# DEMENTIA x VR/AR

GROUP 7BT2

Cui kaixiang
Sojeong Ko
Yu Ma
Eulalie Mathieu

# Table of contents

# Introduction

As our society is becoming increasingly older, seniors are facing more and more obstacles to being fully integrated. This becomes even more true when age-related diseases like dementia become part of the equation. According to the Alzheimer's Society[1], there are currently around 900,000 people with dementia in the UK and 57.4 million around the globe. This number is expected to rise to 152.8 million by 2050. In this project, we explored the opportunities and pitfalls that new technologies such as AR and VR can create in the prevention, treatment and support of dementia patients and their caregivers. When used in the right conditions, research has shown that such technologies can be extremely beneficial for dementia patients, whether it is for dementia diagnosis, task prompting, navigation or simply cognitive stimulation with games or immersion into relaxing environments. Based on this positive observation, and on the belief that these technologies will increasingly become part of our lives, we decided to focus on the problem of their non-inclusivity towards elderly people. The outcome of this project is a hardware design proposal, which aims to provide an example of a more inclusive VR interface and challenge the current solutions.

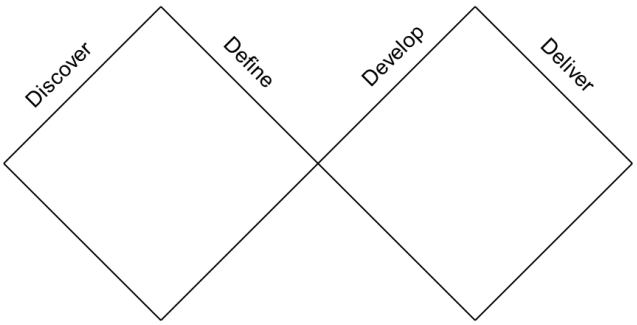



**Figure 1:** Double Diamond Process

# I. Discover

## A. Secondary research

### a. Dementia

Dementia is defined as below by the World Health Organization:

"Dementia is a syndrome – usually of a chronic or progressive nature – that leads to deterioration in cognitive function (i.e., the ability to process thought) beyond what might be expected from the usual consequences of biological ageing. It affects memory, thinking, orientation, comprehension, calculation, learning capacity, language, and judgement. Consciousness is not affected. The impairment in cognitive function is commonly accompanied, and occasionally preceded, by changes in mood, emotional control, behaviour, or motivation."

The disease is particularly characterised by the different stages of evolution.

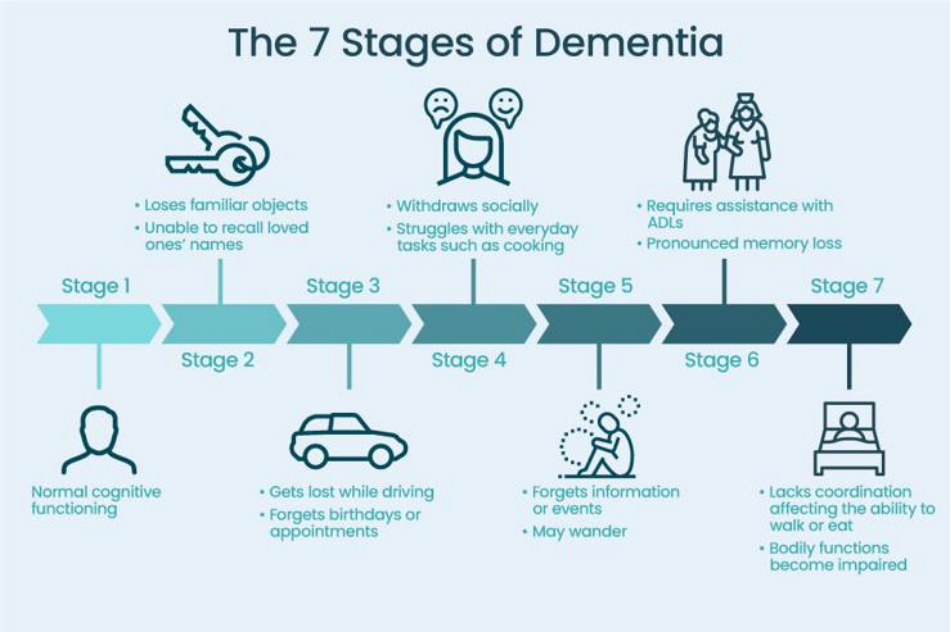



**Figure 2**: The 7 stages of dementia

According to the NHS, dementia symptoms may include problems such as:

- memory loss
- thinking speed
- mental sharpness and quickness
- language, such as using words incorrectly, or trouble speaking
- understanding
- judgement
- mood
- movement
- difficulties doing daily activities

### b. AR and VR

Although AR and VR are often evoked together and both deal with virtual objects, their mode of operation is quite different. AR allows the display of virtual objects in a real-world setting while VR operates in a completely virtual environment. Nowadays, companies such as Google and Meta offer some of the most competitive products on the market. (cf. figure 3, figure 4)

**Figure 3 & 4**: AR glasses - Google glasses. VR glasses and controllers - Oculus Quest 2 from Meta.

The controllers of the VR environment, which could be assimilated into the computer mouse for a laptop, help to navigate the VR environment with multiple functions.

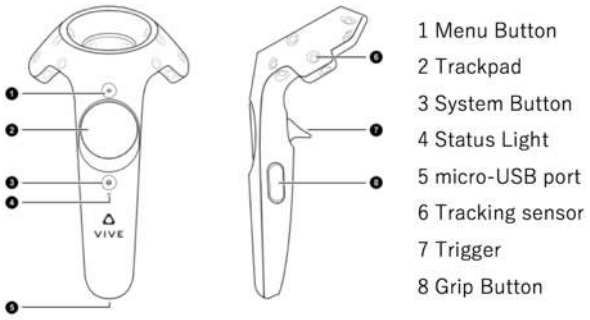



**Figure 5**: VR controllers

### c. Design for dementia projects

The topic of dementia inspired many design projects. We referred to several projects showing interactive environments as well as multiple assistive devices to support dementia patients in their everyday life. More specifically, we found several projects at the intersection of dementia and AR/VR.

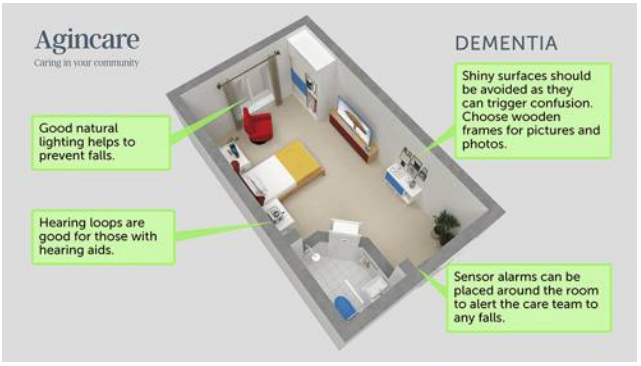
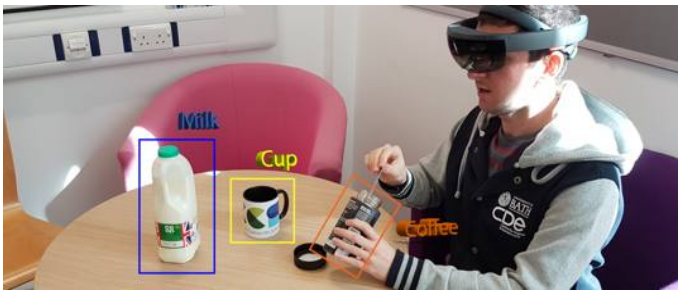



**Figure 6 & 7**: Dementia Ward - Boex. Ideal care home room - Agincare



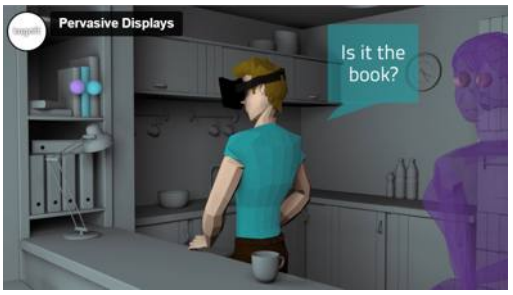




**Figure 8 & 9**: Everyday tasks prompting AR - University of Bath, Thomas Williams thesis. Pervasive Displays, Reasoning games in VR - Kognit


Horse model example


Video example

Nodes example


Image example


Navigation example

Object detection example

**Figure 10**: My Daily Routine (MDR) AR system - University of Regina

## B. Primary research

### a. Dementia research

Our research about dementia led us to contact several London charities working with dementia sufferers and carers. One of them kindly responded and invited us to their place of activity: Age-Exchange. There, we had the opportunity to carry out an interview with the Dementia Services Coordinator as well as a session facilitator specialised in Reminiscence Art (Music).

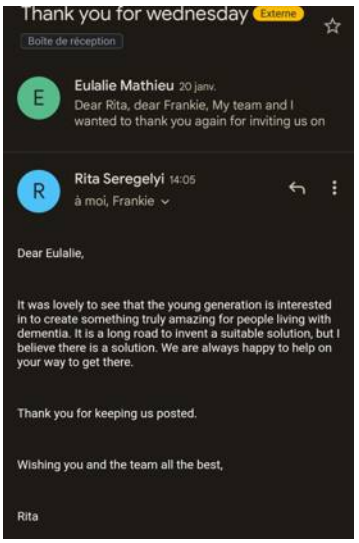




**Figure 11 & 12:** Age Exchange charity entrance, Email communication

Our key takeaways from the interview (see interview notes and questions in Annex 1 and 2) are as follows:

1. People with dementia may remember events from their youth but have short-term memory loss.
2. Any activities requiring fine motor skills (such as controlling pencils, a computer mouse and picking up objects) are challenging and should be regularly exercised.
3. Physical exercises can be sometimes achieved by activating muscle memory.
4. When trying new activities, the safety and well-being of the patient must be considered above all else. Often activities and travels must be accompanied.
5. There are different ways of retrieving memories, whether it is through music, smells, photo albums, videos, memory boxes, or sketching. They often require prompting by the carer (“do you remember when you went there with X and did Y”)
6. Virtual reality seems very promising for cognitive stimulation, however the VR experience should be accompanied and must be static (sitting) for safety reasons.
7. It is important for the carer and the person suffering dementia to spend quality time together and have fun!
8. In advanced stages, the patients won’t remember the visits. However, they will be left with a good feeling after. That is what is important.

9. Designing for dementia means designing with bright colours, contrast and customization. Certain symbols (eg. a sunflower) may be particularly evocative for a patient and can be used to facilitate understanding.

In an attempt to deepen our empathy for dementia patients, we have tried to see the world from their perspective through a 3D immersive smartphone application developed by Alzheimer's Research UK[2]. This app simulates the perspective of a dementia patient through everyday activities.


**Figure 13, 14 & 15:** A Walk Through Dementia experienced by our team

## b. AR research

**Figure 16, 17 & 18:** Demonstration of the potential of AR through surface highlights

Dementia is known to make it difficult for patients to understand their environment. In addition, visual impairment related to ageing makes it difficult to distinguish shapes without bright colours and contrast. Here, we experimented with how AR could help at identifying objects, therefore enabling people to live better at home.

**Figure 19:** AR for navigation guidance

We explored as well the use of AR as a way to support dementia patients navigate in an urban environment.

**Figure 20:** AR for memory aid

In dementia, the most recent memories are often the first to be forgotten, while the older ones remain for a longer period of time. Here we tried to imagine how AR could help dementia patients to remember their loved ones, even when they only know their past version.

### c. VR research

We discovered VR through several angles. Our first approach consisted in learning how to create content for VR display. This meant that we wrote, recorded and edited a 360° video. This exercise helped us to understand the potential and limitations of this format.



**Figure 21, 22 & 23:** Shooting of a 360° video to be experienced in VR

In a second approach, we experienced Virtual Reality at the XR Lab. This gave us a better feeling of the technology and its mode of operation.




**Figure 24, 25, 26 & 27:** Our team experiencing VR at the XR Lab of Battersea

# II. Define

## A. Problem definition

### a. Problem statement

How might we design a dementia-friendly VR Joystick?

### b. Assumptions

On the basis of our research, we formulated some hypotheses which are as follows:

- Dementia patients (and elderly people in general) could really benefit from using AR and VR technologies, when used in specific conditions.
- The current VR joystick is not senior/dementia friendly.
- VR technologies will become increasingly part of our life.
- VR technologies need to be more inclusive.

### c. Key insights

The above-mentioned problem statement is the result of a serie of key points that our research has enabled us to identify:

- Traditional VR controllers are not ideal for users with reduced motion control ability.
- People with dementia and seniors in general would benefit from more fine motor skills training.
- For dementia patients and elderly people, the VR experience has to be accessible while sitting.
- VR can help train motor and cognitive skills. In fact, research has shown that this combination can be extremely beneficial[3].

## B. Persona

Our team has defined a target user for our proposed design to better empathise with dementia patients and their needs.

***ROSE***
is 73 years old and has been ill for over 5 years. She is starting to lose track of important things but is able to take care of herself most of the time and is afraid of further progress. She feels isolated and would like to use VR for cognitive and physical training. However, she is overwhelmed by the complexity of technology. She already has a hard time manipulating her computer mouse and thinks she would struggle even more with the navigation in VR.

## C. Stakeholder map

We identified different types of stakeholders related to the world of Virtual Reality and Dementia care, including leading tech companies such as Oculus, Meta and Windows Mixed Reality.

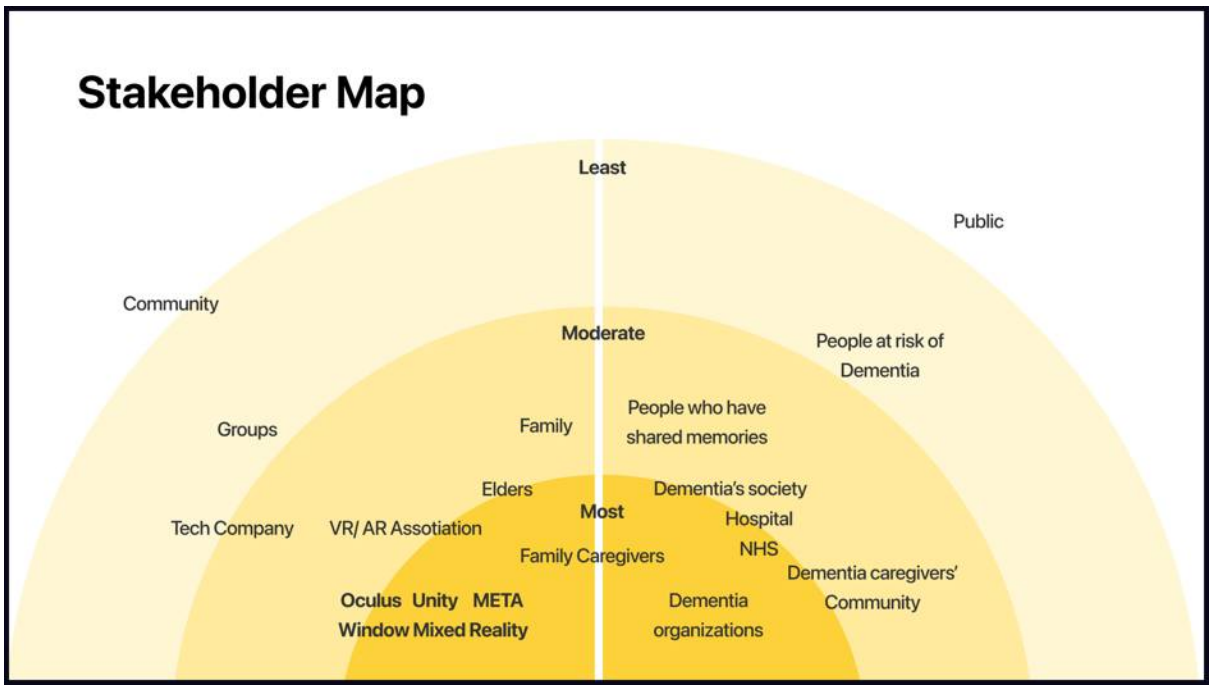



**Figure 28:** Stakeholder map

# III. Develop

## A. In depth research

After discovering Virtual Reality, we realised that the VR controller could be one of the focal points of our project. As the interface for navigating virtual reality, it is absolutely essential to be able to use it to access the technology. Even the simplest commands like playing, pausing or changing angles require its use. However, current VR controllers are complex and not well suited to fine motor decline.

Therefore, we tried to create a VR controller specifically designed for people suffering from dementia and more broadly for the elderly population. Our first focus was simplification. We attempted to reduce the number of buttons and to make the interaction as straightforward as possible. Secondly, we aimed at improving the fine motor skills of the user through controller use. We, therefore, researched current approaches and tools for hand exercises and informed ourselves about specific recommendations for people with dementia and age-related conditions such as arthritis.

Then, in order to better inform our design, we decided to collect data from an exercise which is commonly recommended by doctors in order to strengthen the hands. Indeed, the simple act of unfolding and folding a sheet of paper is known to be a good way to train fine motor skills. More specifically we were trying to understand why this movement is beneficial and how it helps each finger to move.

**Figure 31:** Recording the movement of folding and unfolding a piece of paper

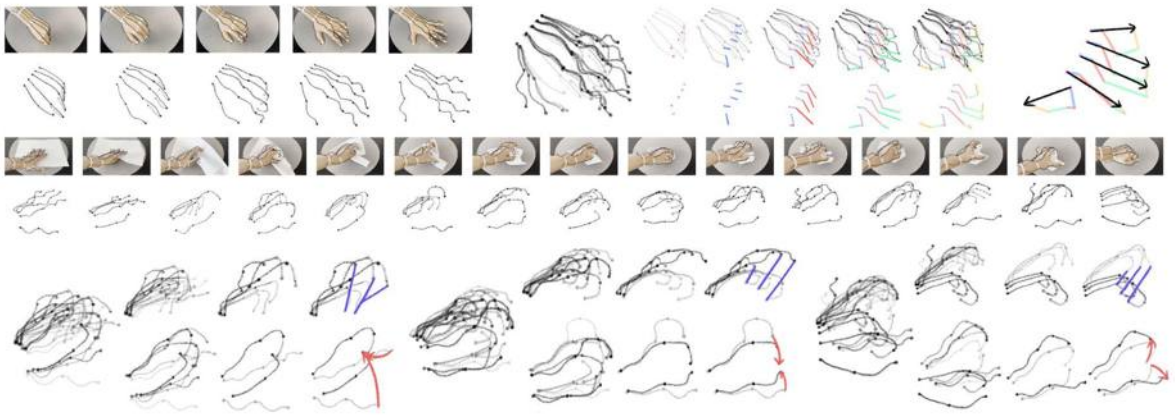


**Figure 32:** Interpreting finger movements

By translating the movements into lines and observing their trajectories, we found that the cooperation between the thumb and index finger is predominant through the pinching movement. This movement seems very important as it allows the control of the folding/unfolding direction. The remaining 3 fingers are repeatedly bent and stretched to match the pinching and unfolding of the paper ball. Their movement track is relatively simple, but they can move muscles well through flexion.

## B. Ideation

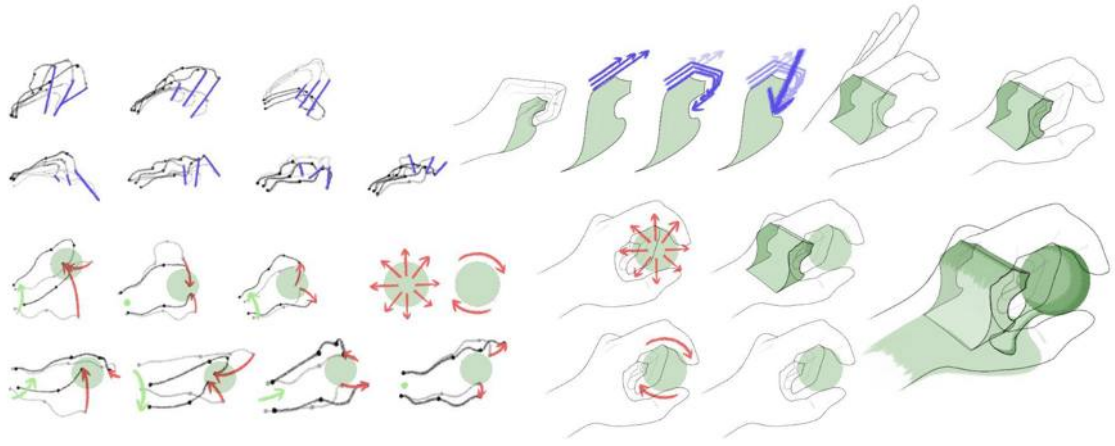


**Figure 33:** Dementia friendly VR controller explorative drawings

Based on the previous observations, we divided the controller into two areas. One side allows the dominant movement: the thumb and index which would be responsible for controlling the direction. The other side enables cooperative movement: the 3 remaining fingers which flexion will serve as a confirmation button, such as for playing a video or pausing a video. We then started thinking about the different possibilities of external shapes these internal principles could be translated into.

## C. Prototype

We used clay for the design and production of the first prototype. Starting with the right half of the prototype, we used our middle, ring and little fingers to repeatedly stretch and bend the clay into the shape of our fingers. This was also a way to make a custom-fit geometry.

**Figure 34 & 35:** Right half of the prototype

We then added the left half (directional control part) of the prototype. Following the same technique as earlier, we made a thumbstick out of wood and a polystyrene ball. After that, we sanded the surface to make it more pleasant to the touch.

**Figure 36, 37 & 38:** Joining the right and left side of the prototype

In order to get a first impression of this prototype we tested its positioning and simulated its use while experiencing VR.

**Figure 39, 40 & 41:** Testing the dementia-friendly VR controller prototype

# IV. Deliver

**Figure 42:** Dementia-friendly VR controller final prototype

The next step in this project would be to develop second-generation prototypes with integrated electronics to be able to test direct interaction with a VR environment. The current form should also be further tested with our target users to be refined and improved. As mentioned earlier, the need for a plurality of hand exercises to train different muscles could also lead to a complete physio - VR kit with several interchangeable controllers.

## Conclusion

This project allowed us to explore a rather unusual intersection. The intersection between advanced technology and dementia. We have found that beyond dementia, the scope of our project has evolved as we have progressed and could be ultimately aimed at an even wider audience, that of our ageing society. We were able to reflect on the inclusiveness of our technologies, and how they are designed, developed and consequently accessible. The design of the VR controller allowed us to think about more inclusive ways of creating and testing new technologies.

## Sources and Figures


(1) https://www.alzheimers.org.uk/about-us/news-and-media/facts-media
(2) https://www.youtube.com/watch?v=nW1Y3Fnv7Mw
(3) https://medium.com/microsoft-design/how-virtual-reality-benefits-seniors-a1896aa41e7e


Figure 1:
https://www.aplaceformom.com/caregiver-resources/articles/dementia-stages
Figure 2:
https://www.aplaceformom.com/caregiver-resources/articles/dementia-stages
Figure 3:
https://www.cnet.com/tech/computing/why-google-is-a-key-piece-of-the-ar-glasses-race/
Figure 4:
https://www.telegraph.co.uk/gaming/features/oculus-quest-2-review-facebooks-new-headset-breaks-virtual-reality
Figure 5:
https://styly.cc/manual/vr-editmode/
Figure 6:
https://www.boex.co.uk/portfolio/cove-ward/
Figure 7:
https://www.agincare.com/news/how-to-create-ideal-care-home-room/
Figure 8:
https://designability.org.uk/projects/projects-2022/exploring-how-augmented-reality-could-help-people-with-dementia-to-carry-out-tasks/
Figure 9:
https://kognit.dfki.de/media/
Figure 10:
https://dl.acm.org/doi/fullHtml/10.1145/3463914.3463918
Figure 11-12:
Personal image
Figure 13-15:
“A walk through dementia” content usage and personal perspective image
Figure 16-18:
Refer to the scene image for drawing processing
Figure 19-20:
Refer to the scene picture for editing, modification and overlay
Figure 21-27:
Personal image
Figure 28:
Personally made stakeholder map
Figure 29-42:
Personal image

# Annex 1: Interview questions

I. General

A. Personal
How long have you been working here ?
What is your role? Motivation?
What is the charity mission?
Do you have direct contact with dementia patients / carers?

B. Dementia patients
What are the challenges that dementia patients face every single day life according to you?
How do Dementia patients find their way home? How do they deal with solo trips in the city (groceries,...)?
How do patients and carers deal with loss of memories, are there any methods to deal with that?

C. Accompanying Dementia patients
What are the challenges in accompanying someone suffering dementia through the different stages?

a) Support/Activities
-> Examples of actions are being taken depending on the level of the symptoms?
-> What is an example of support in everyday activities?
--> dementia friendly activities?
--> Effect of "revisiting the past" on patients ? Seeing old pictures - positive or negative?
--> How do patients feel about the visits of their loved ones, would they like to have it more often?
What is an ideal visit ? (Is visual interaction important?)

b) Environment
--> Any tips to create a dementia friendly environment ?
--> Sensitivity to visual clues (pictures, colour codes, signs)?

II. Technology related
*EXPLAIN THE PROJECT* -> show visuals

A. Relationship to technology
How do patients react to new scenarios/environments/tools? Can they adapt?
Relationship of patients with new technology?
Could dementia patients accept a new technology if it would improve their autonomy, independently?
If technology could allow patients to "travel" within their own home, virtually, would it be something that they would use?

B. Is there really a need for explicit cues/information ?
Do you often find yourself having to "explain" the patient surrounding, where he is? With who?
Do you think that if patients had access to a tool that would provide explanation/more clarity about the situation they would use it?

C. Assistive technology/wearables
Successful example of assistive technology? wearables?
How do patients deal with wearing accessories (glasses ?) temporarily and continuously?

## Annex 2: Interview notes

Dementia patient need simple and easy things to follow activities: pictures, reminiscence art/music - depends on the age
Credit card: to complicated, don't know which side to put in the machine
dementia trainings (videos, 3D immersive, youtube)
Memories with Dementia is like if they were 2 wood shelf (1 made of cardboard (normal memory - top shelves fall down first) and 1 made of oak (emotional memory - more resistant)
emotional memory for eg meeting someone -> feel good
website: user experience is important, has to be simple, easy, colourful, use music, personalised (sunflower means something to someone)
Computer mouse: They can't use it !! Can't double click, click and drag..
Reminiscence Art (RA) (music, art, mvmt, dance)
get to know the person
service-user led
facilitated by the practitioner but led by the participant
muscles memory (dance movement --> make a bandage movement)
dramatising memories activities, depends on
who you are
what is home for you
what is work for you
Music session: questionnaire are given before the session to prepare it
RA is also about
getting to know people + community + support
feeling useful
animation is also for fun, fun is important
training certain skills (grabbing, picking up stuff)
Dementia patients challenges:
dressing up -> better to make it fun
forgetting to change
forgetting that he aged (some retirement place cover mirrors)
Carers needs to
spend quality time with dementia patients
letting them time to do things (be patient, also better for them to keep certain skills)
Travelling
depends on the different stages
voice technology: doesn't really work because some tend to lose voice
google maps -> should be simplified for current person living with dementia, maybe not the future one
display address on the person -> risky, someone could use their vulnerability
some have hallucinations
Dealing with loss of memories
through art
photos in sketchbooks -> needs prompting by the carer "ah you remember this when..." --> this give a closeness, a sense of connection with the carer
safe environment -> receive comfort, therapeutic effect
The facilitator of the session has been trained
Photo album with texture
depends on the stage
allow to explore memories

Accompanying Dementia
creating/preserving memories with family
patient have different pace with dementia

Visiting
in advanced stages, they won't remember the visit but they will be left with the good feeling --> that is what is the most important

Retrieving memories
how music can affect -> send people back in time
sometimes people won't speak but they will be able to sings songs
visuals + music (both visuals and music should be from the right era)

Friendly environment
things from the past of the person: wood, smell

Retrieving memories (feedback on our idea)
think about vision impairment
context is important
risk (should be someone there to accompany the VR experience or the VR experience should be only accessible in one spot -> no moving + VR!
they think that our best idea is about retrieving memories + VR + Music -> they think that the AR + finding a way home or doing stuff is too complex and risky?

Everyday activities support (feedback on our idea)
example of tea making with AR -> too dangerous
clarity is important -> the signal/symbol (arrows...) that appear in front of a person can be distracting -> better to have a colour highlight
Needs to be very careful for safety and wellbeing
needs to be extremely clear