CoBTeK – CMRR Posters

Centre Edmond et Lily Safra

INSTITUT CLAUDE POMPIDOU

CoBTeK Cognition Behaviour Technology

iAU innovation pour la maladie d'Alzheimer

Université Nice Sophia Antipolis

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Automatic Speech analysis for the assessment of cognitive status in dementia patients with the help of a mobile application

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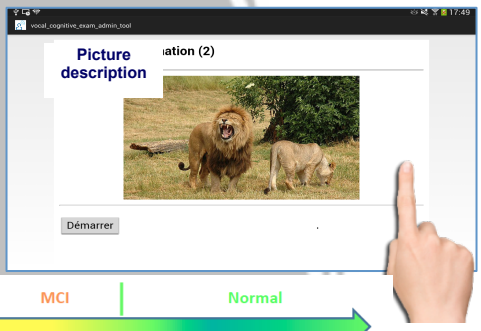
Background : Assessment of cognitive decline, in particular at early stage Alzheimer's disease and other dementia types, as well as Mild Cognitive Impairment (MCI) is complex ; a broad range of heterogeneous assessment methods exist. Various types of dementia and MCI are manifested as irregularities in human speech and language, which have proven to be strong predictors for the disease presence and progression. Therefore, automatic speech analysis is expected to be a useful tool in providing indicators for assessment and detection of early stage dementia and MCI.

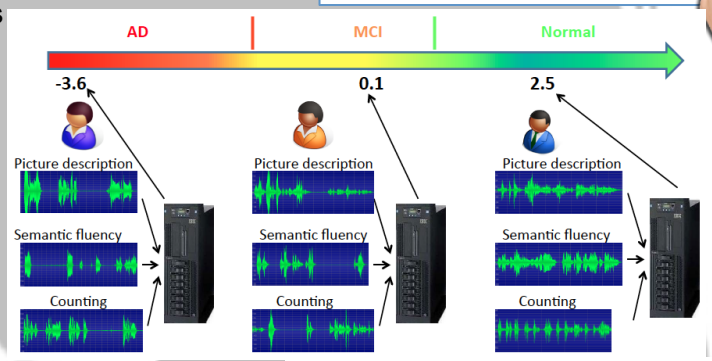
Aims & Methods : In **EU FP7 Dem@Care project IBM Research Haifa and CoBTek, CMRR**, Nice teamed up to develop accurate and cost-effective method supporting clinicians in dementia assessment. The examination protocol includes few spoken cognitive tasks

- Mobile application administers the examination and records patient's voice
- Automatic voice analysis software produces the assessment score

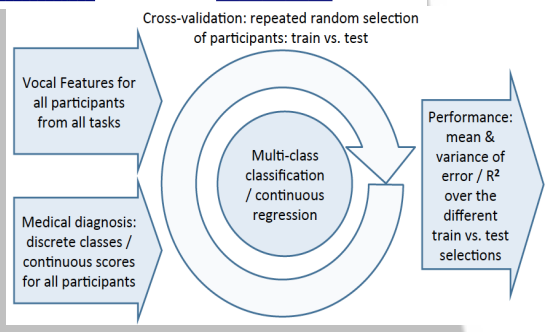
Mobile application for automated cognitive spoken Mobile device presents spoken tasks and records patient's voice

- Easy assessment at clinical consultations for early diagnosis of dementia and its progression monitoring
- Self-assessment at home with assistance of family member





The audio recordings are transferred to a server computer performing voice analysis and Automatic assessment of cognitive status
23 Healthy elderly subjects (HC), 27 MCI patients and 31 AD patients were recorded while performing several short vocal cognitive tasks during a regular consultation.
Tasks included: verbal fluency, picture description, counting down, and free speech task
The voice recordings were processed in two steps:
1/ vocal markers were extracted using speech signal processing techniques, the vocal markers were tested to assess their 'power' to distinguish between HC, MCI and AD.
2/ training automatic classifiers for detecting MCI and AD, based on machine learning methods, and testing the detection accuracy.



Results: Preliminary results show high accuracy rates for the continuous 'cognitive vocal score' which was calculated for each participant within the range of 0 - 1. The fluency and free speech tasks obtain the highest accuracy rates of classifying AD vs. MCI vs. HC. Using the data, we demonstrated classification accuracy as follows: between HC and MCI: 84 ± 4%, between HC and AD: 90 ± 3%, and between MCI and AD: 83 ± 4%.

Conclusions: Decline in cognitive functioning affects speech production in different ways. The results indicate the potential value of automatic speech analyses via a mobile application of recorded vocal cognitive tasks for accurate automatic differentiation between HC, MCI and AD. This can provide the clinician with meaningful information for assessment and early screening and diagnosis purposes, based on non-invasive, simple and low-cost method.

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The use of Virtual Reality for cognitive stimulation in patients with MCI and Alzheimer's disease

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Introduction

⇒ **Virtual reality (VR)** is ideal to design cognitive trainings because it provides realistic, familiar but controllable environments [1].
⇒ Here, **we tested the acceptability of two VR solutions** for **elderly participants** and patients with **Mild Cognitive Impairment (MCI)** and **early to moderate Alzheimer's disease (AD)** to stimulate: **autobiographical memory (study 1)** and **attention and concentration (study 2).**

STUDY 1
Autobiographical memory

Methods

Participants

⇒ 18 healthy volunteers (>60years) without cognitive impairment

Stimuli and conditions

⇒ 4 conditions: **2** with **pictures** (A and B), **2** with **VR** (C and D):

Grey	FamPict	FamVR	UnfamVR
Grey screen	familiar picture	familiar VR	Unfamiliar VR

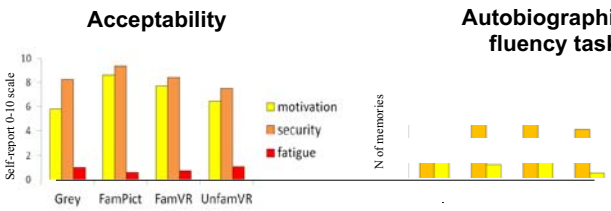
Technology

⇒ Imaged-base rendering system [1] http://dvpr.es/14t0tkj
⇒ BARCO iSpace, screen 320 cm ×240 cm, res. 1,600×1,200 pixels
⇒ Passive Infitec stereo via glasses tracked with ART tracking system

Procedure

⇒ Clinical assessment to verify the absence of cognitive impairment
⇒ **Autobiographical fluency task** in the 4 conditions (2 min). Participants need to generate as many memory as possible. Responses scored following the Remember/Know procedure
⇒ **Self-report questionnaires** assessing **acceptability** (motivation, security, fatigue).

Results



⇒ Participants **less motivated** in the **Grey** condition
⇒ **More "Remember"** response in **FamPict** and **FamVR** compared to Grey and UnfamVR [2]

STUDY 2
Attention and concentration

Methods

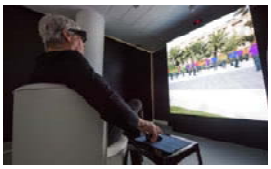
Participants

⇒ **30 MCI** (16 M; Age: M=75.5y, SD= 6.8y; MMSE, M= 25.5, SD= 2.7)
⇒ **30 AD** (18 M; Age: M=76.2y, SD= 7.1y; MMSE, M= 20.0, SD= 3.3)

Stimuli and conditions

⇒ 2 conditions: **paper** and **VR** (same familiar environment)

Paper version



VR version

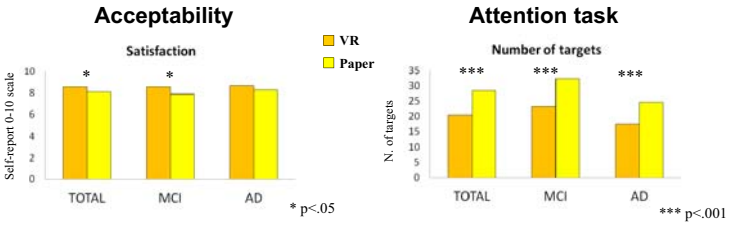
Technology

⇒ Imaged-base rendering system
⇒ BARCO, 2 LEDs screens 155cm x 174cm, res. 1920 * 2160 pixels
⇒ Stereo glasses without tracking

Procedure

⇒ Clinical cognitive and behavioural assessment
⇒ **Attentional task** in the 2 conditions (5 min). Participants need to find characters that meet specific criteria (e.g., a blue T-Shirt)
⇒ **Self-report questionnaires** assessing **acceptability** (satisfaction, security, fatigue).
⇒ Participants are **free to continue** in any condition if they want

Results



⇒ Participants **more satisfied** in **VR** condition, **no differences** in **security and fatigue**; MCI **played more** in **VR** (implicit satisfaction)
⇒ **More targets in VR, no differences** in the number of **errors**

Conclusions

⇒ **VR** setting were considered **acceptable, secure** and **motivating** by both **elderly healthy participants** and patients with **MCI** and **AD**.
⇒ These results suggest that **VR solutions are useful motivational** tools.
⇒ As **apathy** is very common among these populations, having motivating tools is a key element in designing effective rehabilitation programs

References

[1] **Chapoulie et al. (2014). Reminescence theraphy using Imaged-based rendering in VR. Proceeding of the IEEE Virtual Reality Conference**

[2] Benoit et al. (2015). Is it possible to use highly realistic virtual reality in the elderly? A feasibility study with image-based rendering. Neuropsychiatric Disease and Treatment

Ecological assessment of autonomy in Instrumental Activities of Daily Living using an automatic video monitoring system

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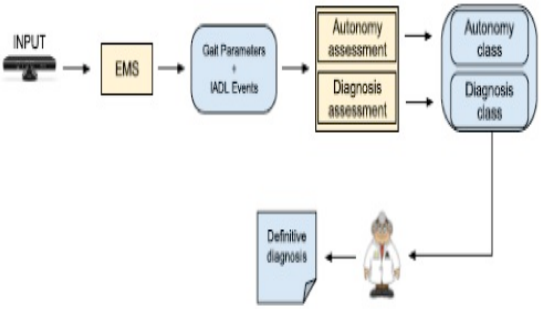
Background: Currently, the gold-standard for the assessment of autonomy and functional ability involves clinical rating scales. However, scales are often limited in their ability to provide objective and sensitive information. In contrast, information and communication technologies (ICT) may overcome these limitations by capturing more fully the functional, as well as executive cognitive disturbances associated with Alzheimer disease (AD). Most available technologies have been developed for monitoring purposes - such as fall detection or gait analyses - relying on wearable, environmental or video sensors.
We investigated the **quantitative assessment of the autonomy in dementia patients** based not only on gait analysis but also on the participant performance on **Instrumental Activities of Daily Living (IADL) automatically recognized by a video event monitoring system**



Methods: Three groups of participants (healthy elderly subjects (HC), Mild Cognitive Impairment (MCI) patients and AD patients) had to carry out a 20-minutes standardized scenario consisting of directed tasks (single and dual task) and several IADLs such as preparing a pillbox or making a phone call. During this time, they were recorded by 2D video cameras capturing all their activities in the room. The performance quality of each participant was manually annotated and grouped into either 'good', 'mediocre' or 'poor' according to the amount of successfully carried out activities. After the recording session, video sensor data was processed by an event monitoring system that automatically extracts kinematic parameters about the participant gait and recognizes the activities undertaken by the participant. These parameters where then used for the assessment of the participant performance during the protocol task, here referred as participant autonomy. Autonomy assessment is approached as classification task using artificial intelligence methods that takes as input the parameters extracted by the event monitoring system, here referred as behavioral data. Dementia diagnosis prediction is also evaluated as complementary information about the patients' cognitive status.

Diagnosis assessment	Input Data		
Performance	Scenario 01	Scenario 02	Both Scenarios
Correctly Classified Instances	36 (73.4694%)	30 (61.2245%)	36 (73.4694%)
Incorrectly Classified Instances	13 (26.5306%)	19 (38.7755%)	13 (26.5306%)

Autonomy assessment	Input Data		
Performance	Scenario 01	Scenario 02	Both Scenarios
Correctly Classified Instances	37 (75.5102 %)	38 (77.551%)	41 (83.6735%)
Incorrectly Classified Instances	12 (24.4898 %)	11 (22.449%)	8 (16.3265%)

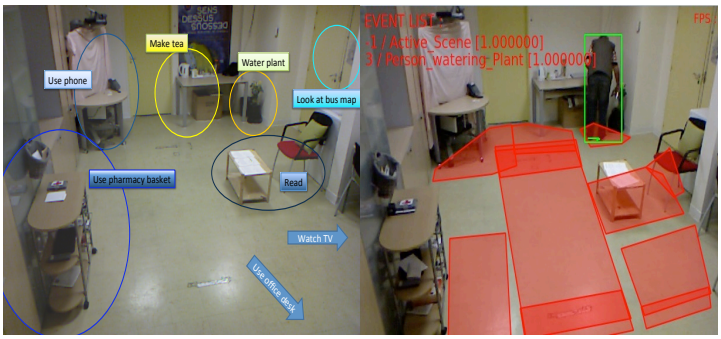


Figure 3. Event recognition based on Activity zones. The left image presents the contextual zones used to describe the scene semantics. The right image presents an example of output of the EMS system.

Results: The overall activities were accurately recognized with high recall and precision results. The most accurately recognized activities were: 'prepare medication' with 93% precision and 'using phone' with 89% precision. The diagnostic group classifier based on automatically extracted video features obtained a precision of 73.46% when combining the analyses of physical tasks with IADLs. However, in a further analysis, the created autonomy group classifier based on simply the automatically extracted video features obtained an precision of **83.67%** when combining directed tasks and IADLs.

Conclusion: The results suggest that it is possible to quantitatively assess IADL functioning supported by an automatic video monitoring system and that even based on the extracted data the groups could be classified with highly accuracy. In particular, IADLs such as preparing medication and making a phone call showed high detection precision captured by the Automatic Video Monitoring System. This means, that the use of such technologies, may provide clinicians with diagnostic relevant information to improve autonomy assessment in real time decreasing observer biases

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