

**TITRE DE LA THESE :**

AUGMENTED REALITY FOR IMPROVING AUTONOMY IN DEMENTIA

**Direction de thèse : Guillaume MOREAU**

**Co-encadrant-es: Mélanie COGNE (CHU Rennes –IRISA), Anatole LECUYER (INRIA Rennes), Jean-Marie NORMAND (CentraleNantes, LS2N)**

**Laboratoire(s):**

GEPEA	IRISA	Lab-STICC	LATIM
Lego	LEMNA	LS2N	hors Laboratoire

**Equipe(s) de recherche : INUIT**

**Département(s)IMT Atlantique :**

DAPI	DSEE	INFO	ITI	LCI	LUSI
MEE	MO	OPT	SSG	SRCD	SUBATECH

**S'agit-il d'une thèse en cotutelle internationale ?**

**Oui** **Non**

*Si oui, organisme avec lequel la cotutelle est envisagée :*

**Le sujet proposé présente-il un caractère interdisciplinaire ?**

**Oui** **Non**

*Si oui, expliquer brièvement pourquoi (2 ou 3 lignes):*

Le projet est à l'interface de l'informatique, des sciences cognitives et de la médecine comme le montre le co-encadrement avec une médecin docteur en sciences et un DR INRIA spécialiste de la réalité virtuelle

**La source du co-financement est-elle identifiée ?**

**Oui** **Non**

*Si oui, préciser quel co-financement est envisagé :*

Co-financement de l'Institut des Neurosciences Cliniques de Rennes (CHU Rennes) : acquis

**Autres informations :**

*Informations utiles que vous souhaiteriez communiquer (si pertinent):*

Projet financé par une bourse ARED en 2022, mais les conditions ARED (contrat de 36 mois IMT Atlantique) ne sont pas compatibles avec de l'INCR qui doit embaucher sur 18 mois pour raisons fiscales, d'où ce dépôt.

**Contexte ou état de l'art scientifique:**

*Décrire en 5 à 10 lignes le contexte de la thèse.*

Many people who suffer from a neurodegenerative disease have topographical difficulties which have a severe impact on their autonomy in daily life. People with dementia due to Alzheimer's disease (AD [1]) have spatial navigation disorders mainly due to memory but also executive, attentional, and perceptual cognitive disorders [2]. Some navigational cues have been already tested using Virtual Reality in order to facilitate navigation and spatial memory [3,4]. Augmented Reality (AR), makes it possible to add synthetic information to the natural environment in which the participant evolves [5]. Some studies focused on helping people with dementia with AR [6], but no AR device is dedicated to navigating in an outdoor environment for people with dementia until now and no prototypes have been tested either with real patients either with the exception of ours [in preparation].

**Objectifs de la thèse:**

*Décrire en 10 à 15 lignes les résultats attendus.*

This PhD program aims at supporting the third phase of the ARIADE project. It intends to design and assess an AR-based guidance system in the *ecological* environment of the patients. This "out-of-the-lab" objective raises two important scientific challenges:

- The first one is to provide the technical background for outdoor AR. There exist a few works on outdoor camera relocalization and tracking but they face important drawbacks such as limited range, drifting or lack of precision and accuracy but also limited computing power. Based on the combined experience in AR tracking of ECN and IMT Atlantique, we will not seek major advances here but incremental ones that will allow a tradeoff between consistent augmentations, availability and usability.
- The second challenge consists on exploring the design space of the selected visual aids and assessing how they can be used depending on our tracking results and most importantly on how the patients will perceive them. One important issue that has been tackled so far in the scientific literature is the assessment of how location-based information can be visualized with degraded tracking: all current systems assume perfect tracking or does not take into the consequences of bad tracking on the user. While it may already be problematic with healthy people in terms of trust, we believe the consequences may be much more severe with patients suffering from dementia.

As a followup to our previous works [7,8] other dimensions we are willing to explore include: visual appearance of aids (size, shape, color, location with regard to the field of view), period of appearance (displayed all the time or at given instants), relation with disease progress. We thus also plan to explore error wanderings and endangerment and develop mitigation measures in a clinical study.

**Compétences attendues du ou de la candidat-e:**

*Lister les principales compétences nécessaires pour ce sujet de thèse.*

The candidate must have a master degree (or equivalent), with a preference in mixed reality or human computer interaction. In addition, the candidate should be comfortable with as much following items as possible: experience in 3D/VR/AR applications (e.g. Unity3D); experience in controlled users' studies; good knowledge in programming languages; good spoken and written English and French; good communication skills.

### Références

- [1] McKhann GM, Knopman DS, Chertkow H, Hyman BT, Jack CR, Jr, Kawas CH, Klunk WE, Koroshetz WJ, Manly JJ, Mayeux R, Mohs RC, Morris JC, Rossor MN, Scheltens P, Carrillo MC, Thies B, Weintraub S, Phelps CH. (2011). The diagnosis of dementia due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimers Dement*; 7: 263-269.
- [2] Cushman LA, Stein K et Duffy CJ. (2008). Detecting navigational deficits in cognitive aging and Alzheimer disease using virtual reality. *Neurology*; 71(12): 888-95.
- [3] Yi J, Lee HC, Parsons R et Falkmer T. (2015). The effect of the global positioning system on the driving performance of people with mild Alzheimer's disease. *Gerontology*; 61: 79-88.
- [4] Cogné M, Auriacombe S, Vasa L, Tison F, Klinger E, Sauzéon H, Joseph P-A, N'Kaoua B. Are visual cues helpful for virtual spatial navigation and spatial memory in patients with Mild Cognitive Impairment of Alzheimer's disease? *Neuropsychology* 2018; 32: 385-400.
- [5] Arnaldi B, Guitton P, Moreau G. (2018). *Virtual Reality and Augmented Reality: Myths and Realities*. France. ISTE; Wiley, pp.322, Computer engineering series, 9781786301055.
- [6] Quintana E, Favela J. (2013). Augmented reality annotations to assist persons with Alzheimer's and their caregivers. *Pers. Ubiquitous Comput.*; 17: 1105–1116. doi:10.1007/s00779-012-0558-6.
- [7] Pillette L, Moreau G, Normand JM, Perrier M, Lecuyer A, Cogne M. (2022) A Systematic Review of Navigation Assistance Systems for People with Dementia. *IEEE Trans Vis Comput Graph*. 2022 Jan 10; PP. doi: 10.1109/TVCG.2022.3141383.
- [8] Perrier M, Pillette L, Normand, JM, Lécuyer A, Moreau G, Cogné M. (2022) Apport de la réalité augmentée comme aide technologique pour le maintien de l'autonomie de personnes présentant une maladie neurologique : revue narrative de la littérature. *Ergothérapies* 86.