Field Evaluation with Cognitively-Impaired Older Adults of Attention Management in the Embodied Conversational Agent *Louise*

P. Wargnier, G. Carletti, Y. Laurent-Corniquet, S. Benveniste, P. Jouvelot and A.-S. Rigaud.

4th IEEE International Conference on Serious Games and Applications for Health (SeGAH), Orlando, USA – May 13th 2016

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Motivations

- Over 100 millions people with dementia by 2050
- Dementia = loss of cognitive functions due to brain diseases in older adults
- High care costs
- Caregivers shortage

Outline

1. Motivations
2. Project overview
3. Why ECAs?
4. The Louise ECA
5. Attention estimation method
6. Evaluation
7. Anthropological analysis
8. Conclusion and future work

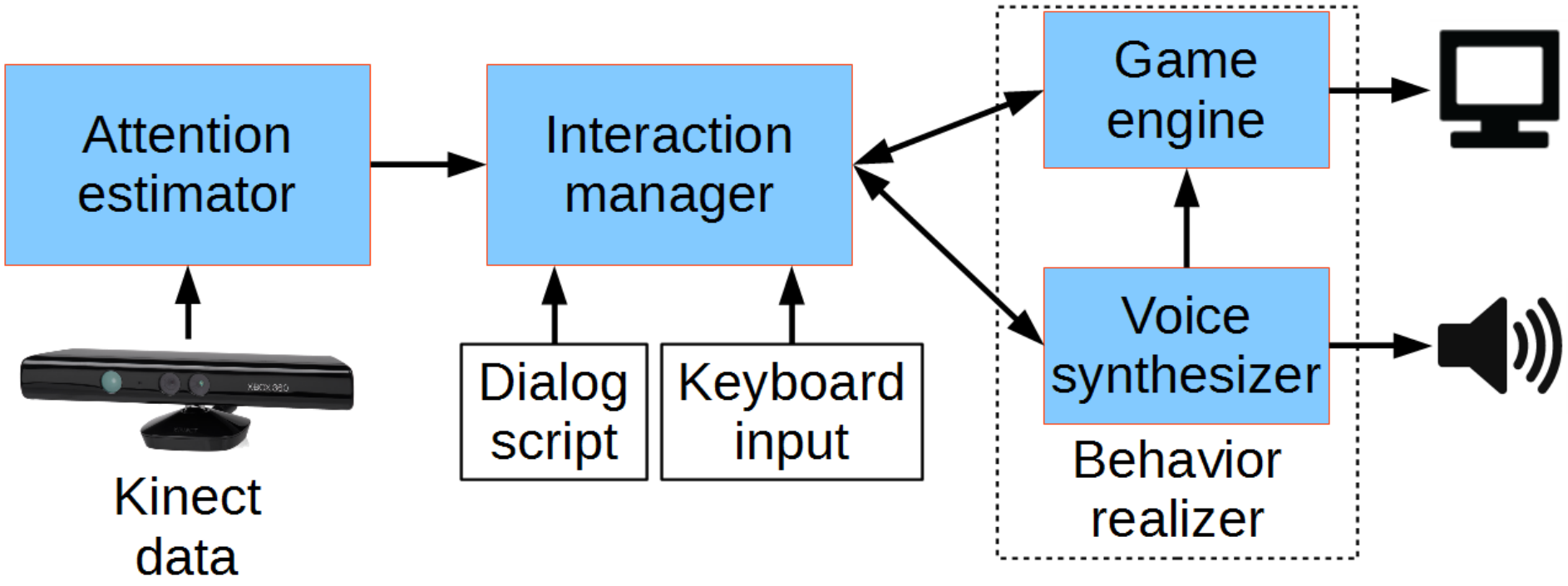
Project overview

- Challenge: Building an adapted user interface for older adults with cognitive impairment (and low computer literacy)
- Proposed solution: embodied conversational agents (ECAs)
- Design methodology: user-centered “living-lab” approach
- Place: Broca Hospital (Paris, France)

Why ECAs?

- Good task performance
- Attention and engagement
- Natural interaction
- Trust
- Better understanding
- Non-verbal behaviors
- Personalization

The Louise ECA (1/2)



The Louise ECA (2/2)

Figure 1 – ECA's embodiment

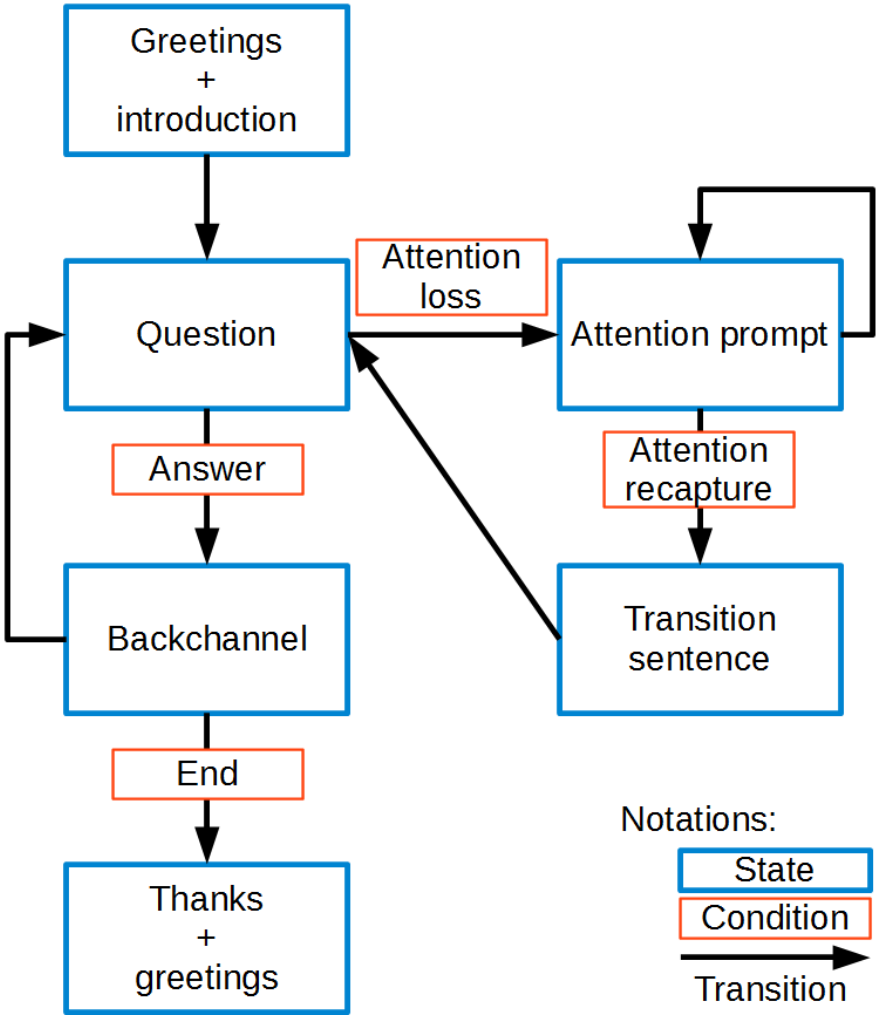


Figure 2 – ECA's behavior

Attention estimation method (1/2)

- *A priori* assumptions:
  - Attention = looking towards the display
  - Sensor placed on top of the display in the middle
- 3 features:
  - φ = divergence from direct orientation of the body towards the sensor
  - Yaw = the head's rotation around the vertical axis
  - Pitch = face up/face down rotation of the head

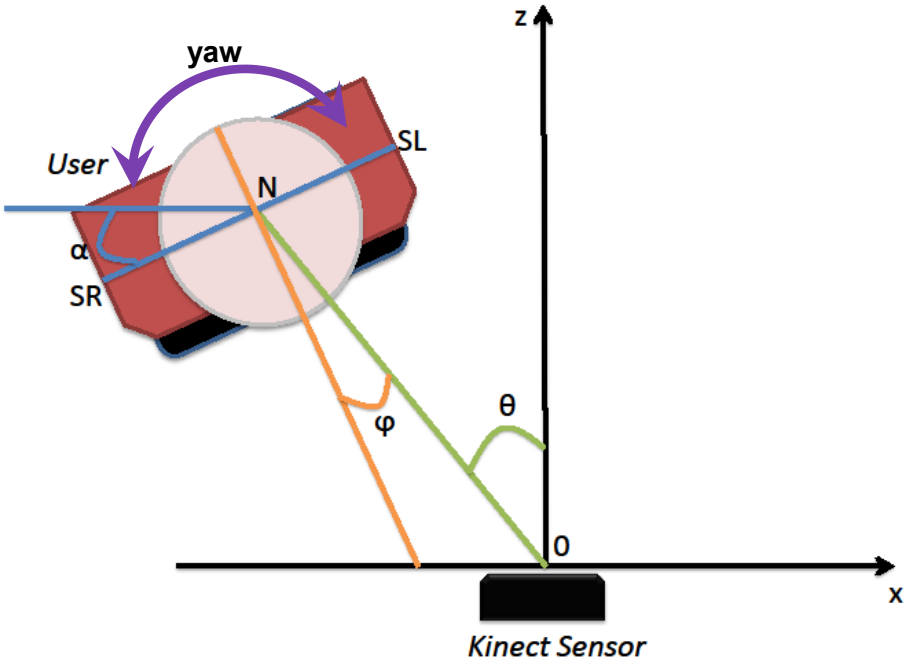


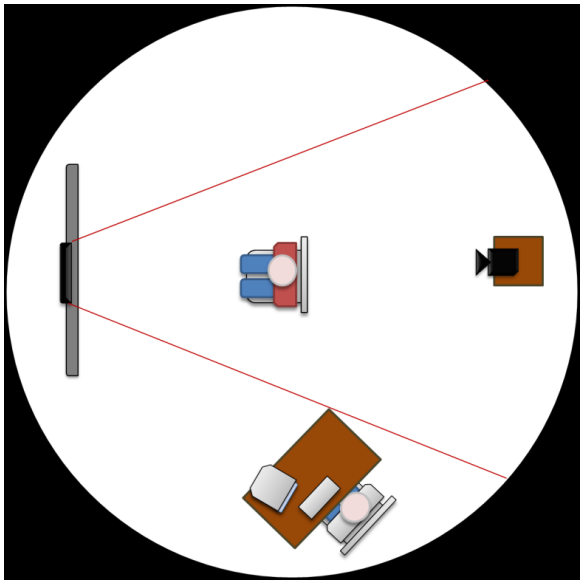
Figure 3 – Angles used for attention estimation

Attention estimation method (2/2)

- Features f_j averaged over 1-second sampling
- Features normalized as: $\overline{f_j} = \frac{\cos(f_j) - \cos(Max_j)}{1 - \cos(Max_j)}$
- Max_j = 60° for φ, 30° for yaw and 20° for pitch
- Attention value *A* computed as: $A = \sum_{j=1}^{n} \omega_j \overline{f_j}$
- Sum of the weights ω_j is 10; features in [0; 1]
- $\omega_\varphi = 3$; $\omega_{yaw} = 4$; $\omega_{pitch} = 3$; n = 3
- Decision: empirical hysteresis threshold

Evaluation

- Phase 1: Healthy younger adults
  - 14 participants : 10 men, 4 women
  - Assistive technology experts
  - 22 < age < 62 (mean = 37)
- Phase 2: Older adults
  - 8 participants : 6 women, 2 men
  - 3 MCI, 3 Alzheimer's disease
  - 17 < MMSE < 29 (mean = 23)
  - 63 < age < 91 (mean = 78)



Results

- 6/8 participants successfully interacted (1 could not hear; 1 lost track of context)
- Correct estimations:
  - 83% in Phase 1
  - 76% in Phase 2
- No statistically significant differences between groups
- Effective attention recapture strategy

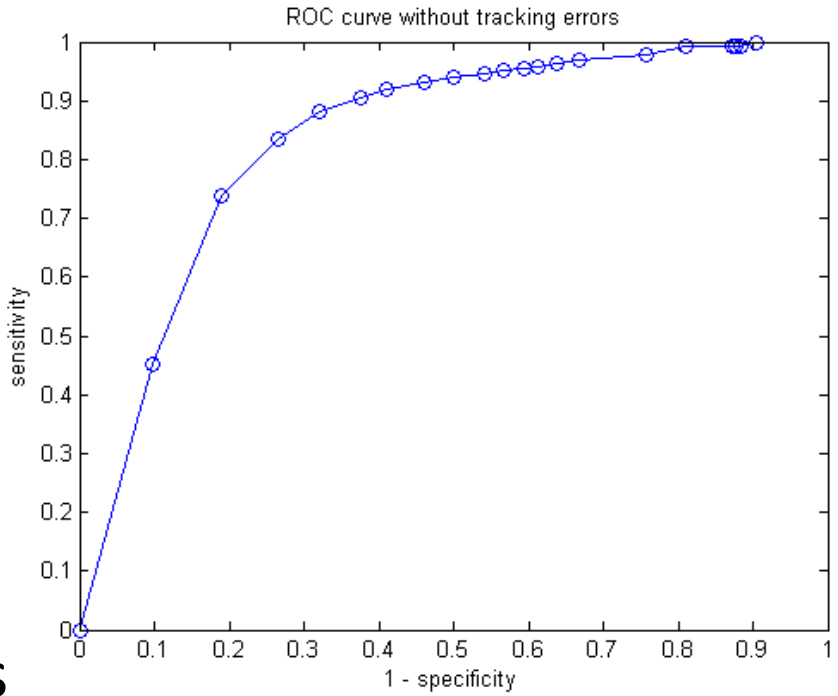


Figure 4 – Receiver Operating Characteristics (ROC) curve of the attention estimator

Anthropological interaction analysis

- Goal: gain insights for future work on interaction management automation
- Method: interaction videos annotation and interviews with Louise's designers
- Observations:
  - People with dementia (PWD) utter more words
  - PWD develop more topic expansion
  - PWD are slower to answer
  - Multi-party interaction (bi-party was intended)
  - PWD talked more to the experimenter

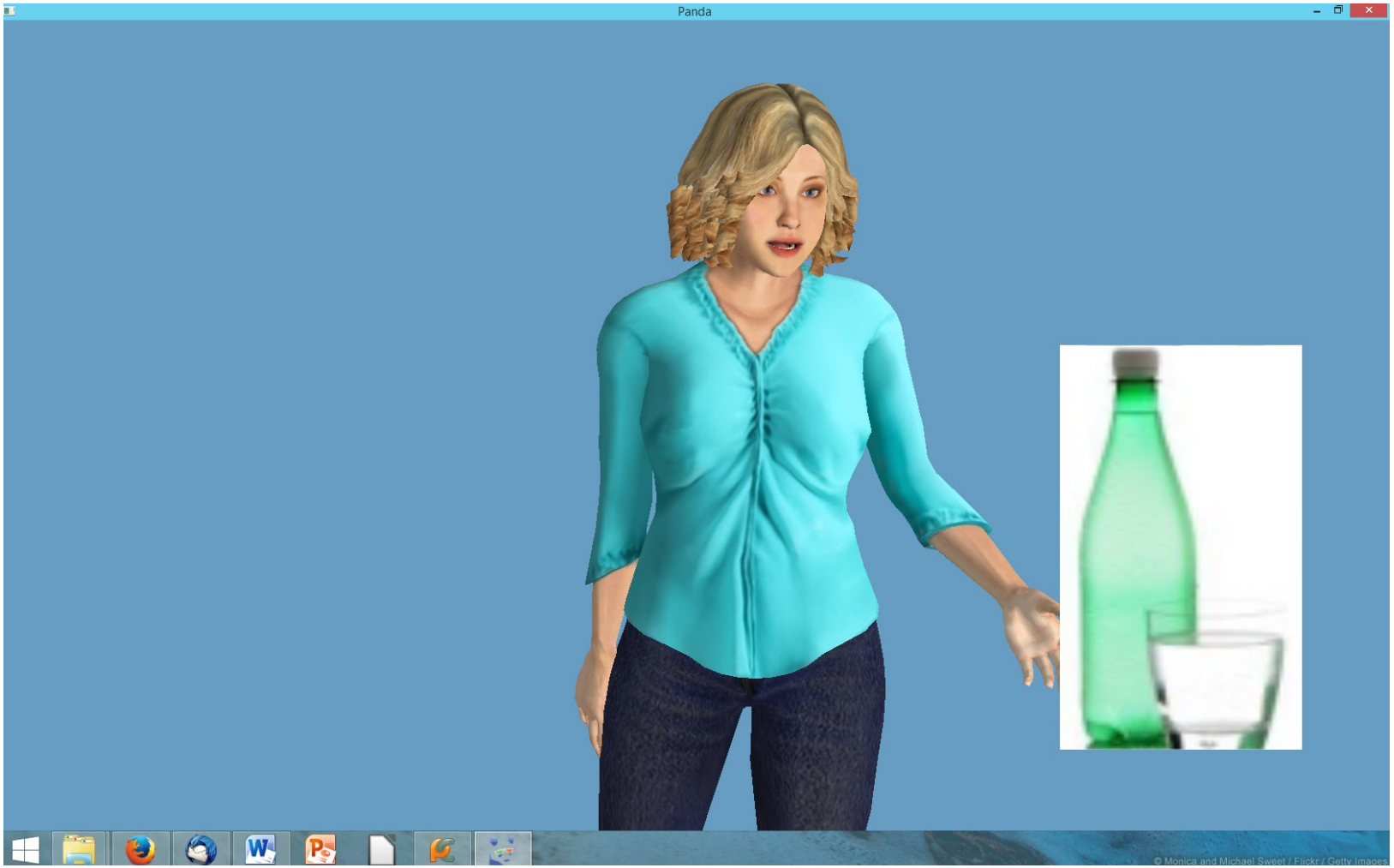
Conclusion

- Simple, fast, cheap and acceptably accurate attention estimation monitoring capabilities
- Little influence of age or cognitive impairment on performance
- Effective attention recapture strategy
- Louise is quite engaging ☺

Ongoing and future work

- Fully automatic system featuring:
  - Attention management
  - Context reminders
  - Keyword-spotting automatic speech recognition
  - Images and example videos display
  - High-quality animation, based on SmartBody
  - Interaction scenario edition in XML
- 2 types of tasks: multiple-option choice and guided task
- 14 participants with MCI or Alzheimer's disease

Louise 2.0



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