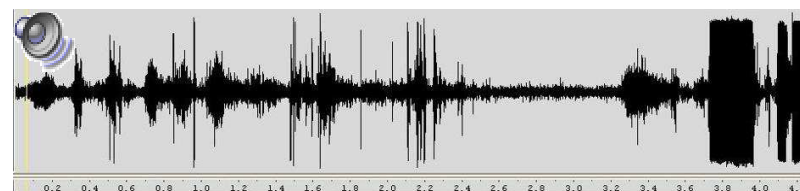
- Useful for localizing phases of interaction with other persons
- Labeling persons on the basis of their clothes appearance [Jaffré 05]
  - Coupled with state of the art face detection
- Orientation compensation when the person moves
  - Orientation histograms



G. Jaffré, and P. Joly, "Improvement of a Temporal Video Index Produced by an Object Detector". *In Int. Conf. on Computer Analysis of Images and Patterns 2005*.

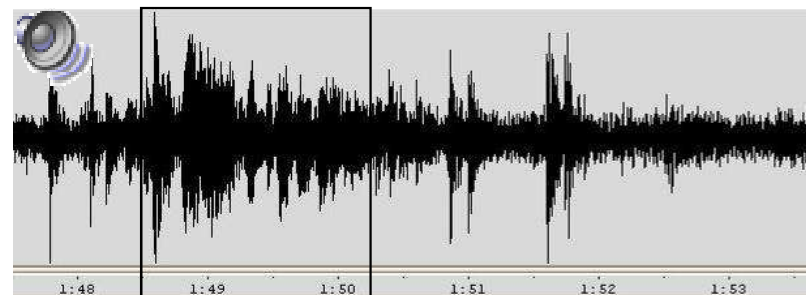
# Speech detection

- Noisy signals
  - Noisy environment
  - Clothes noise close to the microphone
  - Wireless transmission
- Large discrepancies in signal dynamics
- Entropy modulation
  - merged with the classical 4 Hertz modulation energy [Pinquier 02]
- 90% of accuracy for speech detection of the monitored patient



Far Speech

Close Speech



Speech

Pinquier, J. et al. "Robust speech / music classification in audio documents".  
In: *International Conference on Spoken Language Processing*, 2002.



# Conclusion

# Conclusion

- Preliminary study on a wearable video monitoring hardware and software platform
- Capture device
  - Wide-angle image capture at video rate
  - Ergonomic constraints
- Content analysis
  - Challenging data  
(motion, noise, unconstrained environment...)
  - Scene summarization
  - Event detection (faces/speech)

# Perspectives

- Activity based event detection
- Embedded day-long recorder
  - Replace wireless transmission with embedded video frame-rate capture
  - Add other sensors (accelerometers) to facilitate activity detection
- Sharing the data corpus
  - Need to address juridical issues about sharing such data
  - Extension of the experimental larger panel