Final Report for my Bachelor's Project Using Multimodal interactions in the Metaverse to help Alzheimers patients: VirtuAssistant

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Contents

1 Introduction

Never in the history of mankind have we been as safe from diseases and injuries as today. HIV-positive patients can live a life extremely close to that of a HIV-negative person, we have the tools and techniques to recover nearly completely from any kind of non-lethal injury, we mastered the vaccine so well that we could beat a greatly infectious disease in the span of two years, and we can even 3D print animal organs, and soon, human ones.

However, one domain has not seen much improvement and breakthroughs despite having been studied for over a century now: The care and treatment of Alzheimer's patients. To this day, no cure has been found, and the available treatments are slim to none, while all being palliative in nature.

We know however how hard living with this disease is, for the patient as well as their loved ones and caretakers. While AR and VR are not able by themselves to cure the disease, it can definitely help with taking care of patients, and making both their lives and the lives of those close to them easier.

Taking care of an Alzheimer's patient eats up a lot of time. They require near constant attention, and caregivers are often unable to work or live a normal life because of this. Some decide to hire a professional nurse to assist on these basic tasks, which often ends up being extremely expensive. While professional care is absolutely mandatory at the most advanced stages of the disease, the earliest stages require nothing more than supervision, which can easily be *digitalized*.

This thinking led us to imagine a solution that, using AR and artificial intelligence, would help Alzheimer's patients on their day to day lives to accomplish the most basic tasks by themselves, making them a bit closer to living like healthy people.

This report will present to you the details of how we designed and gave life to our solution, from domain research all the way to designing a prototype.

2 Defining the subject

Our first task was to define precisely our domain and the tools we would be working with. In order to get a clear idea of what this field was, we did a presentation, defining *Multimodal interaction design in the Metaverse*. We tried covering the whole domain, and doing so helped us tremendously learn all the possibilities we had, but also the limitations of what we would be able to accomplish, both technological but also biological.

We started with defining *What is the Metaverse?*, and we found that the term originates from a mix of "meta" and "universe", and identifies the blurring of the line between the virtual world, and reality. This is done by integrating more and more ways to interact with our computers and systems, making the experience more and more immersive.

Then, we talked about *how we perceive the Metaverse*. We found that in order to make these interactions immersive, they would have to "trick" our senses into thinking what they perceive is "the real world". This conclusion is what led to the development of **XR**, or Extended Reality. This expression refers to "all real and virtual combined environments and human-machine interactions". It contains everything from the "absolutely real" to the "absolutely virtual".

We understood from this that there are two ways of tricking our senses, the first is to enhance what they perceive (this is what **AR** is about), or fully replacing it (what **VR** is about). We first studied what AR (or Augmented Reality) means.

AR is about altering reality, by adding virtual elements to it. It is defined as "an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information". Here, we want to alter one's ongoing perception of a real-world

environment, with a partially simulated one (or simulated elements of it)

This helped us understand the importance of the tools we use, as they need to have the power necessary to make this experience *real-time*. They also have to blend into the visual and sensory perception of reality in such a way that it's either indistinguishable, or so well integrated that it does not bother the natural flow of our senses.

We then studied what **VR** (or Virtual Reality) means, and found that it is "a simulated experience that can be similar to or completely different from the real world". It doesn't rely on any element actually perceived by the person in the real world outside of the virtual experience created for them. But VR is as good as the sense it fools the least, and in order to experience "true immersion" in the experience, it would need to "fool" all of a person's senses, which, despite being actively researched, is still quite far from being fully achieved.

Our next step was examining how these technologies function, and on what basic human principles do they rely. This led us to study *How human senses work to perceive our reality?*. We found that humans (as well as any other biological organisms) use their senses to perceive reality. We can deduct that a good immersive system is one that can successfully fool all senses, either to alter what they perceive, or make them perceive something else entirely.

Humans have 5 external sensory organs, our **eyes, ears, skin, nose** and **mouth**. However, we also perceive internal sensation from internal organs like balance, movement, spatial orientation, temperature, body position or pain. However, fooling internal sensation still has a long way to go in terms of research, so we would be focusing mainly on external sensation. We found out that humans respond more strongly to multi-modal stimuli, compared to simply making the sum of each single modality together. This effect is called the *Superadditive effect of multisensory integration*[1]

We took a deeper dive into how perception in humans works, based off the five external senses. We first started by studying how the most important sense here would be the vision, as along with hearing, they are the two easiest to trick. So we began studying *what visual perception is and how to influence it?* We found out that visual perception is "the ability to interpret the surrounding environment [...] using light in the visible spectrum reflected by objects in the environment"[2].

But vision in humans is much more than just "seeing things" (not simply a translation of retinal stimuli). **Visual processing**, or the brain's ability to use and interpret visual information, is also extremely important to understand how we use our vision. Important notions of visual processing include:

- Analysis of eye movements
- Face and object recognition (both are different)
- Depth perception

[1] Sensation and Perception by A.J Privitera

[2] https://en.wikipedia.org/wiki/Visual$_{p}erception$

All these notions are extremely important, as in order to design a good immersive system, we will have to take all of them into account.

The next sense we studied was **hearing**. Sound is transmitted through compressional waves, and requires a medium to propagate (e.g. air) which our ears interpret through the outer ear. These waves strike the eardrum thus causing it to vibrate, which moves three bones connected to the inner ear. This sends an electric signal to the brain that is then interpreted as sound. We have already mastered the craft of producing "artificial sound", but in order for it to be immersive, it's not only necessary to produce high quality sound waves, but also give the illusion of direction to these waves, which is achieved through surround sound technologies such as 3D audio.

We briefly studied touch, smell and taste, as even though they are important, technological advances regarding how we can influence these senses are at a very early stage, and far from being at a stage where they could be embedded in small handheld systems. However, results of different studies done on these give us hope that soon, we will see the first integrated systems that incorporate ways of influencing these senses.

We now focus on how we can ourselves interact with our systems. We have seen in the last 20 years a rapid development in solutions to interact with computer systems, involving more and more ways of doing so, these ways include:

- **Movements**: not only using controllers and other handheld devices, but more and more ways of analyzing and transforming human movements into signals are being developed.
- **Sound**: talking to computers has been normalized with the rise of personal assistants like Amazon's *Alexa* and Apple's *Siri*. But speech recognition goes a long way into making human-computer interactions more fluid and natural.
- **Brain**: Brain-computer interfaces can be used not only to receive signal from the brain, but also to input signal to it.

A big part of interacting with a computer is done through movements. A lot of methods are available in the *Metaverse*, there are however two main ones:

- Controllers: using a joystick or other controllers to dictate what movements to do
- Capture movements using extra sets of sensors to detect physical movements and translate them into virtual movements

These do not apply to feet and leg movements only, as we see more and more ways of replicating full body movements using sensors/cameras.

Another way of interacting with computers is sound. It is probably the most advanced one today in terms of requiring the least amount of dedicated hardware to function. There are already very advanced speech recognition AIs,

which are definitely useful in helping us control systems, plan for tasks or other forms of interactions. It is an extremely good tool to add to any interactive experience to make it more immersive, human and to give it an even deeper "social" feel.

Brain-computer interfaces are being developed as we speak, but their developments are still at a very early stage, and it will take a while to see them fully integrated to high-scale commercial systems. There are however very interesting uses for them already, like *BrainRobotic*'s prosthetics to obtain muscle signals and move robotic limbs using them, or *NextMind*'s BCI to decode what someone sees, and translate it into a digital image.

All these methods could enhance human's lives in pretty much all domains, as everything could be made more interactive, more social, or replicated virtually to be made more fun and immersive on a bigger scale. After drawing such conclusions, and having a better grasp on the technologies available, it was time for us to select a domain.

3 Domain Research

All domains are concerned by these developments in technology. However, some domains are even more prone to being upgraded by their use. As such, the main domains of application XR are:

- Healthcare and assistive technologies
- Games and entertainment
- Military and other specialized professions (doctors, rescuers, artists, architects...)
- Rehabilitation (prisoners, mental health patients...)
- Social media and interactions between people
- Operating complex mechanisms (cars, planes, robots, drones...)

When choosing our domain. It was important to us that it was both something these technologies could really have an impact on, but also a domain that made sense for us, and that we deeply cared about. Being absolutely passionate about this subject, we had dozens of ideas we were eager to explore and think about, using things as simple as a smartphone camera all the way to brain-computer interaction systems, or taste and texture simulating devices[3]. After hours of research and brainstorming, we narrowed down our list to three ideas, and wrote their Design Problem Statements. These were selected because they had both real and important implications on the world around us, as well as

[3]Jivanda, Tomas (November 22, 2013). "Digital lollipop simulates taste through electric currents". The Independent.

being backed by technological solutions that would be realistic and within reach. These are:

- Designing a "Meta Society": Using VR, creating a safe environment where mentally ill people or prison inmates could rehab and learn to reintegrate society, in a way that is supervised, and safe for them, and that would make it safer for everyone outside. Inmates need a way of staying in a "society context" to keep their mental health in check and monitor their reinsertion in society because they are often marginalized people that have behavioral problems and, as seen by watching the recidivism rates, current systems put in place in prisons do not handle reinsertion well.

- Alzheimer's patients smart assistance: Using AR, creating an assistant that would help people suffering from Alzheimer's disease to function more naturally and independently, by supervising them and helping them stay safe doing day-to-day tasks alone. These people need a way of helping them handle their basic tasks to be able to function more independently in that context, because they cannot do it themselves, as their crisis' can happen at any moment.

- Driving training using MR: making driving training even better, by putting drivers in dangerous situations they are normally never put in, and teaching them how to handle them (while in a setting as immersive as possible). We often receive little to no preparation for the things that would be the most dangerous when driving, and this could solve that problem. As learning drivers need a safe way to train for exceptional dangerous situations to learn to deal with them without actually putting themselves and others in danger.

The three ideas in hand, it was now time to choose one. After carefully thinking about which would be the most useful, and the most "doable" for third year computer science students. We decided on choosing the **Alzheimer's patients smart assistant**. This cause is extremely important to us, and learning about it has done nothing but cement the motivation to work on a project that would ease the life of all these people and those that care about them.

We then set our sights on gathering as much information about the disease as possible, and then thinking how, using AR, we could help solve or ease these problems.

Alzheimer's disease is "a neurodegenerative disease that usually starts slowly and progressively worsens[4]. It is the cause of 60-70% of cases of dementia (more than 33 million people worldwide with nearly 6 million new cases each year[5])". The most common symptoms are:

- Difficulty in remembering recent events

[4]https://en.wikipedia.org/wiki/Alzheimer%27s_disease
[5]https://www.who.int/en/news-room/fact-sheets/detail/dementia

- Problems with language
- Disorientation and easily getting lost
- Loss of motivation
- Self-neglect

For patients on the late stage of the disease, constant professional care is absolutely necessary, but for early and middle stage patients, things could be done to make their lives better using technology (obviously not by solving the problems, but by helping the patient live better with the symptoms).

A first conversation with a neurologist that specializes in Dementia and Alzheimer's disease gave us a significant clue as to what our solution would look like. In order for it to be effective (in other words, actively used by the patients), it needs to be something they are comfortable with, and not a novelty. For the generation that is currently experiencing this sickness, cellphones have existed for less than half their lives, and so having an AR app on a phone would not be possible. However, they are used to having glasses on their faces, and for most of them watches on their wrists. The solution was then clear as day, we would be designing a solution for AR glasses, as well as an optional tool for smartwatches.

We then imagined a set of features that could be included, that would both be realistically implemented, as well as be really useful for the patient:

- GPS and visual guiding for easy trips on foot
- Reminders in the form of localized posts that the user or their caretaker could set up
- Basic face recognition
- Indications on how to accomplish simple tasks
- Interactions with other alzheimer's patients, which would make the patient feel less lonely and misunderstood
- Have the caretaker see and hear what the patients sees and hears, as well as localize them easily
- Help with planning and time management
- Calming through soothing familiar voice and sounds
- Data collection for the doctor (and why not even research)
- Entertain and challenge the brain which has been shown to slow down the evolution of the disease

After carefully considering all these, as well as the technical possibilities, it was then time to design a storyboard, and have a draft of how the interaction experience would go.

4 Storyboard

To gather user feedback, and to have a more precise vision of what we would be doing, we needed a good storyboard, that shows clearly what the use for our system is, but also the impact it has on the life of the user. The base for our solution would be simple. It has to integrate perfectly to our patient's life, it has to have a visible impact and has to be easy to use and natural for them. A first draft for the storyboard gave us this:

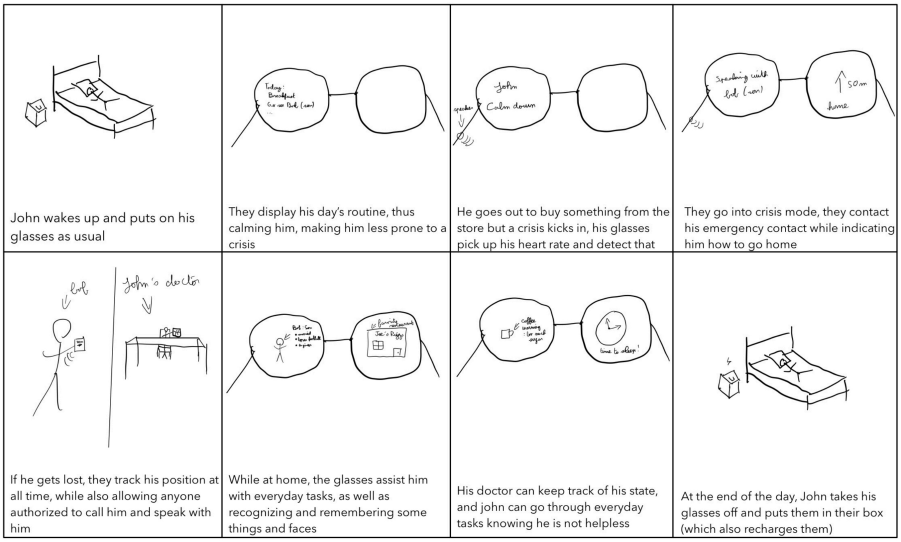

Figure 1: First storyboard draft

However, we quickly understood that drawings, no matter how good or detailed, would not grasp everything this is about, and all the impact it might have. But to present it to users, we would need to see the change it brings, and in order to showcase that, we decided to go with a written story about John, an elderly Alzheimer's patient, and Linda, his daughter that takes care of him. We wrote this story twice, once to showcase what a day looks like for John, and the dangers and problems it brings on, and once using our solution, to show the impact of it, and how it eases John's life and makes it a lot easier both for him and Linda. We also wanted to showcase how John would interact with our system, both using his eyes, gestures and mouth to speak with it. The story we ended up with is this:

Monday, 8:00am

John wakes up, just like every other day, he puts on his glasses, takes his pills and gets out of bed. He goes to the bathroom, puts on some clothes, and goes down to the kitchen where Linda, his daughter, is making him breakfast. It has been years since John last cooked himself something, from the day he

became sick, his daughter has been too scared to let him alone in the kitchen, and he is too scared to start cooking because just like every other time, what if it happens again?

11:00am

He decides to go get something from the grocery shop near the house, after all, it's only a 10 minute walk, and Linda is asleep, without her, how will he fulfill his sugar cravings ?

11:10am

John arrives at the store, he wants to get something, he knows he came to get something, but what?

It is happening again, his mind is failing him again, now he is lost, in a place he does not know why he went to, nor how he got to. His sickness is still at an early stage, and even though it is not easy to live with, his mind will eventually come back from that dark place it went to, it will not fail him completely, for now at least.

12:00am

John finally arrives at the house, he does not find Linda, as she has been out for 30 minutes searching for him. He eats a chocolate bar he bought from the store and searches for his little notepad, the one that allows him to remember things when his brain will not let him. He scrolls through its pages, watching as how little by little, as his hands got shakier, and his mind more and more absent, it went more and more from an organized life planner, to a testament to John's weakening state. The will to get everything together is still there for John, but his mind won't help him, it will not let him.

1:00pm

Linda arrives at the house, her father is there, yet his eyes look completely lost. He looks anxious, Linda knows how bad of a trigger anxiety is, she brings him a glass of water and tries to soothe him. Over the years, she learned what words would appease his mind, not bring it back, but make it calm down, even just for a few seconds. He comes back, she tells him they have a doctor's appointment later, and that they should get ready.

John goes to his room to put on his clothes, but what clothes will he put on? Why is he in the room? What is he doing there? "Oh yes, clothes", he thinks as his mind comes back from that hiding place it goes more and more frequently to.

2:30pm

The doctor has spent an hour with John, but the main information he learned from that visit, is the exhaustion level of Linda. She has barely been able to gather enough words together to make intelligible sentences. John of course, just like every time, was of no use through this visit, sitting down through it, barely here, either from boredom or from his mind, once more deciding to leave

him alone to face the world he inhabits.

7:00pm

John wants pizza, while Linda is in the room, an eye watching the TV, an eye watching her father, he decides to ask her: "Darling, I am hungry, can we go get...", get what? he knows he wants pizza, he can see the pizza, with that level of craving he can already taste the pizza, but what is the word for it already? "oh yes, pizza!". He was lucky this time, next time, he might not be.

8:30pm

Linda is asleep, normally at this time, she would be awake watching her dad, she knows the night makes him anxious, but this time she couldn't help it. She has been working night shifts, since the daytime was reserved for her real job, babysitting her father. John gets a bit anxious, he hears a noise outside, thinks he saw a shadow that looked like a man, he has been this way since he was a kid, but back then, his anxiety had little consequences, he simply needed courage. However, for a few years now, it has been the catalyst of a whole new nightmare, the condition that is eating his life, slowly, bit by bit, taking an inch of his sanity every time his mind leaves his side. Alzheimer's disease made him the man he is today, and he knows it is hard for everyone, mostly his daughter, but it will never go away? what will never go away? What was he thinking about? Why is his heart racing? Where is he? What is happe.....

Monday, 8:00am

John wakes up, just like every other day, he puts on his glasses, takes his pills and gets out of bed. He goes to the bathroom, puts on some clothes, and goes down to the kitchen where Linda, his daughter, is making him breakfast. He could have done it today, but Linda was in a hurry, as today marks the beginning of her new job. While they eat together, the glasses give him an insight on his planning for the day, and other useful bits of information like the weather.

11:00am

Linda is gone, and John is hungry. He craves something sweet, after all, it has always been his weak spot. The grocery store is a 10 minutes' walk away. John goes there, and Linda receives a notification on her phone that he left the house.

11:10am

John arrives at the store, he wants to get something, he knows he came to get something, but what?

It is happening again, his mind failed him again. The glasses print on the display "get something sweet", he said he wanted it earlier, the glasses saw he was at the grocery store, and they knew why.

11:30am

John arrives at the house, a bit lost, yet the glasses indicated him exactly how to get there, blocking from his sight any path that would not lead to his home. The glasses display his next task of the day, doctor's appointment.

1:00pm
Linda arrives at the house, she finds her father in the sofa, a bit stressed out, with the glasses displaying and playing specific messages, known to appease his mind. Sometimes he would rather enjoy some music than words from people, and the glasses will play him just that.

2:30pm
John arrives home from the doctor. Today the visit was quick, she had already analyzed all the data gathered by his glasses, and only wanted to meet him to discuss a change of medication. She thinks this new one will help him stay calm, and she will be able to see whether it works in real time through her phone or computer and the data gathered by the glasses.

7:00pm
John wants pizza, while Linda is in the room, an eye watching the TV, an eye watching her father, he decides to ask her: "Darling, I am hungry, can we go get...", get what? he knows he wants pizza, but the word just went away, the glasses print the three most likely words they imagined to finish that sentence, "oh yeah, pizza" he says.

8:30pm
Linda is asleep, she works early tomorrow and wanted to get a few extra hours of rest, she knows she can take them, if anything happens to her dad, her phone will ring and alert her. John is in the living room, his fear of the dark has not gone away, but the music in his ears from the glasses are definitely soothing. At least enough to make the anxiety more bearable. His mind still leaves him, as much as before, but it is not such a big deal, he is no longer in danger when it happens. His glasses keep him safe, and keep his daughter free. He is reminded that it is bedtime so he goes up to his room, takes off his glasses, and goes to bed, ready to rest before a new day tomorrow.

We now had a full story that encapsulates everything we want to show to prospective users, to get their returns on how this would affect their lives. Our next step was then to find people that would give us meaningful feedback, and here is how we did that.

5 User Research

"User research focuses on understanding user behaviors, needs, and motivations through observation techniques, task analysis, and other feedback methodolo-

gies. [...] It is "the process of understanding the impact of design on an audience.""[6]. As such, our first step was focus on what type of users we would be interviewing. Obviously, not any person would be fit to give meaningful and useful feedback on such a product given the very specific audience it is designed for. However, those who would primarily be using it would also not be ideal as they either (1) don't even know they suffer from these problems or (2) are so out of touch with technology that they see it as close to being gibberish (or magic). We then chose to focus on those who know these patients very well, those who take care of them and see how this affects them, and that would understand how this might (or might not) help a patient improve their life.

After some research, we chose to discuss with two medical professionals, a psychiatrist and a neurologist, as well as members of an NGO that helps patients from Alzheimer's and their families. We went through a very similar process for our five interviewees, first showing them our user story, then, based off their feedback on it, asking them questions about how the experience should go for our users.

We first thought the most interesting feedback for the user experience would be that of the doctors, which see such patients on a daily basis. However we quickly found out that those who had the most to say and the most ideas to give were those that lived and cared for the patients, even without any scientific background. However, the medical professionals were extremely interested by the possibilities of gathering data for research on the sickness at such a large scale, and all the possibilities this would open up.

We mainly wanted to know how we could ensure ease of use for the users, given their possible lack of technological background. We found that everyone insisted on the solution being as natural and close to classic glasses as possible was a must, there had to be no technical skills required, and the interactions had to be minimal and as easy and natural as possible, as such, we had to favor voice and easy movements, like pointing fingers.

We asked what safety features we had to ensure were there in order for such a solution to answer all their needs regarding that, they all told us that GPS tracking was a must. Having the possibility to see what they see and hear would also be good, especially when outside the house, despite having some privacy concerns. The glasses could act as an authority in telling the patient what might be off limits and dangerous for them, whether it's a place, or an activity.

Obviously, having the possibility to track important health metrics such as heart rate and blood pressure, and quickly alert a medical professional and the care giver if anything happens, which would make caring for the sick person a lot less time consuming and stress inducing. Ideally, it would also have to be adaptable to the needs of the patient, as we know people of a certain age tend to have multiple diversified health issues that would ideally also be tracked (such as diabetes).

We then talked with them about the possibilities of interactions for the patient (or main user). They all had the same opinion, that it had to be an

[6] https://www.usability.gov/what-and-why/user-research.html

extremely simplified and welcoming interface, it had to be light and very easy to understand for someone with very little experience with interactive systems. They all agreed that having mainly voice control would be optimal, with a minimalist interface with clear easy instructions. Obviously, to avoid confusion and danger, nothing should obstruct the user's vision, nor distract them too much from what is in front of them. When the user is expected to make an action other than speak, that should be clearly indicated, and if possible, demonstrated prior by the system.

We received from multiple people suggestions that the system had to be able to display video content, especially for the purpose of discussing with the patient through video (like *Skype* or *Zoom*). This would be extremely reassuring for the patient, but it would also make them less lonely, one extremely important issue for these people who's condition unfortunately are unable to meet a lot of people. Having the possibility to chat with other people, maybe even other patients could be a good initiative but would have to be strictly thought through.

As the patients are often soothed during their crisis periods by hearing familiar voices, this could be a good feature to add. However, helping them complete simple tasks, and remember small details and information could also be great. Many suggestions were given, from simple face and facts recognition, all the way to interpreting what they see and hear to complete with what they might have forgotten. These things, although extremely interesting, would also be technically complicated to put in place and would need further research.

Overall, all the people we interviewed agreed on the quality of the project, and the hope it might give them, especially as caregivers, to reclaim part of their lives they "lost" because of the condition of their loved one. For most of them, the cost of such a system would not be a problem, as it is already extremely expensive to take care of an Alzheimer's patient. These interviews did not change our original DPS, it helped us however refine the details of how it would be implemented and what it would look like, but since the original concept was already though of and discussed with many different people, it was already close to what would be expected.

With these information in hand, it was now time to get a first prototype going, to imagine a first look at what the system would look like.

6 Prototyping tools

Here the task was complicated, as we didn't have to design a phone app, for which plenty of resources already exist, but an interface for AR glasses, for which resources are a lot scarcer and a lot more technical and difficult to find.

The first step we did was draw it by hand, to get a sense of what it would look like. We decided on one basic rule, glasses would be represented by two squares, and everything would be done there. After that, we also drew a concept for the phone app for the doctor and the patient's caretaker.

Then it was time to make a wireframe, this would be simple, just to show

how the interface would be presented. As representing everything the system could do would be extremely long and complicated, we decided to represent two important functionalities, cooking a breakfast, and going to the grocery store to get ice cream.

The tool we decided to use was Figma[7], as it was the best one to design personalized size frames, that we could make look like glass frames. The components library is also extremely rich, and there were actually a couple of user designed tools for smart glass prototyping, which was of great help.

Figma was also great in designing interactive prototypes, as it was easy to add and show interactions, both for the phone app and the glass' app.

7 Prototyping

Our first design was that of the wireframe:

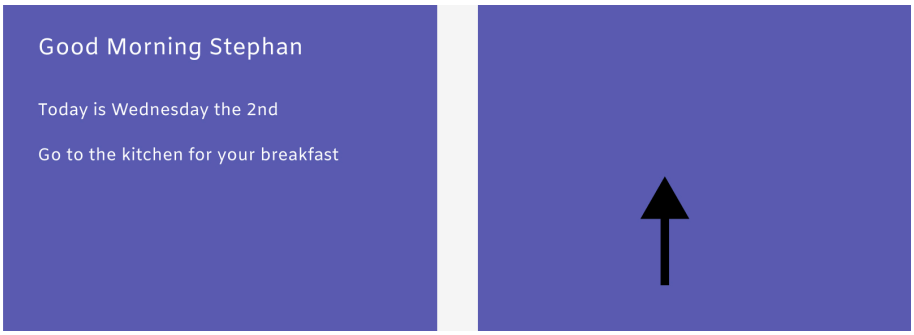

Figure 2: Wireframe for when the patient wakes up and puts on the glasses

We can clearly see what the two frames here do, the one for the left eye tells the patient to go to the kitchen for their breakfast, while the one on the right is a small visual indicator to make the patient accustomed to seeing them.

After that, we developed the prototype for multiple interactions by adding images and actual user interactions, and to showcase how the app would function.

This is different from a "casual app", where the user would launch it when he wants to use it, and close it afterwards, as this would accompany him throughout the day at all times, and would be composed of multiple small interaction flows, rather than one main path to follow.

As such, we showcased multiple small interactions between the user and the system, and how these small interactions would evolve and lead the user from a starting point where they need something, to an end point where they have it, while accompanying them all along.

Here are snippets of it, when the user is preparing a meal:

[7] Figma.com

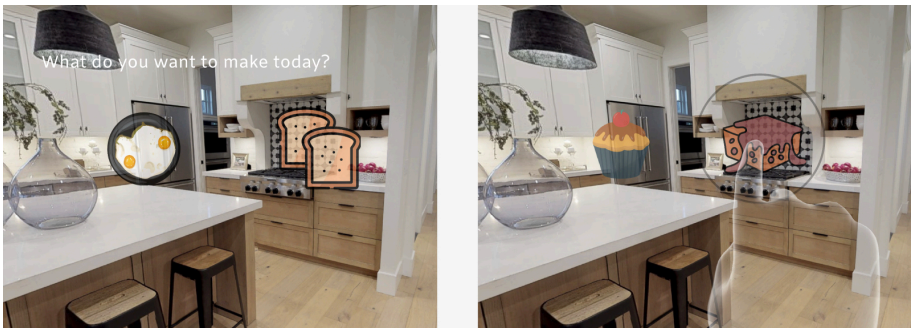

Figure 3: The interface invites the patient to choose a breakfast

Here, the interface invites the user to choose what he would like to make for the breakfast. It also shows the user the way to select a recipe. As can be seen, the visual information is not overwhelming, and is pretty easy to understand, even for someone not familiar with technology.

Figure 4: The interface invites the patient to preheat the oven

This is typically where the app would be most needed, as the user has to do a mundane thing most people (even without the disease) would forget to do. It also has to ensure that they do it in a way that is both safe for them, and for the building and those in it.

We tried to make the instructions as well as the hand showing the action as transparent as possible, so that they blend in what the user already sees, and do not impair his vision. Here the user does not interact with the app, as it is not needed. They simply do the task, and the system acts as a guide (and preferably a guardian). When the user gets close to the oven's control panel, the app would show them exactly on what they would have to press, how they have to interact, and guide them through the whole process, to make it as easy and intuitive for them as possible.

Finally we have:

This last snippet shows a typical example of an interaction between the user

Figure 5: The interface shows the user the ingredients needed, while showing a note the user programmed

and the system. On the right frame, we can see a self-reminder the user created to be displayed on the fridge. The user is able to create these through vocal instructions they would give the app. And the system would remember exactly where the user wants them displayed, so that they are shown to them when it matters the most.

We also see on the left frame the ingredients list for the recipe selected. The check boxes would fill themselves when the user takes each ingredient, while reminding them important details, like to check the expiration date (which could also be done by the system using the camera). Finally, the arrow on the right frame shows the user where to go for the first ingredient, once again this is the app accompanying them to do the task, as easily and intuitively as possible.

Another example where the app would be of major help, is when the user needs to go somewhere outside the house, we created an example to show how this might go, here are a few examples of that:

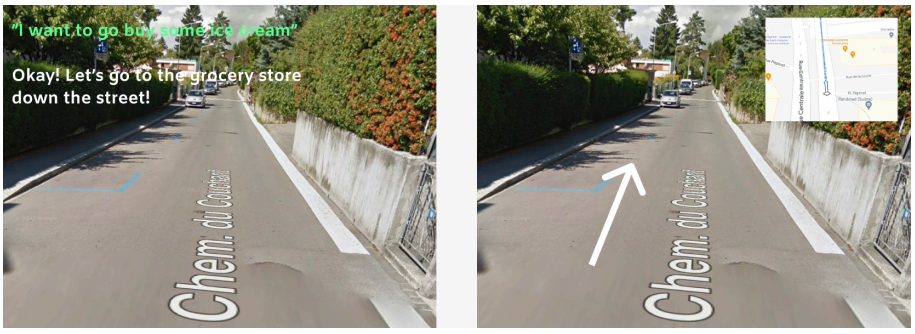

Figure 6: The interface shows the user how to navigate to get where they want to go

The text shown on the right is not necessarily displayed, although it might help, but the text in green is what the user tells the app, to get it to go into navigation mode. Here we can see on the right eye a small map, showing the way, along of course with arrows indicating the route to follow. We can imagine visual indications might be given about where to walk on the road, when to stop and go (on feet of course), and how to navigate through complicated sidewalks. This can be coupled with audio guidance on where to go, the directions to take and other useful information. Once at the grocery store, navigating that place can be just as difficult, so we imagined a way to help the user get a normal experience even there:

Figure 7: The interface shows the user how the food he chose is for them

Often times, Alzheimer's patients have little to no will to take care of themselves and their health, so we try to do it for them. In this example, the user points to an ice cream they want, and the app tells them if they should avoid it, or if it is harmless for them. This is extremely similar to how a caregiver that accompanies the patient would react, so it makes sense to automate that too. The danger message is written in colors that pop up, without rendering the patient unable to see the rest around them. On the right, it displays the nutritional value of the chosen product, showing them why they should avoid it.

The app could of course give advice to the user regarding what product they could take instead, in order to help them achieve what they came to do while helping them take care of themselves along the way.

Obviously, all of this would be useless if we could not give the main caretaker some peace of mind, and reassure them that everything is going well. This will be done through a smartphone app that would give them the main information, and give them control over some actions they could do, here is how it would look:

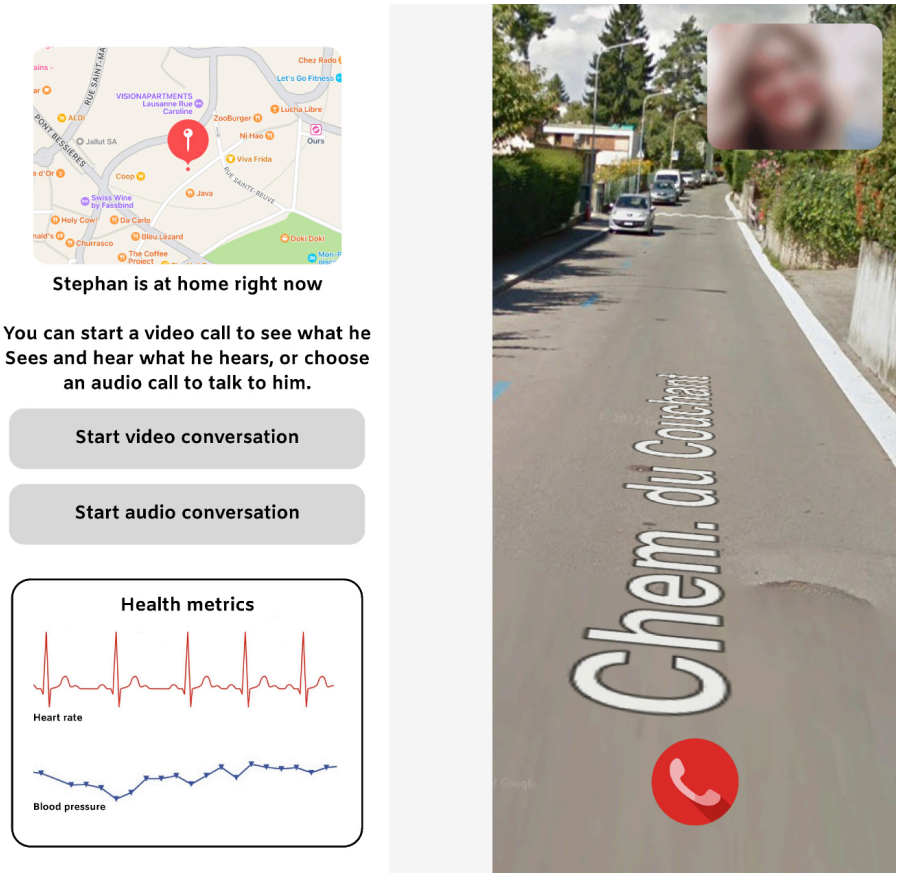

Figure 8: The interface for the caretaker's app

As we can see, they have the basic important info, such as where the patient is, his health metrics, and with a simple touch of a button, they can start a video conversation where the patient sees them, and they see what the patient sees. We can imagine a lot more features that could be added on that app, such as controlling the actions the patient does, and giving him custom indications.

The link to the whole prototype is:
https://www.figma.com/file/o5rCkb48uWjRvBP4AB1maC/Untitled?node-id=0%3A1

8 Conclusion

We have presented in this report everything, from the birth of our idea, the research around the problems we are trying to solve, all the way to the techniques

we used to prototype a solution that would have an impact.

Even though taking on such a project would be a heavy task, the change it would bring to tens of millions of people would be life-changing.

Medical research is one of the most funded domains, with tens of billions of dollars allocated to it worldwide. It is time some of that goes to solutions that will help the millions of people suffering from Alzheimer's disease all over the world. And even though our solution will not cure the disease, it will make all these people able to live a simpler and more normal life, which would already be quite a feat, and a joy for them and those they care about.

The next step in our project is now creating a video prototype, showing how a day goes for someone using our solution in more detail, showcasing how they interact with the system on a daily basis.