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

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Wearable Video Monitoring of People with Age Dementia

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

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
Wearable Video Monitoring of People with Age Dementia

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?

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Related work: wearable video for healthcare (1)

- **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]

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Related work: wearable video for healthcare (2)

- 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.
Wearable video monitoring for the diagnosis of dementia
Wearable Video Monitoring of People with Age Dementia

General principle

- Easy to setup device
- Day-long observation
- Video frame-rate

Need for indexing tools

Audio/video data

Medical office

Behaviour analysis using indexed video

Data center

Computation and storage server

Indexes to help navigating through the videos

Internet

Video

Patient house

Wearable acquisition device

Static recorder
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 scenarios
  - 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

- 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

First wearable acquisition prototype

Batteries

RF audio/video transmission

Receiver and recorder

Camera + Microphone
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

Conclusion
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- 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)
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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