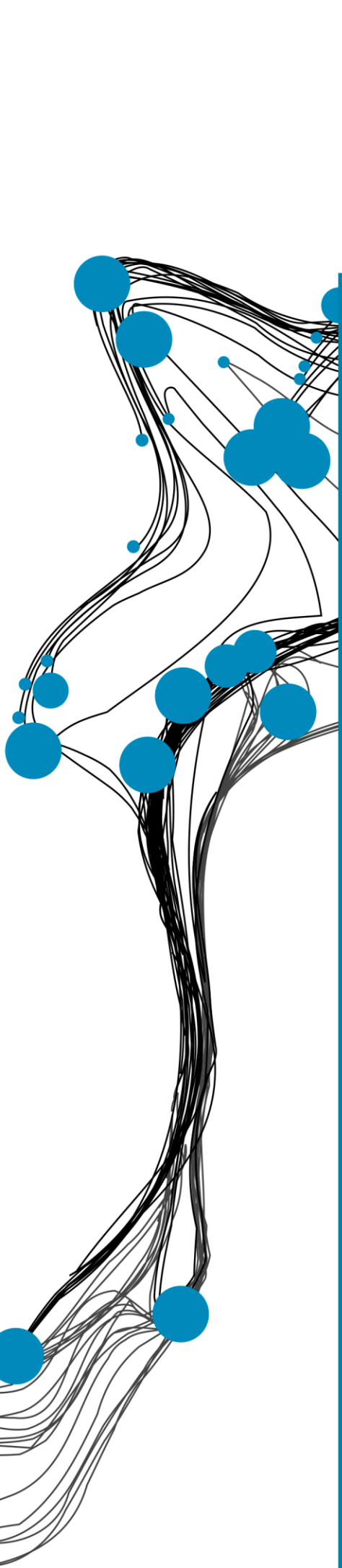

BACHELOR THESIS

REDUCING LONELINESS AMONG ELDERLY WITH DECREASED MOBILITY USING TECHNOLOGY

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Abstract

In this graduation project research was done and a prototype was made to reduce the loneliness experienced by elderly with a decreased mobility living alone. Loneliness is a problem among the elderly. One of the main causes of loneliness among elderly is decreased mobility. Their ability to move around decreases and they start to feel powerless because of it. This takes a toll on their mental and physical health and this leads to loneliness. By doing research and holding a survey, eye tracking technology was used to tackle the problem elderly are having with electronic devices, which helps the elderly stay independent and in control of their surroundings. By using the eye tracker in combination with a screen, the elderly can operate electronic devices in their house while not having to move around or ask someone else for help. They can turn on devices like the tv, the radio, the lights or simply call a family member while only using their eyes.

Acknowledgements

A special thanks to Wendy Oude Nijeweme – d'Hollosy for giving feedback and helping throughout the entirety of this research, and to Geert Quint from Ecare Innovatie for providing the necessary resources, making time, and giving advice. The opportunity to work on this project with Ecare was greatly appreciated.

Thanks to everyone who filled in or helped to spread the survey and to all the people who participated in the user testing and the following interviews.

Even though the situation changed because of the Covid-19 virus, everyone involved in this research helped greatly to make it all possible.

Contents

List of Tables and Figures

1. Introduction

Loneliness is something that every person experiences at some point in their lives. However, research has shown that the risk of loneliness significantly increases with age [1]. In this report, the concept of loneliness from the paper of Jenny de Jong Gierveld [2] is used. She states that the following core elements of loneliness are "… an unwelcome feeling of lack or loss of companionship, the negative, unpleasant aspects of missing certain relationships as well as missing a certain level of quality in one's relationships." There are different reasons for someone to get lonely and it can lead to mental and even physical problems in the long run [3]. Those physical problems can include having trouble with climbing stairs, walking or upper extremity tasks like bathing, dressing and feeding [4]. Research has shown that it can even lead to suicide [5].

Research done by the Central Bureau of Statistics (CBS) in the Netherlands showed that 4 percent of the Dutch people older than 15 felt lonely [6]. The amount of lonely men increased from 4 to 5 percent between 2012 and 2015. Meaning that almost 330 thousand men were lonely in 2015. Among people older than 75 the number is even higher with almost 7% being lonely [6]. The CBS measured loneliness by using a shorter version of the UCLA Loneliness Scale [7], on the basis of 6 different statements. When going from Dutch to English the statements roughly translate to the following.

1. "There are people with whom I can have good conversations."
2. "I feel isolated from other people."
3. "There are people that I can go to when I'm in need."
4. "There are people that really understand me."
5. "I am part of a group of friends."
6. "My social contacts are shallow."

The reason why the loneliness was measured with the UCLA Loneliness Scale is that loneliness is subjective. Someone can feel lonely because they are without any social contacts for a day, while someone else can be on their own with no one around them for years and not feel lonely at all. The presence of feeling lonely depends on that person's personality. People can feel lonely because they are lacking social contacts, but people can also feel lonely even if there are plenty of people around them [6].

There are many reasons for loneliness, but Mirel Nijhuis [8] discovered that one of the main reasons for loneliness among elderly is decreased mobility, because decreased mobility may lead to a feeling of powerlessness. The decreased mobility may require a person to ask for help from other people for activities like turning on the radio, tv or going out, that were no problem in the past. The feeling of powerlessness and not asking for help may lead to the feeling of loneliness. Therefore, the assumption is that when technical solutions can be developed to tackle decreased mobility, the risk of loneliness will decrease. For example, it will be hard to enable an elderly person to walk to the tv to turn it on, but it is possible to provide them with a remote control so the tv can still be controlled without needing help.

Literature shows that decreased mobility does in fact increase the chance of loneliness among elderly. For example, Bowling et al. [9] shows that greater loneliness is related to increased

physical impairment. In addition, Smith and Victor [10] show that lonely people are more likely to report poorer physical health. Because of this, the goal of this thesis is to research how technology can be used to help elderly deal with their decreased mobility. To summarize this, the main research question for this study is: ***"How can loneliness due to decreased mobility among elderly be reduced using technology?"***

This research will be conducted at "Ecare" in Hengelo. Ecare is a software company based in Enschede and Hengelo. They try to optimize the healthcare system by making software for local healthcare instances. The branch in Hengelo is less focused on software and tries to look into more different ways to improve the healthcare system. In the case of this research that is by researching how to decrease the loneliness among elderly.

2. State of the Art

The State of the Art section is divided into three parts. In the first part the solutions for reducing loneliness among elderly will be researched. In the second part the existing solutions to deal with decreased mobility will be discussed and lastly, in the third part, research will be done to find the technologies for reducing loneliness.

2.1 Loneliness solutions

The solutions to loneliness are divided in two categories. Social solutions and Individual solutions. The social solutions will be solutions that help elderly connect better with friends, family, people in general or animals. The individual solutions will be the solutions that exist for elderly at home that they can do on their own.

2.1.1 Social solutions

Social loneliness is caused by a person not having enough meaningful contact with other individuals. This can mean physical contact, meaningful conversation or any conversation at all [3][6].

However, according to E. E. Beals [11] dogs can act as buffers against the stress of traumatic events and contribute to reductions in loneliness, anxiety, and depression as well as increases in self-esteem. So, animals can also help with social loneliness.

It can be seen in many studies that so called 'companion animals' are greatly beneficial to the mental and physical health of people [12]–[15]. Carr et al. [12] did research on the benefits of companion animals following a social loss. They found that people who experienced social loss without a companion animal had a higher chance of experiencing depressive symptoms relative to those with a companion animal. They also found that experiencing a social loss was associated with a greater increase in loneliness.

Dransart et al. [13] list some of the mental health advantages of having pets: "The psychological benefits of companion animals are most likely to be through reduction in depression, anxiety, social isolation, self-reported fear and anxiety, reported loneliness, and through enhanced empathy, improved learning, increased trustworthiness of and trust toward other persons. These benefits, however, are probably linked to the degree of bonding of the owner with the animal." (p1)

However, while having a companion animal may help greatly with the mental and physical health, elderly with a decreased mobility simply might not be able to walk with an animal like a dog. Someone still has to take care of the dog and that might simply not be possible for elderly people.

In the Netherlands, an experiment with a video/voice network was done to increase the amount of social contact someone was having called CareTV. A group of elderly could communicate with a nurse practitioner for 24 hours a day, 7 days a week. After the one year trial period, the average feeling of loneliness of the group significantly decreased [16], [17], this was measured by using a 11-item loneliness scale from de Jong-Gierveld. The elderly also reported that CareTV made them feel safer [17].

2.1.2 Individual solutions

Individual solutions are methods to decrease the loneliness experienced by elderly without having to increase the social contacts. This can include solutions like hobbies or other activities that an individual can do on their own to create purpose and decrease the loneliness.

In a study done by Jonason et al. [18], it was found that how alone a participant felt was correlated with the frequency of talking or singing to themselves and using the TV for company. These solutions trick a person's brain into feeling like they are socially interacting. Jonason et al. [18] also state: "Social snacking may satisfy one's need for social interaction because humans are unlikely to be able to differentiate between virtual and real people because this distinction did not exist in ancestral environments." Social snacking is the seeking or using of alternatives when social interaction is lacking.

2.2 Physical impairment: Decreased mobility

According to the Collins dictionary "A physical impairment is a condition in which a part of a person's body is damaged or is not working properly."[19] For this study the focus will be on the decreased mobility of elderly, so the ability to move arms and legs.

One way to decrease the hinder experienced by decreased mobility is by lowering the rate at which the mobility decreases. This can be done by making sure the elderly exercise more. For example in a study done by Kagwa et al. [20] they tried to encourage sit-to-stand activities to get those into the daily routines of elderly, which has a positive effect on the mobility of the elderly.

Different from preventing the lost mobility is trying to give it back. In a study done in Israel [21] elderly received mobility scooters to move around. Although the mobility scooters seem to improve the quality of life, they also present risks where the elderly are a danger to others on the road. The option is more viable with a proper infrastructure, like having bike paths everywhere.

In another study, several self-transfer systems are reviewed [22]. These so called 'assistive robotic systems' are supposed to support the elderly in their day to day life to help them remain independent in therefore increasing their quality of life. This is done by using powered wheelchairs and lifts. Kirshnan and Pugazhenthi [22] state that "The practical difficulties in walking and moving from bed to wheel chair or wheel chair to toilet seat affect the daily activities of aged people. Depending on caregivers to access toilets affects one's dignity."

2.3 Technologies

In the third and last part, technologies will be researched, namely technologies that already exist to reduce loneliness and technologies that could be used to reduce loneliness.

2.3.1 Existing technological solutions

CareTV

An experiment do increase the amount of social contact someone was having was done called CareTV [17].

PARO Seal Robot

Besides contact with real people, robots can also be used to decrease social loneliness. A well-known therapeutic robot for elderly is the PARO Seal Robot [23]. It was designed for elderly people, particularly those with dementia. The seal acts like a human baby and therefore should encourage nurturing behavior. It is meant to decrease the feeling of loneliness among elderly giving them something they can take care of but does not actually need care to survive.

Figure 1: PARO therapeutic Seal Robot

The preferences of companion robots by elderly was also researched. In a study done by Kim et al. [24], for the female elderly, the preference for robots heavier than 2 kilograms was observed to be significantly lower compared to those lighter. Also, elderly people that were living alone preferred synthetic fur more than elderly people living together. So, the weight and material of companion robots matter.

Smart homes

Smart homes are devices that can be used for a whole variety of appliances. They can be used for simple trivia questions that need answering or used as a control of an entire house to control the heating, curtains, lights or any other technology. Some examples are Google Home[25], Amazon Echo [26], Apple HomePod [27]. Because they all basically serve the same purpose they will not be described individually here.

Figure 2: Google Home, Apple HomePod and Amazon Echo

The Google home is used for elderly with dementia [25]. It can remind them of the date, the weather, and their agenda. It can turn on and off the heating or any other electronic appliances. This kind of help is greatly beneficial for patients with dementia to help them stay independent in the early stages of the disease [28].

However, it might be important that these dementia patients are already able to use/work with Smart Homes. If they abruptly have to learn this, the effect might be significantly less positive, if they are even able to do it in the first place.

Sensing

Technology can also be used to understand elderly better. Goonawardene N. [29] used sensors to detect loneliness among elderly. The time spent outside was associated with the social loneliness level, social network score and overall social isolation level. The time spent in the living room was positively associated with emotional loneliness and elderly who perceived themselves as socially lonely tended to nap more during the day.

Other than using sensors to sense loneliness, the same sensors can also be used to monitor the mobility of elderly. The sensors can be used to measure how fast someone is walking and how often they are falling [30].

The problem with using sensors is the privacy of the elderly is that the sensors will measure at all times. The elderly might get the feeling they are being watched or monitored. In the worst case, hackers might gain access to those sensors because of security issues.

2.3.2 Possible technological solutions

Google Home

Although the Google home[25] is already being used as a technology to decrease the loneliness among elderly, it still has more features that can potentially be used. The Google Home can be implemented with almost every service or device, which gives it almost endless use cases.

Eye tracking

Eye tracking is a technology that can accurately measure in which direction a person is looking. If coupled with a screen, it can be determined where on the screen someone is looking in real time. Eye tracking is already being used to improve designs made for elderly. For example, it was used to determine where elderly were looking on a web page, to be able to improve the design for them [31].

The technology is often used with gaming or computer use in general. Eye tracking devices are already available for prices under €200 as of the making of this report [32]. They can replace mouse and keyboard with the right software, which can make it easier to use for elderly and people with a disability. The eye tracking is already used in combination with a tablet to enable people with a disability to speak or express themselves in other ways using their eyes [33]. In the same way it could be used for elderly to control things in their house.

Eye tracking is already being used for people with special needs and it has a great impact on neurology, cognition, communication and security [34]. A company called Tobii sells eye tracking tablet devices which can be used by people with special needs to communicate. [35] If the technology works for people with special needs, it has the potential to work for elderly people as well.

Artificial Intelligence

Artificial intelligence [36] is a technology that has a lot of potential in many fields. The technology is already used in smaller proportions for companion robots. However, because the AI technology is improving every day, there are always new ways to use the technology. It could therefore also benefit the life of the elderly by helping them with daily tasks, decreasing the loneliness.

Artificial intelligence is able to learn on its own to keep getting better at a certain task. This could be used to have conversations with elderly. The AI could learn the interests and hobbies of an elderly person. It can know how they are speaking and then be a companion that is more than just a cold robot.

For a simpler approach, AI could be used to track the routine of an elderly person and help them with that. If they always wake up at 8 and make coffee, AI could make sure that it wakes them up at 8 and has the coffee already done. Smart Homes like the Google Home [25] already use AI for these purposes.

These Smart Homes also use sensors however, and the same privacy issues might arise as mentioned before. All this gathered information can fall into the wrong hands because of a data breach or might make the elderly person feel uncomfortable.

Internet of Things

The Internet of things or IoT, is a term that is used more and more. IoT is defined by the Cambridge dictionary as “objects with computing devices in them that are able to connect to each other and exchange data using the internet”[37] By using wireless modules, devices are able to communicate with each other and therefore able to transmit data. The technology can be used to sense and quickly act on the found data. Google Home [25] is an IoT device, it’s able to use a microphone and speaker, and can communicate with the internet or with other devices.

Virtual/Augmented Reality

The technology of virtual and augmented reality is also seeing growing attention in the past years. Virtual reality is defined in the Oxford dictionary as “The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.”[38] Over the years the technology has gotten better and is able to display images that closely resemble real life more and more. In a study by Appel et al., virtual reality was used to decrease the symptoms of depression, anxiety, loneliness and apathy due to cognitive and/or physical impairments [39]. The elderly were confined indoors due to their impairment, but the virtual reality allowed them to leave their house in another way.

Augmented reality is a technology that can generate 3d images in a real-world environment using something like a camera. This technology is used in games like Pokémon GO [40], where

the ‘Pokémon’ appears to be in the same location as you if the camera is pointed at the ground (Figure 3). A technology like this could help elderly when they point their camera at something and instructions on how to use the object are shown.

Figure 3: Pokémon GO Augmented Reality

A technology where this is already the case is the Microsoft HoloLens [41]. The HoloLens is able to generate images right in front of the eyes as an overlay of what is already seen, which makes it seem like they are one with the environment.

Figure 4: Microsoft HoloLens

So, the difference between VR and AR is that VR is used to experience a virtually created environment, while AR uses the real-life environment to add virtual elements.

2.4 Conclusion

In conclusion, there are social and individual solutions to loneliness and animals seem to work well to replace human contact. Next to that, decreased mobility is either prevented or is solved by using technology to make the elderly mobile again. However, for this study the aim will be on decreasing the powerlessness that is felt because of decreased mobility and not to solve the decreased mobility itself.

Lastly, technology sees a lot of use in trying to reduce loneliness, but it still has a lot more potential to solve problems that elderly are experiencing. Artificial intelligence could be used

to understand the elderly better than humans could, or eye tracking can be useful to determine what an elderly person by just using their eyes.

The solutions and possibilities found will be useful in designing a product fit for elderly so that it can reduce the powerlessness felt because of decreased mobility and therefore reduce the chance of loneliness.

3. Method

For the development of a product it is important to know what problems elderly are struggling with. Therefore, it is valuable to interview elderly and send out online surveys to find out what elderly with a decreased mobility have the most problems with.

However, due to the Covid-19 outbreak in 2020, it was not possible to visit the elderly or interview them in any way. It was also not possible to ask the formal caregivers for assistance since there should not be any more stress on the healthcare system than necessary.

Because of this situation, the best way forward was to use online surveys to get information from family and the informal caregivers of elderly people living alone. That way there were no lives put in danger and the necessary information could still be gathered.

In the Method section of the report the focus group, the online survey and the usage of the results will be discussed.

3.1 Focus group

For this thesis, the goal is to decrease the feeling of powerlessness experienced by elderly because of their decreased mobility. By decreasing the feeling of powerlessness experienced, their mental health will improve, and the loneliness will decrease. This can either mean that elderly who are already feeling lonely will start to feel less lonely or, if elderly are not lonely yet, the risk of that happening will decrease. An important criterion is that the focus group should be elderly people living alone. When people live alone, the most hinder by the decreased mobility is experienced because there are no relatives living with them to help when necessary.

However, it can mean that the elderly person is living in an elderly home with 24/7 care. In this case the person is still living alone and has to deal with that, even though people are close by to help. Asking the help of a partner will feel more natural than having to ask the help of a caregiver.

3.2 Online Survey

To gather information about the focus group an online survey was done. A survey was chosen over interviews because a wide range of answers is preferred over a couple detailed stories. This way a product can be designed which is beneficial to the largest group possible. At this stage of the development the quantity of information is more important to get a proper understanding of the struggles the elderly are having.

3.2.1 Goal

To develop a product that will help elderly with a decreased mobility deal with their restrictions, a survey was done to find out what these elderly or struggling with the most. By finding the biggest problem experienced due to the mobility problem and tackling it, the risk of loneliness should decrease.

For example, if elderly struggle a lot with not being able to cook and it seems to bother them a lot, a possible solution could be to develop a product or service that improves their ability to cook. Therefore, improving their experience and lowering the risk of them getting lonely.

To tackle the problems using technology, it is also useful to know what kind of technologies the target group is already using. Like if they are already familiar with modern devices or if they already have trouble operating the button that opens their front door. With this information the problems they experience can be solved with technology that they are able to use.

3.2.2 Participants

Unfortunately, the actual focus group could not be contacted because of the Covid-19 virus outbreak and the risk that comes with contacting the elderly and the formal caregivers. Therefore, the participants are not the elderly themselves, but relatives or informal caregivers of elderly with a decreased mobility living alone. USLegal [42] gives the following definition for informal caregivers:

"Informal caregiver is a family member or a natural person who aids and supervises the daily cares of a disabled person. Informal caregiver contributes and involves in caretaking responsibilities of the weak or disable person. They provide services daily like listening to the care recipient, giving companionship and phone contact, assisting with meals, medicines and helping with worries, anxiety, and emotional needs. It is not necessary that s/he may live with the frail person in the same house. To assist and improve the quality of care provided by informal caregivers, training and technical assistant programs are conducted throughout the state."

These people will have a good idea of what the elderly people are dealing or struggling with. It is even possible that the caregivers are more aware of the situation than the elderly person is themselves because the informal caregivers are able to observe from a distance and are in a position where they can get quite close to the elderly person. Family might know even more about a person since they have known the elderly person for probably a long time and have created a deeper knowledge of their personality and likes or dislikes.

3.2.3 Approach

The online survey was made in Google Forms and was spread via Facebook, WhatsApp and email. The survey had to be filled in by preferably at least 20 people to give a proper estimate of the existing problems.

3.2.4 Questions

At the beginning of the survey the participants were briefed, a consent form had to be signed, and the goal of the survey was explained. In the first question the participant was asked if the elderly person they have in mind did in fact live alone, if this was not the case they were thanked for their assistance, but for this research the focus group is elderly living alone.

If they answered yes, they could continue with the rest of the survey, starting with questions about the mobility and loneliness of the elderly person in question. In the survey there are a couple of themes that were used. At first it was asked if the elderly in question was lonely because of their decreased mobility, to see if the loneliness and mobility were correlated. After that, more questions were asked about the mobility to find out what tasks they were struggling with and to find out if they have trouble with the fact that they are struggling. These questions were asked to find out where the problem was and if it could be solved.

In the last part of the survey, questions were asked about their usage of technology. This was to find out if the elderly were already using remote controls or other devices and if the usage was smooth.

The survey took around 10 minutes to fill in and the entire survey can be found in Appendix A.

3.3 Using the Results

The results of the survey were used to guide the development of the product. The problems and struggles found provided the necessary information during the ideation phase. If the elderly were struggling with remote controls and buttons the most, the focus would be on the development of a simple way to use a remote control. If the problems were with an activity like standing up, it would be possible to focus on a design of a better chair.

For the prototype, user testing needed to be done. However, due to the Covid-19 virus was not possible to directly test the prototypes on the user-group. A possible solution for this was to test the prototype on younger people, between the ages 40-60. They might be able to understand the prototype faster than the elderly older than 60, but if younger people are having difficulty understanding or using the product, then the elderly will very likely have trouble too.

When asking these younger people, it was possible to ask them to imagine them being an elderly person living alone. This way it was possible to get results which closely resembled the results that would be gotten from testing on the actual user-group. It is important to do this when considering an empathic design process.

3.4 Ethics

Before the spreading of the survey, the research was approved by the Ethics Committee EEMCS of the University of Twente with number **RP 2020-36**. The approval was based on the layout of the survey, the research description, and the provided checklist.

4. Results

In this section the results of the survey will be analyzed and discussed. The complete results of the survey can be found in Appendix B. Each question will be shown, and the answers are briefly discussed.

The survey was filled in by 44 respondents. 8 of those were excluded after the first question since they were neither caregiver nor family of an elderly person living alone. The results are therefore based on 36 answers.

The ages of the elderly people in question is mostly between 81 and 90 years old with 23 people. When combined with the 90+ group makes that over 75% of the elderly were older than 80 years old. (Figure 5)

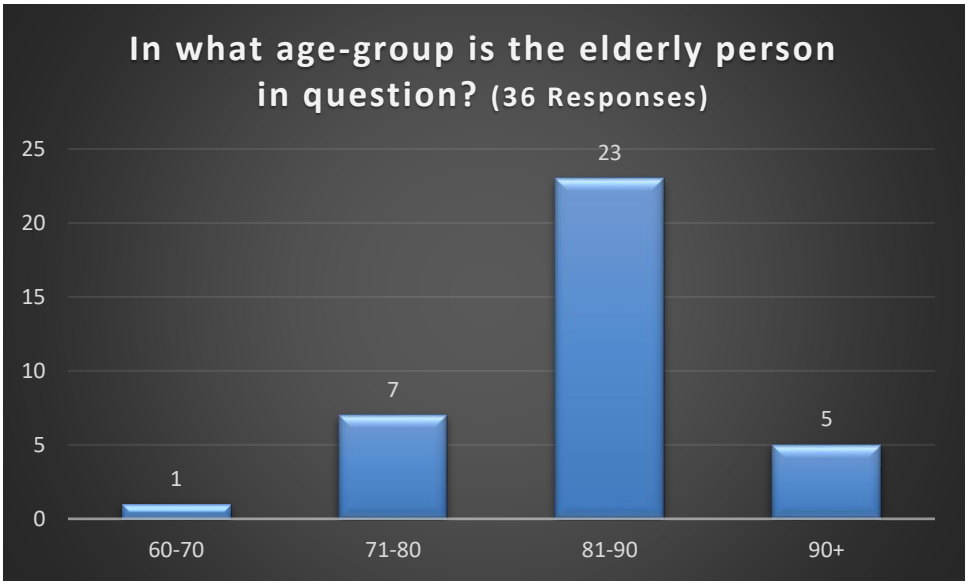


Figure 5: Age-groups of the elderly in question

Out of all the elderly, over 70% of them use a wheelchair or another form of walking assistance to get around. This means they have a higher risk of falling down and might need help getting up. (Figure 6)

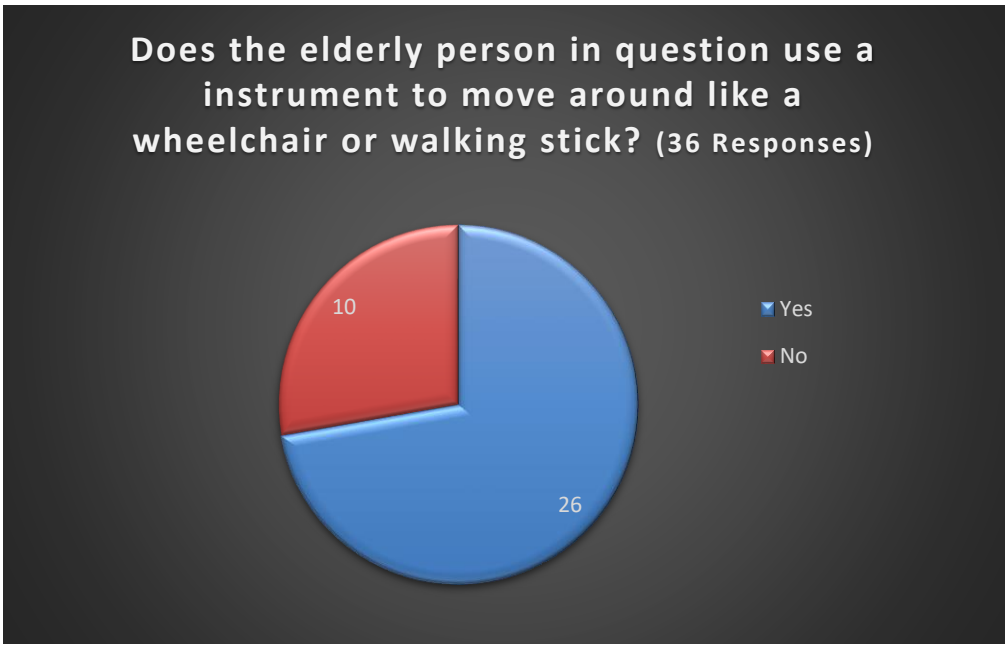


Figure 6: Assistance to move around

In the next question, the family and/or caregivers were asked if they thought the elderly person in question was more lonely due to their decreased mobility. Exactly 50% of the elderly were either a little or a lot lonelier due to their decreased mobility. The other 50% reported that the elderly person was either not lonely at all or was not lonely due to the decreased mobility. (Figure 7)

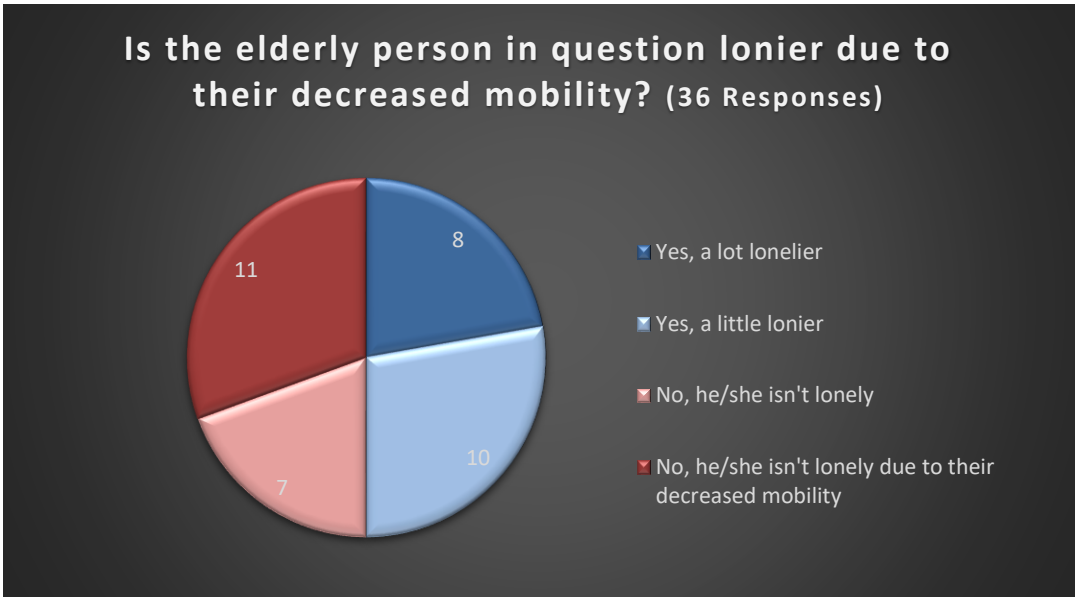


Figure 7: Loneliness

It was also asked if the elderly people had difficulty dealing with their decreased mobility on a scale from 1 to 5. Only one person answered that the elderly person in question did not have any problem dealing with their decreased mobility, so gave a 1, while over 30% of the people

gave a 5, meaning that the elderly had a lot of difficulty dealing with their decreased mobility. The results can be seen in Figure 8.

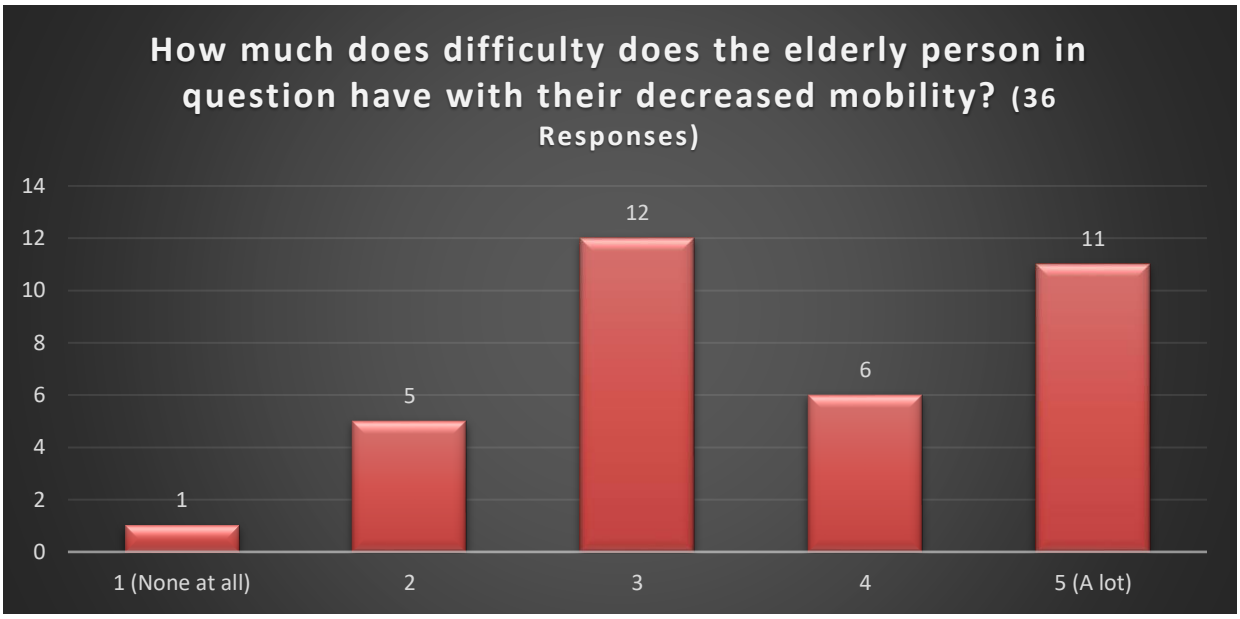


Figure 8: Difficulty in dealing with decreased mobility

To confirm the findings in the literature review, it was asked how much difficulty the elderly were having with six daily tasks. Getting dressed, washing(self), cooking, climbing the stairs, opening the door and using electronic devices. The most difficulty was experienced with climbing the stairs and the least with opening the door. Most of the elderly did have at least a little difficulty or more with using electronic devices. (Figure 9)

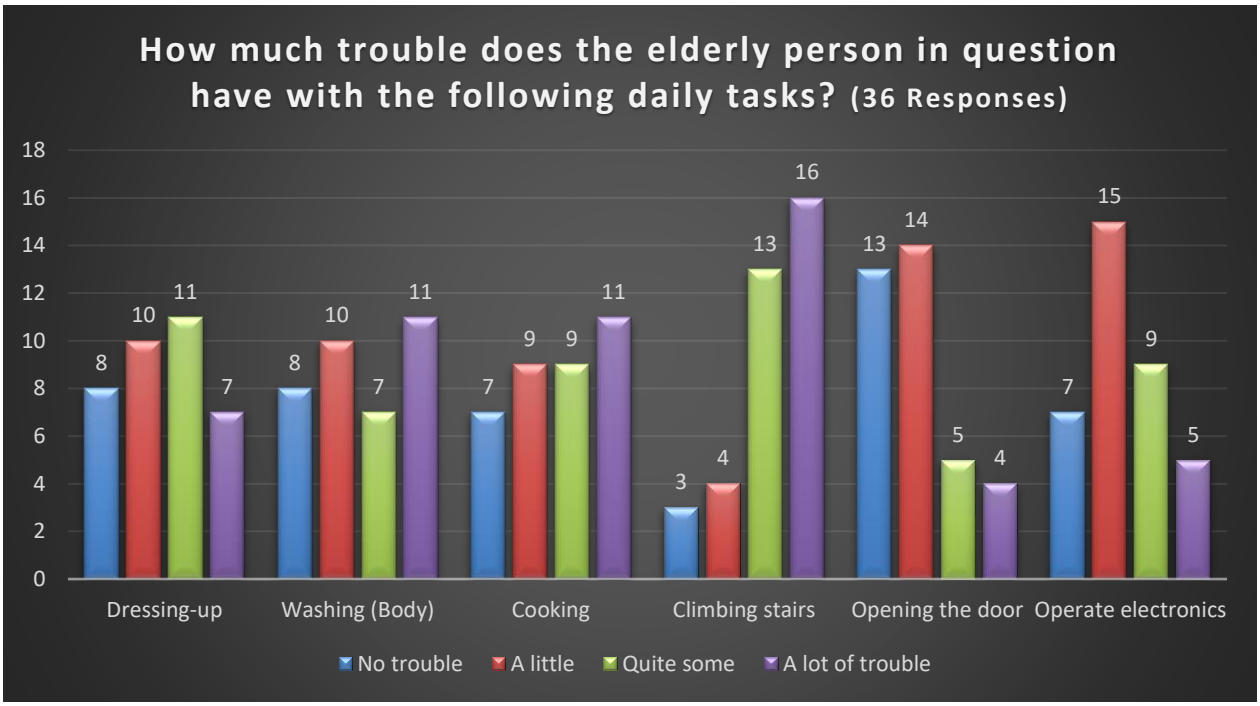


Figure 9: Difficulty with daily tasks

One of the questions was if the elderly in question had a hard time using remote controls for the TV or other devices. A little over half of the elderly scored a 3 or higher out of 5 on the amount of difficulty they had with remote controls. (Figure 10)

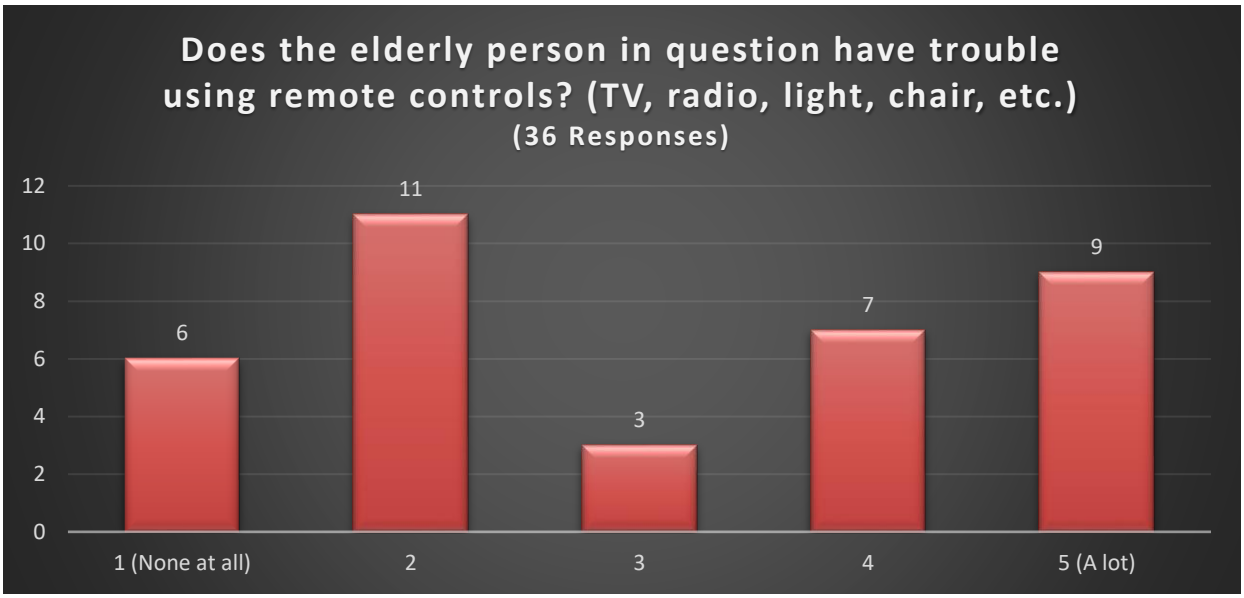


Figure 10: Difficulty with remote controls

The second part of the question was open and asked why the elderly were having difficulty with remote controls if they had any. Some of the responses are translated below, the original answers can be found in the Appendix B.

"Too many small buttons"

"Can't remember what the function is of each button"

"Has a hard time pressing buttons because of muscles"

"Too many different remotes"

"Forgets which remote is for which device"

"If there is a problem, it's impossible to solve it themselves"

As can be seen in these responses, elderly have trouble using remote controls for reasons like that there are too many small buttons or that there are too many remotes in general. These responses were common and seems to be an issue for many elderly as can be seen in the Appendix.

When developing a device, it is important to know what modern devices are already being used by the target group so that those can be used if possible. The question was what Smart devices the elderly people were already using. Almost 50% of the elderly people do not use a Smart device of any kind, and it is important to keep this in mind, since most elderly will therefore have no experience using modern technology. (Figure 11)

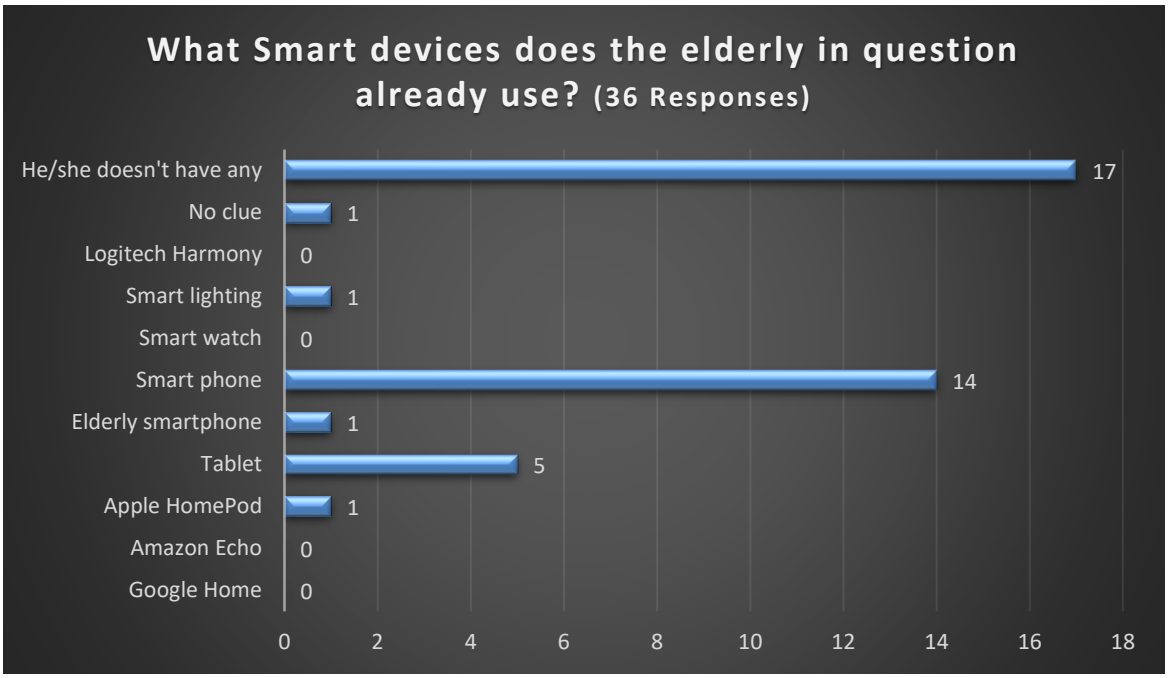


Figure 11: Smart devices already in use

One of the open questions was asking what the elderly person was struggling with the most due to the decreased mobility. A few of the translated responses:

“Giving up independence”

“Not being independent”

“Less grip on the world”

“Losing the control of their own life”

“Remote controls”

“Not being able to do what they want”

“Having to rely on other people”

The elderly people seemed to struggle a lot with them losing their freedom and independence. They did not want to rely on other people to do things for them and feared losing all the control of their own life. Giving them back even a little control could decrease the struggle they experience and will then decrease the risk of them getting lonely or lonelier.

Because of these results, it seemed like there was room for improvement when it comes to the usage of remote controls and other devices that use buttons.

5. Ideation

In the ideation phase the results of the state of the art and the survey results were used to develop a concept and consider the options. After the ideation phase a protype was made. Because of the State of the Art and the survey it was decided to use the eye tracking technology and try to solve the problem the elderly were experiencing with electronic devices and remotes in particular.

5.1 Eye Tracking Technology

When designing for elderly it is important to keep in mind their limitations in terms of mobility and general cognitive abilities. When looking at the State of the Art a technology like eye tracking could be beneficial to use for elderly since that there is no interaction with the hands or voice is needed. Even though the vision of elderly is generally less good, they should still be able to use eye tracking. Using the eye tracking technology, it could be possible to give elderly a tablet which they use with their eyes. They would not need to worry about all kinds of buttons or struggle with a touch screen. The control would be purely with their eyes and feedback from the tablet. This would be beneficial since the elderly would not need to use their arms and legs, which can be difficult for them. An existing eye tracking device like the Tobii Eye Tracker 4C [32] can accurately determine where someone's eyes are looking on a screen and could work perfectly for elderly people.

5.2 Concept

As can be seen from the results of the survey, elderly have trouble with too many small buttons corresponding to different functions. By using colors and images, the elderly would not need to remember anything new and when they need to do something. By also using an artificial voice to talk to the elderly person, confusion is minimalized.

In the design in Figure 12, the elderly person would have a tablet which looks and holds more like a cutting board. It should look simple and be easy to use. On this board there are 6 pictures of different actions like opening the door, turning on the tv, turning on the radio, calling someone, playing the news or anything of the sorts. By looking at one of these pictures for more a few seconds, the device will ask if they want to execute that action and that they can do so by looking at the green circle for a couple of seconds. When they do so the device can do things like open the door, turn on the lights, play the news, etc.

To make sure the elderly get enough feedback the device could start beeping for every second one action is looked at, after the first two seconds are over. So, when an elderly person wants to open the door, they look at the door picture. After two seconds the device starts beeping for every second so three times. The device asks if they want to open the door and that they can do so by looking at the green button. When looking at the green button the device beeps after the four seconds only. Another option would be a visual cue that the device is doing something, such as a bar filling up, letting the person know that they need to keep looking at the action.

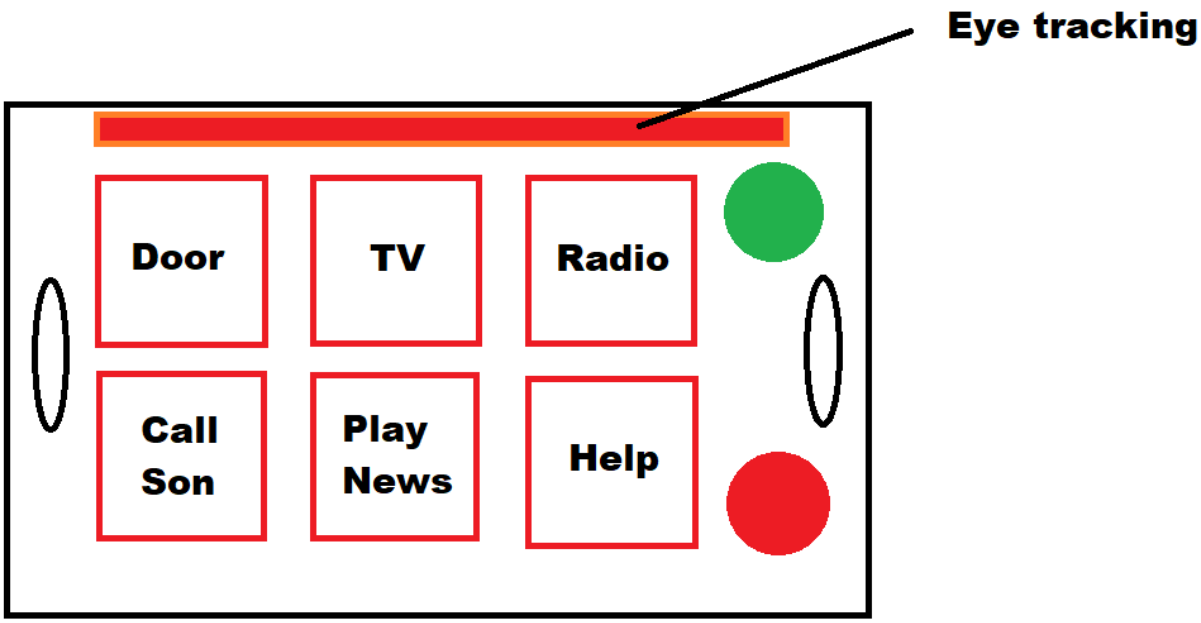


Figure 12 First sketch design

5.3 Programming

To realize a prototype like this, some programming needed to be done. For proof of concept a program like "Processing" [43] was used. It is a simple JavaScript based programming tool in which making simple interfaces becomes an easy task. In processing the prototype could be realized and could be shown on a computer screen to imitate a tablet like device.

Another option was to use Python [44] or a web application using HTML, CSS and Javascript [45]. However, these options were less straight forward than using Processing and required more work arounds to work properly. Since the prototype will only be a proof of concept and not the final product, Processing was the better option.

With Processing, the buttons were made and shown. To actually make the buttons do something, an Arduino [46] was used. For example, the Arduino can turn on lights or other devices, but can also just work with any kind of sensors and actuators to give more than just visual cues on the screen.

6. Prototype

In the prototype section of the report the prototype that was realized is described and discussed in detail. The hardware and software used and why they were used is written here.

6.1 Tobii Eye Tracker

For the prototype, the Tobii Eye Tracker 4C[32] was used in combination with a laptop. The reason the Tobii eye tracker was chosen was because of the price and support for the device. The device is already being used for similar purposes and has software to make it work on a windows device. Using the Gaze Point [47] software by Tobii, the input that is received by the eyes can be turned into mouse movements, which can therefore be used to make it work with the Processing program. The Gaze Point software also offers the possibility to hide the mouse cursor and this was used to top the mouse from being a visual distraction for the elderly.

6.2 Design

6.2.1 Version 1

The design of the first prototype was kept similar to the original design. Eight large buttons with pictures and the name on them were made. This way their visibility would be good and understandable. On the buttons pictures of the action that could be performed were visible, if the pictures were still unclear, the name of the action was also at the top of the button. To make the overall visual of the program calm and to make sure someone could only look at one button at the same time, spaces were left between all of the buttons.

The actions that can be performed are displayed by six large square buttons. To make it clear that the confirm and cancel buttons were not action buttons, they were made to be round buttons. Two big round buttons on the right side of the screen, one of them was green to confirm the actions and the other one red to reset or cancel all the actions.

When looking at a button, a grey circle showed up where the user was looking and a red circle that started as a dot and kept getting bigger was shown in the middle of the grey circle. This was to indicate the loading. When the user looked at the button until the red circle was as big as the grey circle, the action was triggered.

The actions that were shown in the first prototype include Door, Lights, TV, Radio, News and Help. These are common actions but can be replaced with anything. In the actual product calling could be one of the options with a follow up menu showing a few most used contacts. In the same way a second page could be shown for the TV where the use can control some basic TV functionalities like changing the channel and adjusting the volume.

The design result of the first prototype in Processing can be seen in Figure 13.

Figure 13: First prototype in Processing. (While looking at the "Licht" button.)

6.2.2 Version 2

In the second version of the prototype changes were made to improve the prototype. The short patch-notes can be read below and are explained in more detail in Section 7. The prototype after the changes were made can be seen in Figure 15: Prototype Final version. (While looking at the "Licht" button.)Figure 14.

- The loading circle was changed to a square and instead of following the eyes, it is stuck to the button that the user is looking at.

- The loading animation now starts after two seconds rather than instantly. This is to make the overall experience less busy.

- The color of the background was made a little darker to increase the contrast.

- The color of a button when hovering over it was changed from red go grey. This is to decrease the number of and intensity of colors.

- No longer can multiple voice lines be played at once. All audio will now stop before a new voice line is played.

- The Reset button has been redesigned by using the green button model and making it red. The word "RESET" has been put on the button to make the function of the button clearer.

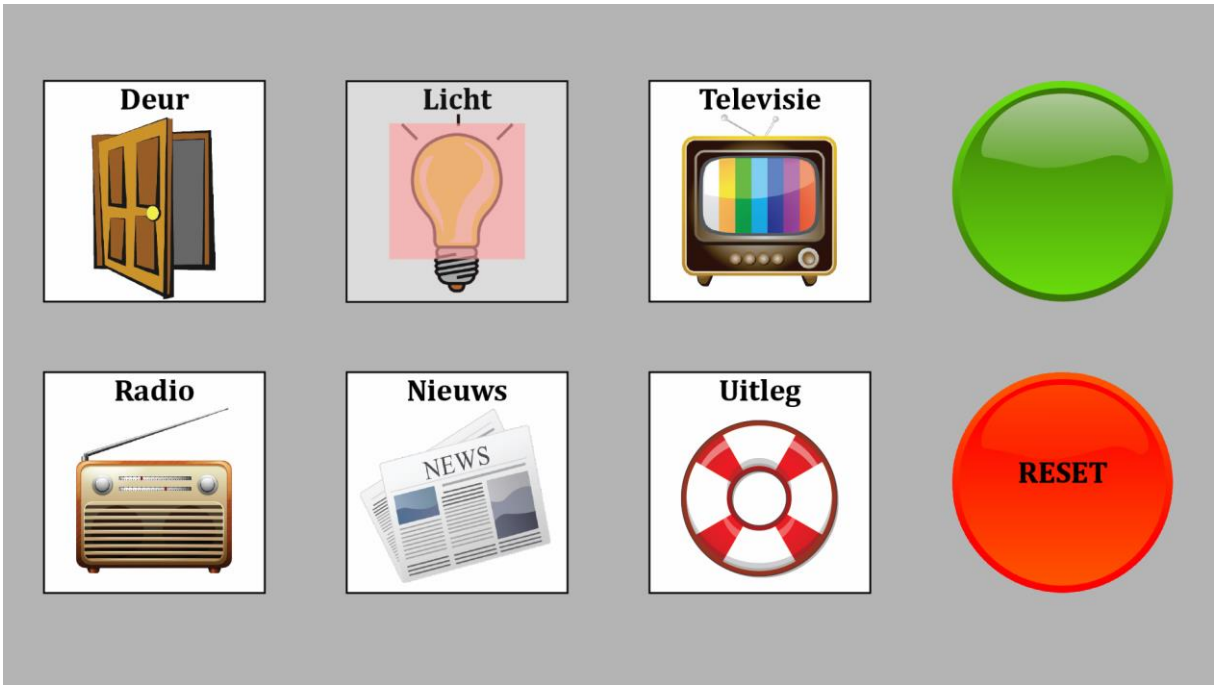


Figure 14: Prototype version 2. (While looking at the "Licht" button.)

6.2.3 Version 3

After the second user testing, more changes were made to the prototype. They will be listed as patch-notes and can be read in more detail in Section 7. The prototype after the changes can be seen in Figure 15: Prototype Final version. (While looking at the "Licht" button.)Figure 15.

- The Reset button was changed to a rectangle and moved to the top right of the program. This is to reduce confusion and make clear the button has a different function.

- A percentage counter has been added to the middle of each button when being looked at to make it easier for users to hold focus. The percentage start after 2 seconds of looking and goes from 0 to 100%.

- At the top right of the buttons a state indicator was added where relevant. The user can now see whether someone is on or off to avoid confusion.

- The grey hover color when looking at a button was disabled. The constant flickering was considered distracting by some users.

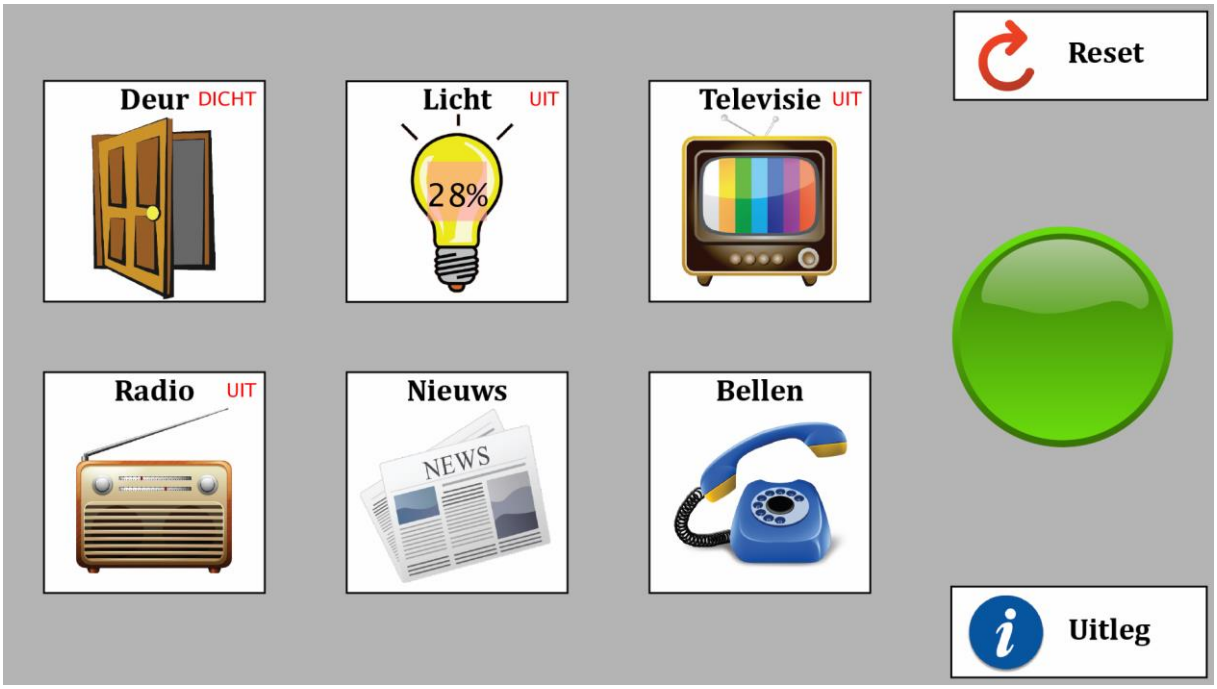


Figure 15: Prototype Final version. (While looking at the "Licht" button.)

6.3 Processing

Processing was used for the design of the prototype. As mentioned in the Ideation section the program is easy to use and works well with other programs. The design could quickly be realized and tested without many work arounds or other hacks.

The code consists of a main tab and a second tab for creating the buttons. In the buttons tab the properties of the buttons are established and created. In the buttons tab there are also 2 functions to determine if someone is looking at the button and if it is selected.

In the main tab the buttons are placed, and the different actions are performed. For example, playing sound or controlling the Arduino. The entire code can be found in Appendix E and the code is commented. For every version of the prototype the code was changed, only the final version of the code can be found in the Appendix.

6.4 Arduino

To enable the prototype to do more than just reply to the click of a button with a voice line, an Arduino Uno [46] was used to make more actions possible. The Arduino is connected via USB to the same laptop and has an 233Mhz radio transmitter connected, as well as an IR transmitter. This is done just as a proof on concept because in reality, anything can be connected to the device that can be remotely controlled. It can be combined with Smart homes to control all those devices, or it can be configured using the IR and radio transmitters to control older devices of people that do not have smart devices and don't want them either. The eventual device would be versatile, and its application would be different for every elderly person.

The 233Mhz radio transmitter is used to turn on and off socket plugs that normally work with a remote control. The normal set can be seen in Figure 16. By using these radio-controlled

power sockets instead of ones that work with Smart devices, a lot of money can be saved. Some elderly people might already have these radio-controlled power sockets as they are popular under the elderly people. For the prototype that transmitter is used to turn on Christmas lights.

Figure 16: Switch set 233Mhz

The IR transmitter or Infra-Red transmitter is used to turn on any device that works with IR. The transmitter can send any codes that are necessary and therefore can work on every device if preconfigured. The transmitter can also send more than just on and off commands, it can send any of the commands that would normally be on the remote control of the device. It is therefore possible to get all the controls of all devices on just one device. However, in this prototype it is just used to turn on and off a Samsung TV and a Sony Stereo (Radio).

Although the prototype was able to control an Arduino, the Arduino part of the prototype was not used in the user testing as it would not affect the results of the user test. It could even distract the participants from the software. The Arduino part of the prototype was a proof of concept and was used during presentation of the product.

7. Evaluation

In the evaluation section the prototype was tested, and the results were analyzed. When developing a product, it is important to have multiple phases of testing and iteration. Therefore, the product was tested three times and also iterated three times based on results of testing. In this section the different participant groups will be described, the results that were gotten and what iterations were made because of the results.

7.1 Iteration cycle 1

During the first user test, the first prototype from the Prototype section of the report was used for testing.

7.1.1 Participants

For the first user test, a couple of fellow students were asked to be a participant. Although the users were way younger than the desired user group, they were also critical users and could notice flaws or problems way faster than an elderly person could.

One of the participants was a woman in her 20's and the other was a man, also in his 20's. The man was chosen as a participant because of his glasses, since it was important to test the product on people with glasses since most elderly people wear glasses. It could have been the case that the eye tracking technology worked less well on people with glasses.

7.1.2 Procedure

The laptop with the eye tracker was put down on a table and the participants could open the program and control it with their eyes. After using it for a few minutes they could stop, and they were asked what they thought of the prototype. Although the answer to the question was also important, even more important were the observations that were made during the testing. The behavior of the participants is valuable, because the participants can do things they don't realize themselves.

7.1.3 Questions

During the first user test the observations were the most important part of the testing. However, after the participants used the prototype, they were asked what they thought of the prototype and what could be improved. The testing was informal and therefore the answers were not recorded or transcribed.

7.1.4 Results

Something that immediately became clear when testing was that calibration was necessary for every individual person. Especially when someone had glasses. The eye tracker could not directly determine where someone was looking if it was not calibrated for their eyes. However, this only took one minute and only needed to be done once for every participant.

As is described in the Prototype section, the first iteration of the product had a loading circle wherever the user was looking. According to the participants this was very distracting, and this could also be observed while watching the participant. When the loading circle was even a few millimeters off where the participant was actually looking, their eyes would start to follow the circle, which would then move the circle even further away et cetera. It was obvious this was a problem that needed to be fixed.

Something else that was said by the participants was that the amount of colors was distracting. When looking at a button it would light up, the loading circle would change color and then the button would change color again. This could also be observed while looking at the participants because their eyes kept darting everywhere.

Another problem that could be seen while watching was that the voice lines would keep looping and stacking over each other if the user did not look away from a button in time. This can be extremely confusing for elderly people and needed to be fixed as well.

The last thing that could be observed was that the function of the reset button was not clear. The participants did not know what it was for or when to use it and therefore ignored it.

7.1.5 Iteration

Because of the first user tests several changes were made to the prototype. Firstly, the loading circle no longer appeared exactly where the user was looking but was instead moved to be on the button. So instead of a small circle which became bigger, the loading was now a red square which would increase in size overtime until it was as big as the button itself. After this it would register as an action. Since the participants also thought everything was a bit too busy, the loading animation would now start after looking at a button for about one second instead of instantly.

The second thing that was changed were the colors. For the second version of the prototype the color of the background became darker to increase the contrast and the color when hovering over a button was changed to grey instead of red. The loading animation color was kept as red, this way the colors were not as intense and did not change as often.

The problem with the voice lines looping and/or stacking was also solved. The voice line would only start once unless the user looked away and then back at the button. It was also no longer possible to stack the voice lines, all audio was stopped before starting a new one.

Lastly, the reset button was changed slightly, the model of the green button was used and made red and the word “RESET” was put on the button to make it more clear what it was for. After all the iterations were done, the prototype was ready for the first formal user testing. The second version of the prototype can be seen in Figure 14 in the Prototype section of the report.

7.2 Iteration cycle 2

7.2.1 Participants

The developed product is for elderly who are living alone and are having trouble with their mobility. However, as mentioned before, because of the Covid-19 outbreak in 2020 it is not possible to test any prototypes on these people to prevent any unwanted consequences. Therefore, it was decided to test the prototype on people between the age of 40 and 60. These are people that still have a job and are already going back to the office. The four participants were found at the office of Ecare in Hengelo and were asked to imagine them using the product as an elderly person living alone. Although this was not ideal, this way of testing would

still show possible problems and parts that could be improved. It could even be the case that because that participants were a little younger, they would be better at breaking the program and pointing out flaws.

7.2.2 Procedure

The participant was called in and given a short briefing. They were told that they were testing a device that was meant for elderly and had to imagine them being old as well. Afterwards the participant would have to answer a few questions and they would be observed while testing the device. Because they would be recorded, they had to sign a consent form which can be found in Appendix F. They were given as little instructions for the device as possible to mimic a possible scenario where an elderly person forgot how the device worked. Some elderly will immediately forget instructions they have received and a device for them will therefore need to speak for itself every time they pick it up.

After the participant had used the application for a few minutes and figured out how to use it, they had to answer a few questions. The questions were asked in Dutch and the answers can be found in Appendix C. The English translations of some of the answers can be seen in the next section.

While the participant was testing the device, they were being observed so that any behavior that they would not notice themselves could be written down. Noting where the eyes of the participant were drawn to and how long the participant was able to look at a button before looking away were useful questions that a user could maybe not know themselves when asked. How long it takes for them to understand the device was also something that was important to know. If these participants take a long time to understand how to use the device, chances are elderly people take even longer or may never understand it at all.

7.2.3 Questions

The first questions were to see if the user understood what the device was for without much explanation and could use it properly.

“Was it clear what the device was for in this setup?”

“Was it easy to use the device once you understood how to?”

Then to find out if there was anything about the device or program that annoyed the participant or made them feel uncomfortable. This was to find out any features that might be annoying or distracting to the user.

“Did you feel any discomfort while using the device? Can you describe it?”

Although the participants were not elderly, they could imagine being so and say what they thought of the time they had to look at something before something happened.

“What did you think of the time that you had to look at a button?”

After that, the participants were asked a few questions about the design of the program. What they thought of the general design, the positive and negative points and what they would change about the design.

"Can you mention a few positive things about the design?"

"Can you mention a few negative things about the design?"

"Would you change something about the design?"

The participants were then asked if they thought the device would be fit for an elderly person to use and if they would consider buying it for an elderly person with a decreased mobility living alone.

"Do you think this device would be fit for elderly people to use? Why?"

"Would you consider buying this product for an elderly person? Why?"

Lastly, the participants could add a last remark or point of feedback to improve the product. This was to make sure they said everything they had to say.

"Do you have any extra remarks or feedback which can be used to improve the device?"

7.2.4 Results

After the second user test, the results while observing seemed better. The participants were less often distracted with their eyes and were able to look at a button for a longer time because of it. In this section the answers to the questions will be discussed and the most interesting answers will be translated. The original answers can be found in Appendix D.

According to the participants the purpose of the prototype was clear in the setup. However, participant 1 mentioned that "It was not immediately clear how long I had to look at a button and, in my opinion, it was kind of long. I was distracted and wanted to look away, but then the timer would reset." Most of the participants mentioned that the looking time might have been a little too long. However, because the participants were not actually in the target group, it is hard to determine if the looking time is indeed too long. Testing with the actual user group would need to be done to find out.

When asked if the prototype was in any way uncomfortable, participant 2 mentioned that it took quite some time before the loading was complete and that it was possible to get distracted. Adding something on each button that takes the attention could solve the quickly getting distracted. Participant 4 was wondering if it was okay to blink, since they would automatically start to blink less. They suggested mentioning to the user in some way that blinking would be no problem.

All of the participants were positive about the simplistic design and were under the impression that it would work well for elderly people. When asked about the negative points of the design, participant 1 mentioned that they were wondering how long someone would be able to hold focus, and that it might be different for every person. They suggested building in some sort of calibration, changing the time needed to confirm actions based on the attention span of that person. The same participant also suggested that the timer should not completely reset when looking away but should rather start to count down when looking away. This way users would not get punished as hard for looking away for a short moment. However, it is possible

that this is less of a problem for elderly people, who might not look around as much and are not able to process the information as fast.

Participant 4 said “It is following your eyes the whole time and a lot is happening because of it. The flickering is also little bit annoying.” It might be a good idea to stop the buttons from lighting up when looking at them and thereby decreasing the number of visual things happening at once.

When asked what the participants would change about the design, participant 3 mentioned it might be nice if the order of the buttons could be changed. To put it alphabetically, to manually order them or to have them ordered per part of the day. So that in the morning the layout is different than the one in the afternoon. This is a little bit of a later stadium design point, but it is good addition to have the users edit the layout as they want.

Generally, the participants were positive about the product being used by elderly people and would consider buying it if they knew someone of the target group. At the end of the interview participant 4 suggested to add calling to the list of possibilities and maybe even an emergency button. Lastly, something suggested by participant 4 and the client at Ecare was to add an indication whether a device was on or off and open or closed. Although for the prototype this would be a simple indication, it would be a good addition for the elderly.

7.2.5 Iteration

After the second iteration cycle a couple of adjustments were made to the prototype. Once again, the changes will be mentioned and why they were made.

Firstly, the reset button has been changed. The button was changed to a rectangular shape and was places in the top right part of the screen. This should make it clearer that the button is a reset button and is not a part of the process of turning on a device.

Because the participants were getting distracted while testing the prototype, something had to be added to keep their eyes on the button. This was done by adding a percentage in the middle of the button the user is looking at. The percentage goes up to a 100% when the button is activated. The changing number should get the attention of the user and hold their attention while the loading takes place.

At the top right of four of the buttons, a state indicator was added. The indicator lets the user know whether a device is on or off. So, when the lights are turned on, in the top right corner of the lights button, the word “ON” can be seen in green text. When turned off, it says “OFF” in red text. This way, the user knows which devices are on, or open and does not need to check. This can be useful for when the door or light in question is not in a direct line of sight but is behind a wall.

Lastly, the color change when looking at a button was turned off. This way it should be less chaotic when the user is just looking around. The visual cues now only start when the user is looking at one button for a few seconds.

7.3 Iteration cycle 3

7.3.1 Participants

The five participants of the third iteration cycle were found at Educared [48] in Hengelo, which is a company that works together with Ecare. None of the participants had seen or tested the prototype before to keep the results consistent. More details about the reason for these participants can be found in Section 7.2.1.

7.3.2 Procedure

For the user test the exact same method of the second user test was used. The participants were briefed and had to sign a consent form, they then had to calibrate using the eye tracker and were told to just use the program for a little bit. After they had tested most of the functions they were interviewed. The procedure can be read in more detail in Section 7.2.2.

7.3.3 Questions

The same questions were used for the third iteration cycle. The questions can be found in Appendix C. The most interesting answers will be translated to English and discussed in the next section. The exact answers that were given to the questions can be found in Appendix D.

7.3.4 Results

Even though some participants had to get used to using the prototype, all of them thought it was clear and easy to use without too much explanation. However, participant 5 said that it was not clear what the help button was for. They thought the icon should be changed to an ‘i’ icon to indicate it being an information button.

Some of participants struggled with the loading sometimes resetting when they would blink or look away too quickly. Participant 8 mentioned they started to doubt themselves because the program did not respond all though they thought they completed the action. Adding an indication for the reset might help in this.

Like in the previous iteration cycle, testing if the time it takes to activate a button is right is difficult. The participants are not the user group. However, most of the participants liked the time it took and thought it was about right.

Some of the participants were worried about elderly being able to use the device and thought they would still need some prior experience with electronic devices to use it. Participant 5 also mentioned the explanation of the help button was quite long and that they did not hear all of it. They were also wondering if the device would still work if it was dark inside, especially if someone wants to turn on the lights.

Participant 6 said they thought the prototype could use some more visual cues as to what a user should do. Like showing a couple of eyes at the green button after activating an action button. This way, not hearing the explanation should not be an issue.

There were some questions about where the product would be placed in a real-life scenario. Some thought it would be better to place the product on some sort of extendable arm instead of it being a standalone tablet.

Overall, the participants were positive about the product being used by elderly and buying it for someone they knew if it was a possibility. Participant 6 mentioned that they would especially use it if they would just try it out for a while.

An additional comment by participant 6 was that it might be a good idea to use a real person's voice instead of a robot one. They thought this would help to make it more personal for the elderly person, and that it might help them bond, decreasing the loneliness even further.

7.3.5 Iteration

After the third user test the final adjustments were made to the prototype. The adjustments were again based on the results of the interviews and on the comment of the client at Ecare.

Because of the comments made about the help button, it was changed in appearance and position. The button now has an 'i' icon which stands for information and is positioned in the same way as the reset button but instead of the top-right corner, the bottom-right corner. By doing this it should become clearer what the button is for but will also not be in the way if the user already understands how the program works. It will just be there if the user needs a reminder.

The reset button was changed again to make it seem more neutral. Participants of the user testing mentioned that they did not understand what the button did and that therefore would not activate it. The buttons color has been changed from red to white and a refresh icon was added to indicate the reset button simply refreshes the program and is there as a safe button.

The final protype after all the changes had been made can be seen in Figure 15 in the Prototype section of the report.

8. Conclusion

The goal of this project was to reduce the loneliness experienced by elderly people. Research needed to be done to discover the different kinds of loneliness and the already existing solutions. As a result of the research, the target group was narrowed down to elderly people with a decreased mobility who also live alone. These elderly experience a feeling of powerlessness because of their decreased mobility because they feel like they are losing control. This impact on their mental health can lead to loneliness. Helping these people was therefore an opportunity to decrease the risk of loneliness by lower the feeling of powerlessness that this group experiences.

Due to the Covid-19 pandemic, all research had to be done from home. Another effect of the outbreak was the risk for the elderly and therefore also the target group. Because of this, it was not possible to approach the elderly in any way or form to not put them at any unnecessary risk.

To find what the target group was struggling with the most, a survey was put out. The survey was spread to family and/or caregivers of elderly with a decreased mobility living alone. As a result of this survey, it was found that the target group was often struggling with electronic devices and their remote controls. The buttons were small, high in number and their function was hard to remember.

Already existing technologies to battle this problem were often not very elderly friendly and left room for improvement. Because of the existing potential technologies that were found, it was decided to use eye tracking technology so that elderly could operate a device with only their eyes and would not need any remote controls.

Using the eye tracking technology and a laptop, a prototype was realized to test the potential of the target group using such a device. However, because of the Covid-19 virus outbreak, testing the prototype on the target group was not possible and therefore there was no possibility to get the most accurate results. The prototype was therefore tested on people below the age of 60 who were told to imagine being an elderly person. The testing was done in three phases and the prototype was adjusted after every testing cycle.

For the prototype, the buttons were made big and simplistic so that elderly people would always understand their function without explanation. Because of this, the function of the buttons was always clear during the testing. Furthermore, to perform any task using the device, 2 steps would need to be done. First looking a couple of seconds at the task and then a couple of seconds at the green button. This way, accidental executions of a task are minimized, and the elderly will not panic because of it. A help button and a reset button were added to help the elderly person if they were ever confused while using the product. The help button gives an explanation of how to use the product and the reset button stops everything and reset the program.

As a result, it can be concluded that the prototype shows potential for elderly people to use. The eye tracking is accurate, and it is easy to use. Using the technology in combination with other IoT devices can increase the quality of life for an elderly person unable to do daily tasks by themself. Not having to ask others for help will decrease their feeling of powerlessness and will therefore decrease the chance of them getting lonely.

9. Discussion

In the discussion section of the report the results will be analyzed and discussed where there was room for improvement.

When spreading the survey, it was not quite clear yet what the preferable outcome was. Because of this, not all the questions were as useful as they could have been and if they were more directed towards a single goal, the information gathered would be even more valuable.

Due to the Covid-19 virus outbreak it was not possible to contact the target-group for either interviews or user testing. Because of this, testing was done on people between the age of 20 and 50 years old. Even though this can have some benefits, like them being more capable of finding obvious flaws, testing on the actual user-group is important to find mistakes that are not easily discovered. This makes the results of the testing not 100% accurate and leaves room for improvement whenever it is possible to test again.

Furthermore, even though the testing of the prototype was done consistently and accurately, the way the prototype was used is not the way the eventual product is intended to be used. During testing everything was stationary and in optimal conditions. In an actual use scenario, the conditions might not be optimal and therefore the prototype might show different results. This could have been tested in a wider variety.

As was mentioned the Arduino part of the prototype was only used during the presentation of the product because it would only distract the users during user testing. However, using the Arduino during the user testing could have brought up other problems or made the prototype clearer because the user would see what their actions would do. The testing might therefore not be complete. Other than that, that prototype was also used on a laptop rather than a tablet as was intended for the final product. This means the users were not holding anything and this will make a difference.

Lastly, because the prototype aims to solve the loneliness by reducing the powerlessness experienced by elderly, it becomes difficult to measure the results of a solution. Measuring something as loneliness is difficult and not always accurate, and it is therefore difficult to determine the effects a product like the one in this report has on the loneliness among elderly. Besides, this effect can only be measured in the long term.

10. Recommendation

As the product was only developed into a prototype, there is still room for improvement. The recommendations for Ecare and future researchers will be given in this section.

Firstly, to discover the true potential of eye tracking for elderly people, testing will need to be done with people in the actual user group. Because of the Covid-19 virus that was not possible while doing this research. When in the future this is possible again testing on these elderly is recommended to find any problems that were not found while testing on people not in the target group.

Secondly, further testing needs to be done with the eye tracker itself to discover what the possibilities are and where the limits of the device lie. This is important to know if the eye tracker is used in actual tablet form and might move around a lot while being used. It needs to still give accurate results. In the same way more testing needs to be done with different kinds of people with different kinds of eyes or using the device in the dark.

Lastly, to realize a product like this, partnerships would need to be made. Developing a new eye tracking device would be extremely unpractical so partnering up with Tobii could be a possibility to use their eye trackers. In the same way a partnership with Google could be made to use their Home systems and smart devices in combination with the eye tracking device. Then Ecare could simply write the code for the program and let other companies do the manufacturing. This way, the product is feasible and not one company needs to produce everything from scratch.

Furthermore, it is recommended to continue experimenting with using eye tracking for elderly people. The technology shows a lot of potential and could mean a big improvement for elderly people in general. Using this technology to help the elderly feel in control can truly lower their feeling of powerlessness and therefore decrease the risk of them getting lonely.

11. References

[1] K. Yang and C. Victor, "Age and loneliness in 25 European nations," *Ageing Soc.*, vol. 31, no. 8, pp. 1368–1388, Nov. 2011, doi: 10.1017/S0144686X1000139X.

[2] J. De Jong Gierveld, "A review of loneliness: Concept and definitions, determinants and consequences," *Reviews in Clinical Gerontology*, vol. 8, no. 1. Cambridge University Press, pp. 73–80, 1998, doi: 10.1017/S0959259898008090.

[3] L. Couture, "Loneliness Linked to Serious Health Problems and Death Among Elderly," *Activities, Adaptation and Aging*, vol. 36, no. 3. Taylor & Francis Group , pp. 266–268, Jul-2012, doi: 10.1080/01924788.2012.708846.

[4] A. S. Cornwell, J. Y. Liao, A. M. Bryden, and R. F. Kirsch, "Standard task set for evaluating rehabilitation interventions for individuals with arm paralysis.," *J. Rehabil. Res. Dev.*, vol. 49, no. 3, pp. 395–403, 2012, doi: 10.1682/jrrd.2011.03.0040.

[5] M. C. S. De Minayo and F. G. Cavalcante, "Suicide attempts among the elderly: A review of the literature (2002/2013)," *Cienc. e Saude Coletiva*, vol. 20, no. 6, pp. 1751–1762, 2015, doi: 10.1590/1413-81232015206.10962014.

[6] "Eenzaamheid in Nederland." [Online]. Available: https://www.cbs.nl/nl-nl/achtergrond/2016/38/eenzaamheid-in-nederland. [Accessed: 26-Mar-2020].

[7] D. G. Weeks and & Bragg, "Self Report Measures for Love and Compassion Research: Loneliness and Interpersonal Problems."

[8] M. Nijhuis, "Creating a Google Home System Agent to reduce loneliness among older adults," 2019.

[9] A. P. Bowling, R. J. Edelmann, J. Leaver, and T. Hoekel, "Loneliness, mobility, well-being and social support in a sample of over 85 year olds," *Pers. Individ. Dif.*, vol. 10, no. 11, pp. 1189–1192, 1989, doi: 10.1016/0191-8869(89)90085-8.

[10] K. J. Smith and C. Victor, "Typologies of loneliness, living alone and social isolation, and their associations with physical and mental health," *Ageing Soc.*, vol. 39, no. 8, pp. 1709–1730, Aug. 2019, doi: 10.1017/S0144686X18000132.

[11] E. E. Beals, "Emotional Benefits of Dog Ownership: Impact of the Presence of a Pet Dog on Owners‟ Responses to Negative Mood Induction," 2009.

[12] D. C. Carr, M. G. Taylor, N. R. Gee, and N. Sachs-Ericsson, "Psychological Health Benefits of Companion Animals Following a Social Loss," *Gerontologist*, vol. 60, no. 3, pp. 428–438, Apr. 2020, doi: 10.1093/geront/gnz109.

[13] C. Dransart, P. Janne, and M. Gourdin, "Companion animals and pets: An underestimated medico-psychological support?," *Ann. Med. Psychol. (Paris).*, vol. 178, no. 2, pp. 145–149, Feb. 2020, doi: 10.1016/j.amp.2018.08.023.

[14] L. Powell *et al.*, "Companion dog acquisition and mental well-being: A community-based three-arm controlled study," *BMC Public Health*, vol. 19, no. 1, Nov. 2019, doi: 10.1186/s12889-019-7770-5.

[15] K. Black, “The Relationship Between Companion Animals and Loneliness Among Rural Adolescents,” *J. Pediatr. Nurs.*, vol. 27, no. 2, pp. 103–112, Apr. 2012, doi: 10.1016/j.pedn.2010.11.009.

[16] L. A. Van Der Heide, C. G. Willems, M. D. Spreeuwenberg, J. Rietman, and L. P. De Witte, “Implementation of CareTV in care for the elderly: The effects on feelings of loneliness and safety and future challenges,” in *Technology and Disability*, 2012, vol. 24, no. 4, pp. 283–291, doi: 10.3233/TAD-120359.

[17] L. Van Der Heide, M. D. Spreeuwenberg, C. G. Willems, L. De Witte, and J. Rietman, “The effects of CareTV on feelings of loneliness and safety in frail elderly,” in *Assistive Technology Research Series*, 2011, vol. 29, pp. 96–103, doi: 10.3233/978-1-60750-814-4-96.

[18] P. K. Jonason, G. D. Webster, and A. E. Lindsey, “Evolutionary Psychology Solutions to the Problem of Diminished Social Interaction.”

[19] “Physical impairment definition and meaning | Collins English Dictionary.” [Online]. Available: https://www.collinsdictionary.com/dictionary/english/physical-impairment. [Accessed: 19-Apr-2020].

[20] S. A. Kagwa, A.-M. Boström, C. Ickert, and S. E. Slaughter, “Optimising mobility through the sit-to-stand activity for older people living in residential care facilities: A qualitative interview study of healthcare aide experiences,” *Int. J. Older People Nurs.*, vol. 13, no. 1, p. e12169, Mar. 2018, doi: 10.1111/opn.12169.

[21] V. Gitelman, F. Pesahov, R. Carmel, and S. Chen, “The Use of Mobility Scooters by the Elderly - A Feasibility Study in Israel,” in *Transportation Research Procedia*, 2016, vol. 14, pp. 2324–2333, doi: 10.1016/j.trpro.2016.05.249.

[22] R. H. Krishnan and S. Pugazhenthi, “Mobility assistive devices and self-transfer robotic systems for elderly, a review,” *Intelligent Service Robotics*, vol. 7, no. 1. Springer, pp. 37–49, 22-Jan-2014, doi: 10.1007/s11370-013-0142-6.

[23] “PARO Therapeutic Robot.” [Online]. Available: http://www.parorobots.com/index.asp. [Accessed: 18-Apr-2020].

[24] S. Y. Kim, Y. H. Oh, and D. Y. Ju, “A Study on the Design of Companion Robots Preferred by the Elderly,” in *Advances in Intelligent Systems and Computing*, 2020, vol. 962, pp. 104–115, doi: 10.1007/978-3-030-20467-9_10.

[25] “Google Home - Slimme speaker en assistent voor in huis - Google Store.” [Online]. Available: https://store.google.com/nl/product/google_home. [Accessed: 18-Apr-2020].

[26] “Amazon.com: Echo (3rd Gen) - Smart speaker with Alexa - Twilight Blue: Amazon Devices.” [Online]. Available: https://www.amazon.com/all-new-Echo/dp/B07NFTVP7P?th=1. [Accessed: 19-Apr-2020].

[27] “HomePod - Apple.” [Online]. Available: https://www.apple.com/homepod/. [Accessed: 19-Apr-2020].

[28] W. Moyle, “The promise of technology in the future of dementia care,” *Nat. Rev.*

Neurol., vol. 15, no. 6, pp. 353–359, Jun. 2019, doi: 10.1038/s41582-019-0188-y.

[29] N. Goonawardene, X. P. Toh, and H. P. Tan, "Sensor-driven detection of social isolation in community-dwelling elderly," in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2017, vol. 10298, pp. 378–392, doi: 10.1007/978-3-319-58536-9_30.

[30] Marques M.R., Raymundo T.M., and Santana C.S., "Use of sensors systems to monitor the mobility of elderly," *J. Phys. Conf. Ser.*, vol. 477, Dec. 2013.

[31] X. Y. Su, M. Li, S. F. Lu, Y. Zhou, P. F. Liu, and N. Zhong, "An eye tracking study on visual search and browse strategies of elderly people on web pages," in *Applied Mechanics and Materials*, 2014, vol. 556–562, pp. 6154–6158, doi: 10.4028/www.scientific.net/AMM.556-562.6154.

[32] "Tobii Eye Tracker 4C for PC Gaming. Buy Now at €169 - Tobii Gaming." [Online]. Available: https://gaming.tobii.com/tobii-eye-tracker-4c/. [Accessed: 13-May-2020].

[33] "Assistive technology for communication/AAC - Tobii Dynavox." [Online]. Available: https://www.tobiidynavox.com/. [Accessed: 14-May-2020].

[34] A. F. Klaib, N. O. Alsrehin, W. Y. Melhem, and H. O. Bashtawi, "IoT smart home using eye tracking and voice interfaces for elderly and special needs people," *J. Commun.*, vol. 14, no. 7, pp. 614–621, Jul. 2019, doi: 10.12720/jcm.14.7.614-621.

[35] "Devices, Software and Accessories for Assistive Technology & AAC - Tobii Dynavox." [Online]. Available: https://www.tobiidynavox.com/products/. [Accessed: 02-Jul-2020].

[36] "What is Artificial Intelligence? How Does AI Work? | Built In." [Online]. Available: https://builtin.com/artificial-intelligence. [Accessed: 20-Apr-2020].

[37] "THE INTERNET OF THINGS | meaning in the Cambridge English Dictionary." [Online]. Available: https://dictionary.cambridge.org/dictionary/english/internet-of-things. [Accessed: 19-Apr-2020].

[38] "Virtual Reality | Meaning of Virtual Reality by Lexico." [Online]. Available: https://www.lexico.com/definition/virtual_reality. [Accessed: 19-Apr-2020].

[39] L. Appel *et al.*, "Older Adults With Cognitive and/or Physical Impairments Can Benefit From Immersive Virtual Reality Experiences: A Feasibility Study," *Front. Med.*, vol. 6, Jan. 2020, doi: 10.3389/fmed.2019.00329.

[40] "Pokémon GO." [Online]. Available: https://pokemongolive.com/en/. [Accessed: 19-Apr-2020].

[41] "Microsoft HoloLens | Mixed reality-technologie voor bedrijven." [Online]. Available: https://www.microsoft.com/nl-nl/hololens. [Accessed: 19-Apr-2020].

[42] "Informal Caregiver Law and Legal Definition | USLegal, Inc." [Online]. Available: https://definitions.uslegal.com/i/informal-caregiver/. [Accessed: 14-May-2020].

[43] "Processing.org." [Online]. Available: https://processing.org/. [Accessed: 22-Jun-2020].

[44] “Welcome to Python.org.” [Online]. Available: https://www.python.org/. [Accessed: 22-Jun-2020].

[45] “Web Design 101: How HTML, CSS, and JavaScript Work.” [Online]. Available: https://blog.hubspot.com/marketing/web-design-html-css-javascript. [Accessed: 22-Jun-2020].

[46] “Arduino Uno Rev3 | Arduino Official Store.” [Online]. Available: https://store.arduino.cc/arduino-uno-rev3. [Accessed: 03-Jul-2020].

[47] “Gaze Point - Tobii Dynavox.” [Online]. Available: https://www.tobiidynavox.com/software/free-resources/gaze-point-1/. [Accessed: 22-Jun-2020].

[48] “Educared | Home.” [Online]. Available: https://www.educared.nl/. [Accessed: 03-Jul-2020].

12. Appendices

12.1 Appendix A: Online Survey

Beste mevrouw, meneer,

Allereerst bedankt voor uw tijd.

Mijn naam is Rudolf Lok en ik studeer Creative Technology aan de UT in Enschede.
Binnen mijn Bachelor afstudeerproject wil ik technologie ontwikkelen die ouderen kan helpen die door leeftijdsgebonden lichamelijke beperkingen, zichzelf eenzamer zijn gaan voelen.
Oftewel, ouderen die zichzelf niet meer kunnen redden doordat ze minder goed kunnen lopen of dingen kunnen pakken en daardoor extra zorg nodig hebben.

Hierbij gaat het vooral om alleenwonende ouderen, zowel in een huis als in een verzorgingscomplex.
Bent u mantelzorger of familie van een alleenwonende ouder die minder mobiel is?
Dan wil ik u vragen om deze vragenlijst in te vullen. Dit zal mij enorm te helpen in mijn onderzoek.

Het invullen van de vragenlijst kost maximaal 10 minuten.

Deelname aan deze online vragenlijst is geheel vrijwillig en u kunt zich op elk gewenst moment terugtrekken uit dit onderzoek. Om uw privacy te beschermen wordt er op geen enkele wijze vertrouwelijke informatie over u naar buiten gebracht. Uw gegevens worden anoniem gemaakt en daardoor kan ik de data wel onderzoeken, zonder ik uw persoonsgegevens weet. De vragenlijst is dus volledig anoniem, tenzij u aan het einde uw email wilt invullen voor verder contact.

Voor eventuele vragen kunt u mailen naar: r.m.lok@student.utwente.nl

Het invullen van de vragenlijst kost maximaal 10 minuten.
Deelname aan deze online vragenlijst is geheel vrijwillig en u kunt zich op elk gewenst moment terugtrekken uit dit onderzoek. Om uw privacy te beschermen wordt er op geen enkele wijze vertrouwelijke informatie over u naar buiten gebracht. Uw gegevens worden anoniem gemaakt en daardoor kan ik de data wel onderzoeken, zonder ik uw persoonsgegevens weet. De vragenlijst is dus volledig anoniem, tenzij u aan het einde uw email wilt invullen voor verder contact.
Voor eventuele vragen kunt u mailen naar: r.m.lok@student.utwente.nl

1. **Bent u familie en/of mantelzorger van een alleenwonende ouder (geweest)?**
2. **In welke leeftijds categorie valt de persoon in kwestie?**
3. **Maakt de persoon in kwestie gebruik van hulpmiddelen om zich voort te kunnen bewegen, zoals een rollator of rolstoel?**
4. **Is de persoon in kwestie eenzamer doordat zijn of haar mobiliteit is verminderd?**
5. **Heeft de persoon in kwestie moeite met het omgaan met zijn of haar verminderde mobiliteit?**
6. **In welke hoeveelheid heeft de persoon in kwestie moeite met de volgende dagelijkse taken? Aankleden, wassen, koken, traplopen, deur opendoen, apparaten bedienen**
7. **Heeft de persoon in kwestie moeite met het gebruik van afstandsbedieningen? (Tv, radio, licht, stoel, etc.)**
8. **Zo ja, waarom heeft hij/zij hier moeite mee?**

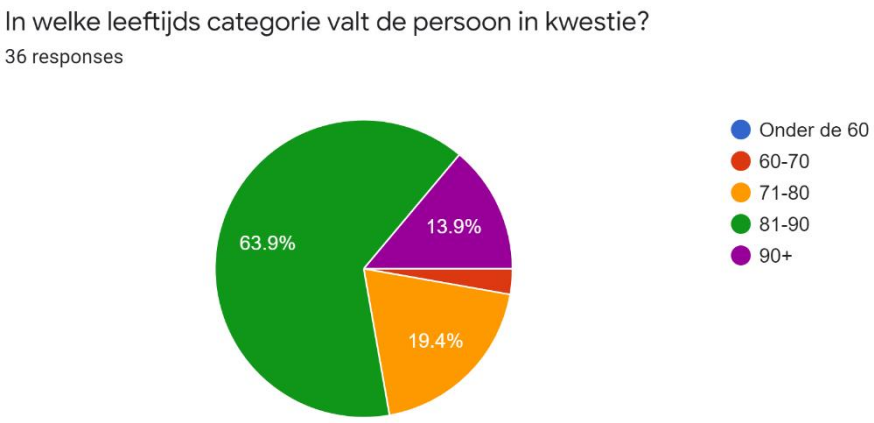
9. **Selecteer van welke Smart apparaten de persoon in kwestie gebruik maakt.**
10. **Waar heeft de persoon in kwestie het meeste last van door de verminderde mobiliteit?**

Hartelijk bedankt voor het invullen van deze vragenlijst, dit helpt mij enorm bij mijn onderzoek.
Als u nog vragen of opmerkingen heeft mail mij dan op …
Bent u te benaderen voor verdere vragen over een potentiele oplossing of product?
Vul dan alstublieft hieronder uw email adres in.
Uw email adres zal uitsluitend gebruikt worden gebruikt voor eventuele vragen binnen dit onderzoek en zal na de afloop worden verwijderd.
Uw email adres zal niet worden doorgespeeld aan derden.

12.2 Appendix B: Online Survey Responses

Question 1:

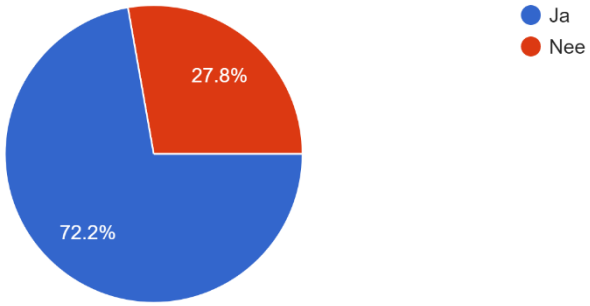
Question 2:



Question 3:

Maakt de persoon in kwestie gebruik van hulpmiddelen om zich voort te kunnen bewegen, zoals een rollator of rolstoel?

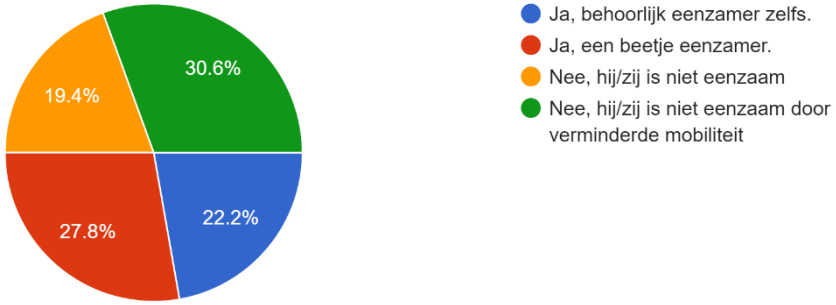
36 responses



Question 4:

Is de persoon in kwestie eenzamer doordat zijn of haar mobiliteit is verminderd?

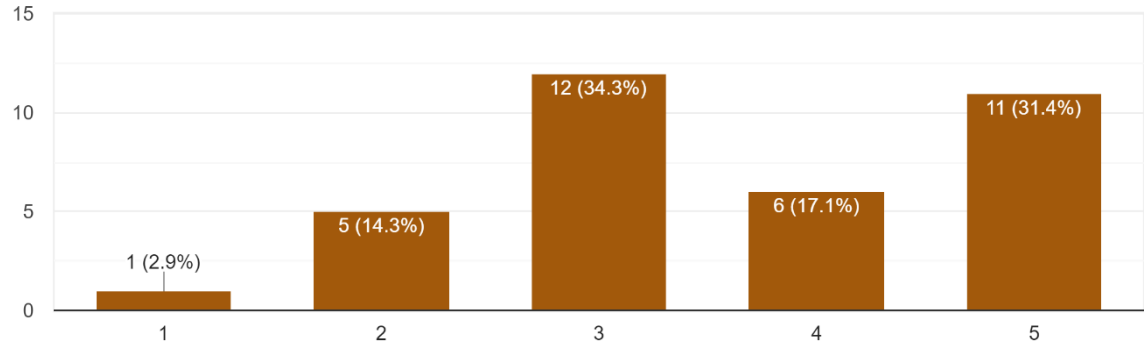
36 responses



Question 5:

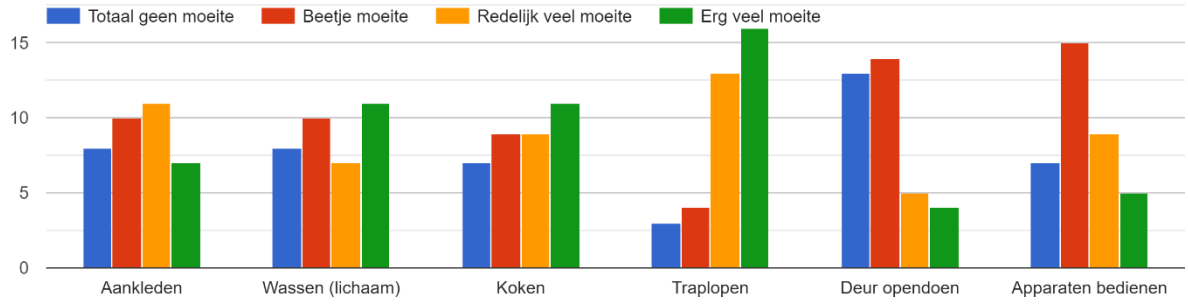
Heeft de persoon in kwestie moeite met het omgaan met zijn of haar verminderde mobiliteit?

35 responses



Question 6:

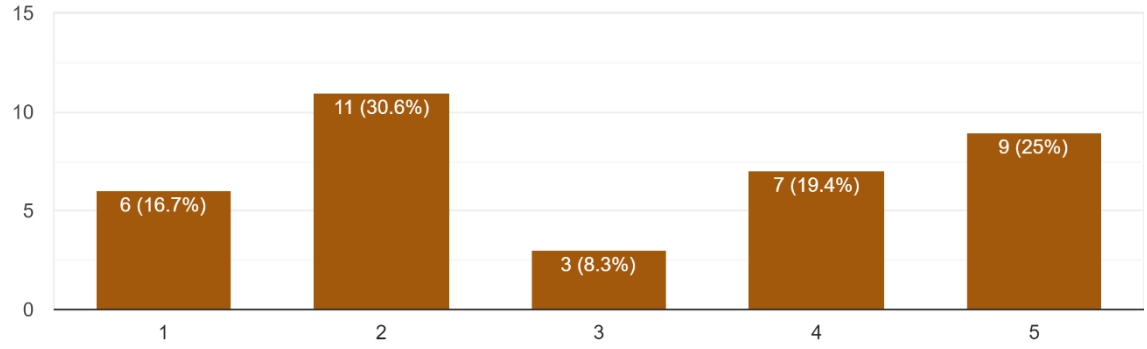
In welke hoeveelheid heeft de persoon in kwestie moeite met de volgende dagelijkse taken?



Question 7:

Heeft de persoon in kwestie moeite met het gebruik van afstandsbedieningen? (Tv, radio, licht, stoel, etc.)

36 responses



Question 8:

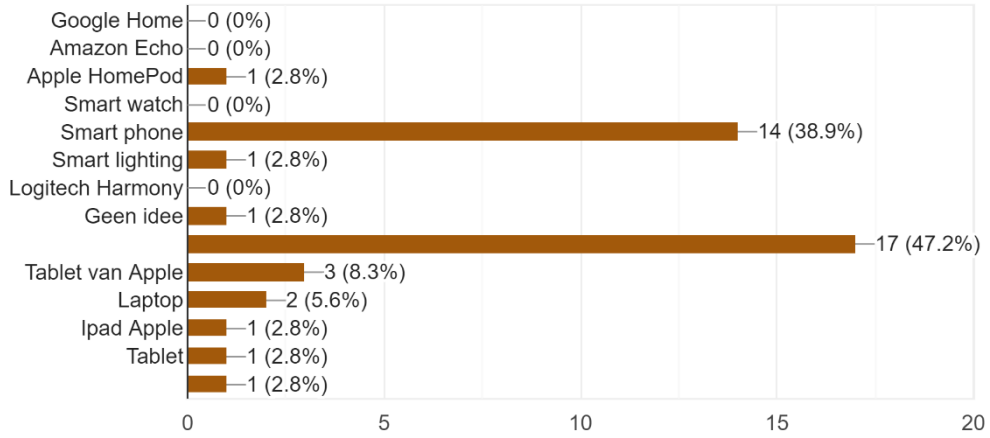
Zo ja, waarom heeft hij/zij hier moeite mee? 19 responses

Begrijpt het niet / motoriek
Kan niet onthouden waar welk knopje voor dient.
Vergeet welke afstandsbediening waar voor is en welke knopjes gebruikt moeten worden.
Ze zijn voor haar onbegrijpelijk, en de knopjes zijn moeilijk te bedienen, omdat ze te klein zijn of te gevoelig (dan wordt er te lang op gedrukt).
Kleine knopjes en zoveel
Beperking aan haar handen i.v.m. spierziekte
Snapt het niet
Te veel mogelijkheden . Meerdere afstandsbedieningen in gebruik.
Vaak veel en kleine knoppen, niet altijd duidelijk wat de functie per knop is.

Ze weet niet meer welk knopje waarvoor is. Ook na elke keer voordoen. Druk vaak op verkeerde knop en kan dat dan niet meer herstellen.
Ze kan slecht onthouden hoe het moet.
Mijn moeder had Alzheimer dus apparaten bedienen was ingewikkeld voor haar, naast minder mobiel zijn.
Reset etc of zelf storing verhelpen is ladtlastig ig
Onthouden
Vergeet welke afstandsbediening bij welk apparaat hoort.
Op deze hoge leeftijd is het allemaal veel om te verwerken, lastig om nieuwe dingen te onthouden.
Ze denkt dat het ingewikkeld is en heeft de neiging dan er niet aan te beginnen. Het is niet ingewikkeld, maar psychologisch trekt mijn moeder het niet: het zal wel niet gaan.
Welk knopje waarvoor dient en dit onthouden

Question 9:

Selecteer van welke Smart apparaten de persoon in kwestie gebruik maakt.
36 responses



Question 10:

Waar heeft de persoon in kwestie het meeste last van door de afgenomen mobiliteit? 36 responses

Inleveren onafhankelijkheid
Lopen
Verminderde contacten
Minder contact, daardoor minder grip op de wereld / meer eenzaamheid
Moeite met dingen oprapen
met de afstandsbediening van televisie en radio
Verplaatsingen naar winkelcentra
nvt
Niet meer kunnen doen wat ze zou willen doen.

Niet kunnen bewegen, lopen, wandelen en zelf zorg
Zelfstandigheid
Verlies van eigen regie op het leven.
Langzaam steeds meer uit handen moeten geven. Het huishouden wat te veel wordt, boodschappen doen wordt zwaar er cetera.
Dat alles lang duurt en om hulp moet vragen
Afhankelijk zijn van anderen
Amputatie tenen
Niet meer kunnen fietsen
Heeft sowieso meer te maken met het feit alleen te zijn en steeds graag in contact met anderen te willen zijn. Dus de eenzaamheid komt meer voort uit het feit dat ze niet makkelijk alleen kan zijn. Veel behoeft aan aandacht en contact. Dit heeft niet te maken met verminderde mobiliteit. Deze wordt wel ingezet wanneer het goed uit komt of ze ergens geen zin in heeft.
Met een binnen- en een buiten rollator gaat het lopen redelijk goed. Meeste last van en ontkenning dat ze niet alles meer kan. Wordt boos als anderen willen helpen.
Risico op vallen. Dat gebeurt soms.
Kwijtraken van zelfstandig zijn dus hulp nodig hebben
Sociale zelfstandigheid
Zelfstandig
Geen zelfstandigheid meer, afhankelijk van anderen om naar buiten te kunnen
Sociale contacten
Weinig sociale contacten
Minder zelfstandigheid
Zich niet meer zelfstandig kunnen bewegen in en buiten het huis.
Mensen bezoeken
Opzien tegen autorijden naar verre plaatsen, of plaatsen die ze niet goed kent. Bang voor files of wind en regen. Dus daardoor minder snel in de auto stappen.
Verlies van zelfstandigheid en controle over zijn eigen leven.
Langere afstanden afleggen te voet of per fiets.

12.3 Appendix C User test 2 interviews

Is de functie van de tablet in deze opstelling duidelijk?

Participant 1:

"Op zich was het wel duidelijk, je geeft het wel netjes aan met de vierkantjes die groter worden, maar in het begin had ik niet door hoelang je moest kijken naar een knop. Ik vond het ook wel te lang eigenlijk, hoelang je moest kijken. Je raakt te snel afgeleid en je wil stiekem weg kijken. En dan reset het programma."

Participant 2:

"Ja, het is even wennen voor het eerst natuurlijk. Maar ja, het is vrij simpel opgezet. Het is goed te begrijpen."

Participant 3:

"Ja, maar het is denk ik wel belangrijk dat je weet in de ruimte of je deur nou open staat of dicht, want hij zegt van goh om aan of uit te doen. En dan denk ik, ja wat ben ik nou eigenlijk aan het doen. Dat komt misschien ook omdat je niet fysiek in die ruimte aanwezig bent."

Participant 4:

"Op zich wel, maar ik kan mij voorstellen dat ouderen misschien niet echt snappen wat er precies gebeurt als je naar zo'n knop kijkt Ze zijn misschien bang dat ze kijken en dat de deur dan opeens open gaat."

Was het eenvoudig om te tablet te bedienen, nadat u uitleg had gekregen hoe het werkt?

Participant 2:

"Ja, dat dan gaat het wel goed. Misschien dat je inderdaad nog wel iets kan doen met het activeren omdat je elke knop eerst moet activeren en dan net zo lang op die groene kijken. Misschien dat die nog iets korter zouden kunnen halen."

Participant 3:

"Ja vond ik op zich wel. Ik kon inderdaad gewoon naar de groene knop kijken en werd de functie of geactiveerd of gedeactiveerd."

Voelde u enige vorm van ongemak tijdens het testen? Kunt u dit ongemak omschrijven?

Participant 1:

"Nee, op zich niet, buiten dat ik vind dat je te lang moet kijken."

Participant 2:

"Het duurt wel lang voordat het vierkantje is gevuld, ik was wel snel afgeleid en dan reset het laden."

Participant 4:

"Wat ik mij afvraag is of je wel normaal kunt knipperen, want je hebt de neiging om je ogen open te houden terwijl dat eigenlijk misschien helemaal niet nodig is. Misschien kun je dat laten weten dat het oké is om te knipperen en dat soort dingen."

Wat vond u van de tijdsduur dat u naar een knop moest kijken?

Participant 3:

"Maar ik vond het eigenlijk wel prima, ik had niet het idee dat ik lang aan het wachten was. Maar ik had ook niet het idee van goh, ik kijk nu naar de groene knop en het is patsboem verandert, dus ik denk dat dat wel een snelheid is die ook bij ouderen mensen past."

Participant 4:

"Voor mijn gevoel duurde het lang maar aan de andere kant als je de hele dag zit en dan 3 seconden moet kijken dan ja. Ouderen hebben ook een veel lagere verwerking snelheid dus ik denk dat het hartstikke goed is, juist voor ouderen dat het niet te snel is."

Noem, indien mogelijk, 3 positieve punten van het design.

Participant 1:

"Het is heel simpel, ik denk dat het voor ouderen geschikt is. De plaatjes zeggen gewoon welke handling daarachter zit dus dat is gewoon duidelijk."

Participant 2:

"Het design simpel opgezet. Ja, ik denk dat dat voor iemand die echt voor het eerst naar kijkt, dat gewoon echt wel duidelijk is. "

Participant 3:

"Ik vind het op zich wel overzichtelijk met die kaders. Ik denk dat ouderen het prima vinden qua vormgeving. Zelf zou ik het iets fancier willen."

Participant 4:

"Het zijn lekker grote letters dus dat is goed. Het is gewoon duidelijk, maar ik weet niet hoe dat voor ouderen is."

Noem, indien mogelijk, 3 negatieve punten van het design.

Participant 1:

"Die heb ik niet. Ik denk inderdaad dat je dit moet testen met ouderen en kijken hoelang zij hun focus op een bepaald item kunnen houden, dat is het belangrijkste. Misschien dat je ze dat ook kunt aanleren met een testje ofzo. Je zou van te voren een kalibratie kunnen doen en ze eerst naar een ding laten kijken en dan naar twee, en dan kijken hoe lang ze focus kunnen houden"

Participant 2:

"Dat dat je wat langer moet kijken, maar kan me voorstellen dat iemand anders dan misschien wel behoefte aan heeft."

Participant 3:

"De stijl spreekt mij niet echt aan"

Participant 4:

"News is misschien beetje raar, weet niet wat ik me daarbij moet voorstellen. En Engelse taal is misschien wat lastig voor ouderen. Hij volgt ook de hele tijd je ogen en daarom gebeurt er wel veel. Het flikkeren is misschien wat storend. Het maakt wel uit wat de gebruiker prettig vind, misschien kunnen ze het zelf aangeven."

Zou u iets veranderen aan het design? Waarom wel/niet?

Participant 1:

"Ik denk, je zou het grafisch nog iets mooier kunnen maken."

Participant 2:

"Nee, ik denk het niet, want het is gewoon simpel opgezet. En ja, het is gewoon meteen duidelijk."

Participant 3:

"Misschien dat je de items alfabetisch kunt neerzetten of dat je ze zelf ergens neer kunt zetten. Misschien afhankelijk van je dagindeling, als je bijvoorbeeld altijd 's ochtends iemand voor de deur hebt staan dus de deur open moet doen en de lichten aan. Of dan 's middags TV gaat kijken."

Denkt u dat het apparaat geschikt zal zijn voor gebruik door ouderen? Waarom wel/niet?

Participant 1:

"Ik denk wel dat het dat het potentie heeft. Mensen die wat minder mobiel zijn, ik denk dat die het wel fijn vinden."

Participant 2:

"Ja, ik heb nog een vrij technische opa, maar ik heb ook nog een andere opa en die zou dit wel makkelijk vinden. Dan merk je ook heel erg dat die aan het zoeken is en dan kan het met elkaar echt heel lang duren."

Participant 3:

"Ik denk dat dat er heel handig is voor oudere mensen, maar ik ben ook wel van mening dat het heel goed is om oudere mensen gewoon nog in actieve verstand hebben, dus om ze zelf naar de deur te laten lopen waar mogelijk. Als je ze altijd in de stoel laat zitten dan is e rook geen verbetering van de mobiliteit. Maar ik denkt dat in het kader van zelfredzaamheid het mensen wel kan helpen om wat langer thuis te blijven wonen."

Stel u kent een alleenwonende ouder die wat minder mobiel is, zou u dan overwegen dit apparaat aan te schaffen? Waarom wel/niet?

Participant 1:

"Ja, dat lijkt me wel handig, ja."

Participant 3:

"Ja, dat denk ik op zich wel. Op het moment dat ik constateer dat die persoon problemen heeft met bijvoorbeeld het aan en uitzetten van de televisie of dat het best ver weg is. Of als die person op de bank zit en het wel fijn vind om 's avonds om tien uur buiten het licht aan te doen zonder naar buiten te hoeven."

Participant 4:

"Voor mijn schoonmoeder was het heel erg handig geweest."

Heeft u nog aanvullende opmerkingen of feedback waarmee ik het apparaat kan verbeteren?

Participant 3:

"Ik vind het een hele leuke toepassing, waarvan ik denk van nou volgens mij is het binnen de ouders welkom dat er gewoon gedacht wordt om te kijken waar je met zorg technologie het leven van oudere mensen zo aangenaam mogelijk kunt maken."

Participant 4:

"Als je er ook mee zou kunnen bellen, dat zou heel handig zijn. Misschien ook nog een noodknop. Uitbreidingen zouden handig zijn."

12.4 Appendix D User test 3 interviews

Is de functie van de tablet in deze opstelling duidelijk?

Participant 5:

"Ja, het was wel duidelijk, ja, wel duidelijk instructies, gewoon in het begin. Ik vond het wel met die reddingsboei daarvan wist ik eigenlijk niet zo goed wat ik moest verwachten. Maar toen ik het horde dacht ik: o hij legt het system uit."

Participant 6:

"Op zich wel, dat kwam ook wel door de uitleg. Als je gewoon ergens naar kijkt, dan zegt die dan ook wel wat je moet doen. Dus het was duidelijk."

Participant 7:

"Relatief duidelijk zeker, ik kan me voorstellen dat als die werkt, dat nog duidelijker wordt, maar het concept zeker duidelijk."

Participant 8:

"Ja, dat was eigenlijk helemaal duidelijk. Wel op het begin nog wel eventjes even wennen omdat je moet alles met je ogen doen, dus ik ben je natuurlijk niet gewend, dus dat is eventjes even aftasten hoe dat werkt. Maar na de eerste twee opties had ik het volgens mij wel aardig door."

Participant 9:

"In het begin moest ik wel heel erg wennen want ik dacht moet ik nou wel met mijn hoofd bewegen of niet of alleen met mijn ogen. Maar als je het eenmaal door hebt is het duidelijk."

Voelde u enige vorm van ongemak tijdens het testen? Kunt u dit ongemak omschrijven?

Participant 5:

"Nou af en toe, volgens mij twee of drie keer dat ik een beetje met mn ogen knipperde of net iets weg keek dan begon die weer opnieuw. Dan dacht ik, huh, wat heb ik nou verkeerd gedaan."

Participant 6:

"Het percentage wat oploopt is voor mij niet per se nodig. Ook omdat het heel snel verandert, je ziet direct nummers oplopen als je er naar kijkt en het is voor mij niet per se heel relevant. Ook had ik na een poosje had ik het idee van. Ik wil eigenlijk niet op de groene knop hoeven drukken, want ik weet inmiddels wel hoe dat werkt."

Participant 7:

"Je merkt dat je wat bewuster wordt van waar je je ogen gaat plaatsen. En dat is normaal iets onderbewust denk ik."

Participant 8:

"De percentages liepen op en het vakje werd breder, maar soms dat pikte het programma dat niet helemaal op en dan denk je, kijk ik niet goed of.. Dan ga je aan jezelf twijfelen, dat zou nog iets verbeterd kunnen worden."

Participant 9:

"Het viel me dus op dat als ik knipper dat die één keer uitging, dat ik dan helemaal opnieuw moest kijken. Op zich duurt het wel lang voordat er iets gebeurt."

Wat vond u van de tijdsduur dat u naar een knop moest kijken?

Participant 5:

"Ja, wel prima denk ik. Ik denk dat het wel een mooie lengte is. Je hoeft niet heel lang te wachten en niet dat ik echt verveeld raakte, maar ik denk dat het voor ouderen al helemaal wel goed is."

Participant 6:

"Voor mij denk ik met iets te lang, dus ik zou wel nog iets sneller zou willen hebben, niet heel veel maar misschien een een halve seconde op seconde korter of zo. Voor ouderen denk ik wel dat het klopt, die mensen schrikken echt van elke actie die je doet. Maar er is ook nog de groene knop om ervoor te zorgen dat ze niet zomaar iets verkeerds doen."

Participant 7:

"Goed, ik vond het relatief smooth."

Participant 8:

"Ja, nou prima en ik denk dat dat een perfecte tijd om iets te kunnen realiseren."

Noem, indien mogelijk, 3 positieve punten van het design.

Participant 5:

"Het is gewoon heel simpel en duidelijk, ook met die groene knop weet je gewoon waar je moet kijken en ook met die percentages is het best wel duidelijk hoelang je moet wachten, en die gaan ook heel snel. Dus dat scheelt ook. Dat is beter dan als je gewoon, 1, 2, 3 ,4, 5 hebt.

Ik vond het ook best wel een nice stem, want meestal heb je dat dan die robot stem toch een beetje echt gemaakt is, maar ik vond deze goed klinken."

Participant 6:

"Het is heel eenvoudig, en het systeem laat je ook gewoon duidelijk zien wat aan staat en wat uit. Overal wordt heldere uitleg gegeven als je er naar kijkt en dat is handig. Ook dat je feedback krijgt van wat aan staat is handig te weten voor een persoon die misschien wel eens vergeet dat het licht ergens anders aan staat."

Participant 7:

"Ik denk dat het inderdaad wel een mogelijk oplossing is voor hun probleem, dat beperkte ouderen nog steeds hun dagelijkse dingen kunnen doen. In dit geval met media, zeker positief vernieuwend. Als je kijkt naar als een koppeling achter zit met bijvoorbeeld een Home functie. Ja, dat is hartstikke top, zeker positief en ik denk ook dat het relatief goed bedienbaar is en dat het in ieder geval wel duidelijk is van wat het kan doen."

Participant 8:

"Nou, de icoontjes zijn heel duidelijk, dus die weet wat er wat er gaat gebeuren. Dus dat vind ik heel positief en het is gewoon wel clean, dus niet te veel poespas. Duidelijke uitleg van je moet naar de groene knap als je iets bewerkstelligen. Ik vind het allemaal heel duidelijk, alleen zou ik de uitleg zo dan toch wat prominent in beeld laten komen, voor de eerste keer misschien en dat het daarna niet meer in beeld is."

Participant 9:

"Eenvoudig, maar nuttig. Niet te ingewikkeld, ziet er goed uit."

Noem, indien mogelijk, 3 negatieve punten van het design.

Participant 5:

"Ja, ik vond het stukje uitleggen wel echt een beetje lang. Ik kan me voorstellen als je oud bent dat je dan wel even denkt: oh, ik was er niet aan het opletten, wat heb je nou allemaal gezegd? Uiteindelijk kom je er wel uit, maar het is wel lang achterelkaar."

Participant 6:

"Ik vraag me wel bijvoorbeeld af hoe het dan werkt als je bijvoorbeeld het nieuws wel aanklikt, kun je dat dan ook weer makkelijk uitzetten. Ik vraag me af waar je dan dit moet hebben in huis om dat allemaal makkelijk in één keer te bedienen."

Participant 7:

"Kijk, de vraag is natuurlijk in hoeverre zo'n oudere nog zit te wachten om digitaal dingen te gaan bedienen of hoe ze verder daarmee komen. In de implementatie zou het enige wat in de praktijk blijkt dat zo'n oudere daar helemaal niet op zit te wachten. Dus dat is meer gedragsproblemen. Maar in theorie zou het heel goed kunnen werken."

Participant 8:

"Nee, eigenlijk niet, alleen vraag ik me wel af waar die reset functie dan voor is. Ja, dat zou misschien terugkomen in de uitleg, maar die heb ik dus gemist."

Participant 9:

"Misschien de kleur van de achtergrond, die springt er niet uit."

Zou u iets veranderen aan het design? Waarom wel/niet?

Participant 5:

"Ik zou misschien de reddingsboei veranderen in een i'tje ofzo. En hoort van hij gaat nu uit of hij gaat nu aan. Want nu moest je zelf opletten of iets aan stond of niet. Ik ben ook benieuwd of het ook werkt als het donker is, al helemaal als je de lichten wilt aan doen."

Participant 6:

"Ik zou misschien iets meer gebruik maken van contrast. Dat de achtergrond veranderd. Ik zou misschien de kleur van het vakje wat steeds groter wordt ook iets schreeuwender maken zodat je die niet over her hoofd ziet. Ook zou ik doen dat als je naar de uitleg kijkt, dat die dan laat zien wat je moet doen, dat je bijvoorbeeld twee oogjes ziet die staan bij de groene knop."

Participant 7:

"Ik denkt dat het simpel en duidelijk is en dat het juist de kracht is. Al helemaal voor iemand met beperkte kennis denk ik dat het vrij effectief is. Dus ik denk niet dat je veel moet veranderen."

Participant 8:

"Nee, als het voor een oudere doelgroep is, zou ik zeggen van, dit is een goeie opzet."

Denkt u dat het apparaat geschikt zal zijn voor gebruik door ouderen? Waarom wel/niet?

Participant 5:

"Dat lijkt me wel handig inderdaad, dan moet je wel kijken hoe ver je er van af kunt staan, anders zou je hem echt nog ergens kunnen ophangen, zo dat je vanuit je bed zo kunt bedienen."

Participant 6:

"Ja ik denk het wel. Het enige wat misschien lastig zou zijn is dat dit apparaat ergens zou moeten staan of als het een tablet is, dat het ook gekalibreerd blijft. Maar als het gewoon werkt dan denk ik dat het goed te doen is en ook al moeten mensen gewend raken dat het wel geschikt is"

Participant 8:

"Ik denk het wel, maar ze zijn wel wat minder digitaal vaardig dus ik denk wel dat even wennen is. Normaal moeten ze iets met de handen doen en met de ogen is vrij nieuw. Maar ik denk, als het eenmaal gewend zijn, dan zou het heel prettig zijn voor de voor de oudere generatie."

Participant 9:

"Ik denk het wel ja. Ik denk dat het voor veel gemak kan zorgen als je het anders niet kan. Als je niet hoeft op te staan uit een stoel, ik denk dat het de kwaliteit van leven wel omhoog kan halen. Het is best vervelend als je telkens iemand moet vragen van, wil je de deur dicht doen of kun je het licht in de kamer uit doen. Dat kunnen ze dan gewoon zelf."

Stel u kent een alleenwonende ouder die wat minder mobiel is, zou u dan overwegen dit apparaat aan te schaffen? Waarom wel/niet?

Participant 5:

"Ja, ik denk wel de opa van mijn partner is dement en die vergeet gewoon allemaal dingen. Dan lukt het niet om de tv aan te krijgen en dat is gewoon best wel wat gedoe. Dus ik zou dan wel proberen om te kijken of hij het begrijpt. Ik denk ook dat het wel fijn is om een stem te horen."

Participant 6:

"Ja, ik denk dat mijn opa zelf al te oud is, maar mijn ouders zouden wel baat hebben bij zo'n scherm. Als ze wat ouder zouden zijn dan zou ik het ze wel aanraden. Ook als je het apparaat een tijdje zou kunnen uitproberen zou dat wel een leuke optie zijn."

Participant 7:

"Ja, waarom niet? Ik zou er niet zoveel tegen zien als iemand echt slecht mobiel is en moeite heeft met tv en radio. Je kunt ook nog apparaten toevoegen en dan denk ik dat het zeker bij zou dragen."

Participant 8:

"Ja, dat dat denk ik wel, het kan voor de ouderen gewoon heel erg behulpzaam zijn. Voor ouderen om op een afstandje het licht gewoon aan of uit te kunnen doen."

Participant 9:

"Ik denk dat het wel handig is. Het moet dan iemand zijn die er wel een klein beetje handig en mobiel is, anders heeft het weinig zin. Maar ik zou het wel aanraden ja."

Heeft u nog aanvullende opmerkingen of feedback waarmee ik het apparaat kan verbeteren?

Participant 5:

"Ik ben wel benieuwd naar het resultaat."

Participant 6:

"Ik zou die stem laten inspreken door een echt persoon. Oude mensen pikken er snel uit dat het lijkt op een computer stem. Dus als je iemand vraagt met een rustige stem dan voelen ze meer herkenning. Dan is het wat meer persoonlijk."

Participant 7:

"Ik denk dat het nog wel breder te trekken. Niet alleen voor ouderen."

Participant 8:

"Het enige nadeel is wel, als je ouderen juist probeert te stimuleren om wat meer ook te bewegen. Kijk die die functie schakel je daar nu wel mee uit. Maar anderzijds om de zelfredzaamheid te bevorderen is het superhandig denk ik."

12.5 Appendix E Prototype final Processing code

12.5.1 Main class

```
import processing.serial.*; //import the Serial library
import processing.sound.*;

Serial myPort;  //the Serial port object
SoundFile[] soundFiles = new SoundFile[20];

String val;
String[] state = new String[10]; //that state of the buttons
// since we're doing serial handshaking,
// we need to check if we've heard from the microcontroller

int RectX, RectY, RectS, row1Y, row2Y, oncounter, offcounter, actionNr, buttonNr=0;
int hoverTint=200; //color when hovering over a button
int[] Tint = new int[10];
color[] statecolor = new color[10];

boolean firstContact = false;
boolean rectOver = false;
boolean circleOver = false;
boolean selection = false;
boolean[] statebool= new boolean[10];

PImage doorbtn, lightbtn, tvbtn, radiobtn, newsbtn, callbtn, helpbtn, greenbtn, redbtn;

Button doorBtn;
Button lightbulbBtn;
Button tvBtn;
Button radioBtn;
Button newsBtn;
Button callBtn;
Button helpBtn;
Button greenBtn;
Button redBtn;

void setup() {
 fullScreen();
 frameRate(45);
 surface.setAlwaysOnTop(true);
 imageMode(CENTER);
 rectMode(CENTER);

 myPort = new Serial(this, Serial.list()[1], 9600); //begin contact with the arduino
 myPort.bufferUntil('\n');

 //import all the images
 doorbtn = loadImage("data/doorbtn.png");
 lightbtn = loadImage("data/lightbtn.png");
 tvbtn = loadImage("data/tvbtn.png");
 radiobtn = loadImage("data/radiobtn.png");
 newsbtn = loadImage("data/newsbtn.png");
 callbtn = loadImage("data/callbtn.png");
 helpbtn = loadImage("data/helpbtnv2.png");
 greenbtn = loadImage("data/greenbtn2.png");
 redbtn = loadImage("data/redbtnv5.png");

 //create variables to allign the buttons
 RectX = width/8;
 RectY = height/32;
 RectS = 400;
 row1Y=9;
```

```
 row2Y=23;

 doorBtn = new Button(RectX, RectY*row1Y, doorbtn, 1);
 lightbulbBtn = new Button(RectX*3, RectY*row1Y, lightbtn, 2);
 tvBtn = new Button(RectX*5, RectY*row1Y, tvbtn, 3);
 radioBtn = new Button(RectX, RectY*row2Y, radiobtn, 4);
 newsBtn = new Button(RectX*3, RectY*row2Y, newsbtn, 5);
 callBtn = new Button(RectX*5, RectY*row2Y, callbtn, 6);
 helpBtn = new Button(0, 0, helpbtn, 9);
 greenBtn = new Button(RectX*7, RectY*16, greenbtn, 7);
 redBtn = new Button(0, 0, redbtn, 8);

 //import all the audio files
 soundFiles[0]  = new SoundFile(this, "data/audio/doorp1.wav");
 soundFiles[1]  = new SoundFile(this, "data/audio/doorp2.wav");
 soundFiles[2]  = new SoundFile(this, "data/audio/lightsp1.wav");
 soundFiles[3]  = new SoundFile(this, "data/audio/lightsp2.wav");
 soundFiles[4]  = new SoundFile(this, "data/audio/tvp1.wav");
 soundFiles[5]  = new SoundFile(this, "data/audio/tvp2.wav");
 soundFiles[6]  = new SoundFile(this, "data/audio/radiop1.wav");
 soundFiles[7]  = new SoundFile(this, "data/audio/radiop2.wav");
 soundFiles[8]  = new SoundFile(this, "data/audio/newsp1.wav");
 soundFiles[9]  = new SoundFile(this, "data/audio/newsp2.wav");
 soundFiles[10]  = new SoundFile(this, "data/audio/helpv2.wav");
 soundFiles[11]  = new SoundFile(this, "data/audio/reset.wav");
 soundFiles[12]  = new SoundFile(this, "data/audio/callp1.wav");
 soundFiles[13]  = new SoundFile(this, "data/audio/callp2.wav");
 //make all the buttons white at the start
 for (int i=0; i<10; i++) {
  Tint[i]=255;
 }
}

void draw() {
 background(180);
 doorBtn.drawImg(Tint[1]);
 lightbulbBtn.drawImg(Tint[2]);
 tvBtn.drawImg(Tint[3]);
 radioBtn.drawImg(Tint[4]);
 newsBtn.drawImg(Tint[5]);
 callBtn.drawImg(Tint[6]);
 helpBtn.drawImg(Tint[9]);
 greenBtn.drawImg(Tint[7]);
 redBtn.drawImg(Tint[8]);

 if (doorBtn.isOver())
 {
  //Tint[1]=hoverTint;
  if (doorBtn.isSelecting())
  {
   buttonNr=1;
   stopsound();
   soundFiles[0].play();
   selection=true;
   actionNr = 1;
  }
 } else if (lightbulbBtn.isOver())
 {
  //Tint[2]=hoverTint;
  if (lightbulbBtn.isSelecting())
  {
   buttonNr=2;
   stopsound();
```

```
    soundFiles[2].play();
    selection=true;
    actionNr = 3;
   }
  } else if (tvBtn.isOver())
  {
   //Tint[3]=hoverTint;
   if (tvBtn.isSelecting())
   {
    buttonNr=3;
    stopsound();
    soundFiles[4].play();
    selection=true;
    actionNr = 5;
   }
  } else if (radioBtn.isOver())
  {
   //Tint[4]=hoverTint;
   if (radioBtn.isSelecting())
   {
    buttonNr=4;
    stopsound();
    soundFiles[6].play();
    selection=true;
    actionNr = 7;
   }
  } else if (newsBtn.isOver())
  {
   //Tint[5]=hoverTint;
   if (newsBtn.isSelecting())
   {
    buttonNr=5;
    stopsound();
    soundFiles[8].play();
    selection=true;
    actionNr = 9;
   }
  } else if (callBtn.isOver())
  {
   if (callBtn.isSelecting())
   {
    buttonNr=6;
    stopsound();
    soundFiles[12].play();
    selection=true;
    actionNr = 13;
   }
  } else if (helpBtn.isOver())
  {
   if (helpBtn.isSelecting())
   {
    buttonNr=9;
    stopsound();
    soundFiles[10].play();
    reset();
   }
  } else if (greenBtn.isOver())
  {
   //Tint[7]=hoverTint;
   Tint[buttonNr]=hoverTint;
   if (greenBtn.isSelecting() && selection==true)
   {
    action(actionNr);
```

```
   }
  } else if (redBtn.isOver())
  {
   //Tint[8]=hoverTint;
   if (redBtn.isSelecting())
   {
    buttonNr=8;
    reset();
    stopsound();
    soundFiles[11].play();
   }
  } else
  {
   for (int i=0; i<10; i++) {
    Tint[i]=255;
    Tint[buttonNr]=hoverTint;
   }
  }
}

void reset() {
 if (buttonNr==8)
 {
  for (int i=0; i<10; i++) {
   if (i!=1)
   {
    state[i]="UIT";
   } else
   {
    state[i]="DICHT";
   }
   statecolor[i]=color(255, 0, 0);
   statebool[i]=false;
  }
 }
 for (int i=0; i<10; i++) {
  Tint[i]=255;
 }
 selection=false;
 buttonNr=0;
}

void stopsound() {
 for (int s=0; s<12; s++) {
  soundFiles[s].stop();
 }
}

void action(int i) {
 stopsound();
 soundFiles[i].play();
 if (!statebool[buttonNr])
 {
  if (buttonNr!=1)
  {
   state[buttonNr]="AAN";
  } else
  {
   state[buttonNr]="OPEN";
  }
  statecolor[buttonNr]=color(0, 255, 0);
  statebool[buttonNr]=!statebool[buttonNr];
 } else
```

```
 {
  if (buttonNr!=1)
  {
   state[buttonNr]="UIT";
  } else
  {
   state[buttonNr]="DICHT";
  }
  statecolor[buttonNr]=color(255, 0, 0);
  statebool[buttonNr]=!statebool[buttonNr];
 }
 if (buttonNr==2)
 {
  myPort.write('0');       //send a 0
 }
 if (buttonNr==3)
 {
  myPort.write('2');       //send a 2 to turn the tv on/off
 }
 if (buttonNr==4)
 {
  //myPort.write('3');       //send a 3 to turn the radio on/off
 }
 reset();
}

//connecting to the arduino
void serialEvent( Serial myPort) {
 //put the incoming data into a String -
 //the '\n' is our end delimiter indicating the end of a complete packet
 val = myPort.readStringUntil('\n');
 //make sure our data isn't empty before continuing
 if (val != null) {
  //trim whitespace and formatting characters (like carriage return)
  val = trim(val);
  //println(val);

  //look for our 'A' string to start the handshake
  //if it's there, clear the buffer, and send a request for data
  if (firstContact == false) {
   if (val.equals("A")) {
    myPort.clear();
    firstContact = true;
    myPort.write("A");
    println("contact");
   }
  } else { //if we've already established contact, keep getting and parsing data
   //println(val);
   // when you've parsed the data you have, ask for more:
   myPort.write("A");
  }
 }
}
```

12.5.2 Button class

```
class Button
{
 int posX, posY, btnWidth, btnHeigth, counter, Nr;
 PImage img;
 float loadingx, loadingy;
 float loadingspeedx, loadingspeedy; //time it takes to select
 float looktime=150; //time looking at a button before confirming
 float pause = 30; //time before visual loading
 float percentf, nbrupdate;
 int percenti;

 // make a button using by setting it's postion an image
 Button(int constPosX, int constPosY, PImage constImg, int btnNr)
 {
  posX = constPosX;
  posY = constPosY;
  img = constImg;
  Nr = btnNr;
  btnWidth = img.width;
  btnHeigth = img.height;
  if (btnNr==8) //reset button has a special position
  {
   posX = width-(btnWidth/2+10);
   posY = (btnHeigth/2+10);
  }
  else if (btnNr==9) //help button has a special position
  {
   posX = width-(btnWidth/2+10);
   posY = height-(btnHeigth/2+10);
  }
  loadingspeedy=btnHeigth/(looktime-pause); //loading animation is done at the time the voice line starts
  loadingspeedx=btnWidth/(looktime-pause); //loading animation is done at the time the voice line starts
  nbrupdate=100/(looktime-pause);
  statecolor[Nr]=color(255,0,0);
  if (Nr==1) //the door can not be off
  {
   state[1]="DICHT";
  }
  else
  {
   state[Nr]="UIT";
  }
 }
 // draw the button on the screen
 void drawImg(int btnTint)
 {
  tint(255,btnTint,btnTint);
  image(img, posX, posY);
  if(offcounter>2500) //reset selection when not looking at a button for a while
  {
   selection=false;
   offcounter=0;
   buttonNr=0;
  }
  if (Nr<=4) //on/off state for the first 3 buttons
  {
   textAlign(RIGHT, TOP);
   textSize(30);
   fill(statecolor[Nr]);
   text(state[Nr], posX+(btnWidth/2)-15, posY-(btnHeigth/2)+12);
  }
 }
```

```
 // check if the mouse is hovering over the button
 boolean isOver()
 {
  if (mouseX >= posX-(0.5*btnWidth) && mouseX <= posX+(0.5*btnWidth) &&
    mouseY >= posY-(0.5*btnHeigth) && mouseY <= posY+(0.5*btnHeigth)) {
    counter++;
    offcounter=0;
    if(Nr==7) //circles because the red and green button are round.
    {
      noStroke();
      fill(255,200,200,150); //the animating
      circle(posX,posY,loadingx);
    } else
    {
      noStroke();
      fill(255,160,160,160);
      rect(posX,posY,loadingx,loadingy);
    }
    if(loadingx<=btnWidth-5 && counter>=pause) //when looking at a button for a while, start animation.
    {
      loadingx=loadingx+loadingspeedx; //increase the value of the box size
      loadingy=loadingy+loadingspeedy; //increase the value of the box size
      percentf=percentf+nbrupdate; //the percentage counter on the buttons
      percenti = round(percentf);
      textAlign(CENTER, CENTER);
      textSize(50);
      fill(0);
      text(percenti+"%", posX, posY);
    }
    return true;
  } else
  {
    offcounter++;
    //reset timers when looking away from a button
    counter=0;
    loadingx=0;
    loadingy=0;
    percentf=0;
    return false;
  }
 }
 // check if someone is selected by looking for a certain period
 boolean isSelecting()
 {
  if (counter==looktime) {
    stopsound();
    return true;
  } else
  {
    return false;
  }
 }
}
```

12.6 Appendix F Interview Consent form

Information brochure

Beste lezer,

U wordt gevraagd om mee te doen aan een onderzoek, dat onderdeel uitmaakt van een onderzoek dat eenzaamheid onder ouderen wil verminderen. Dit onderzoek wordt gedaan als bachelor opdracht vanuit de studie Creative Technology aan de Universiteit Twente, in samenwerking met het bedrijf Ecare uit Hengelo. Dit onderzoek is beoordeeld en goedgekeurd door de ethische commissie van de faculteit EEMCS van de universiteit Twente.

Het onderzoek waar u aan deelneemt duurt ongeveer 5 minuten. U kunt op elk moment aangeven dat u wilt stoppen met het onderzoek en u doet aan dit onderzoek mee vanuit uw vrije keuze, u wordt hier niet toe gedwongen.

Het onderzoek bestaat uit een korte uitleg, het uittesten van het prototype en een kort interview daarover. Dit korte interview wordt opgenomen met audio, waar u specifiek toestemming voor gevraagd wordt.

In dit onderzoek zullen uw ogen gevolgd worden met een EyeTracking apparaat, zodat u het prototype kunt besturen. Hiervoor wordt het systeem eerst ingesteld op uw ogen. Deze gegevens zullen direct na het onderzoek weer verwijderd worden.

Met vriendelijke groet,

Rudolf Lok

Begeleider: Dr.ir. W. Oude Nijeweme - d'Hollosy

Universiteit Twente

Creative Technology

Informed Consent form

‘Hierbij verklaar ik dat ik geïnformeerd ben op een duidelijke manier over de vorm en de methode van het onderzoek zoals beschreven in de hier bovenstaande informatie brochure. Ik ben tevreden met hoe mijn vragen beantwoord zijn. Ik verklaar dat ik deelneem aan dit onderzoek vanuit vrije wil. Ik behoud het recht om deze toestemming ten alle tijd terug te trekken, zonder dat ik daarbij een reden hoef te geven en ik ben me ervan bewust dat ik mij elk moment kan terugtrekken uit dit onderzoek. Ik sta de onderzoeker toe om de audio van het interview op te nemen. Als de onderzoeksresultaten gebruikt worden in een wetenschappelijke publicatie of publiekelijk gemaakt worden op een andere manier, dan worden ze helemaal anoniem gemaakt. Mijn persoonlijke gegevens worden niet doorgegeven aan derde partijen zonder mijn toestemming. Als ik meer informatie wil over dit onderzoek, nu of later, dan kan ik contact opnemen met Rudolf Lok.

Als u klachten hebt over dit onderzoek, stuur ze dan alstublieft naar de secretaris van de Ethische Commissie van de faculteit van Electrical Engineering, Mathematics en Computer Science aan de Universiteit Twente, P.O. Bus 217, 7500 AE Enschede (NL), email: ethics-comm-ewi@utwente.nl)

Ondertekend in tweevoud:

…… ……

Naam deelnemer Handtekening

Ik heb uitleg over het onderzoek gegeven. Ik ben bereid om tijdens het onderzoek eventuele vragen goed en duidelijk te beantwoorden.’

…… ……

Naam onderzoeker Handtekening