UNIVERSITY OF TWENTE

Robot applications for elderly care

Author:
Babiche POMPE

Supervisor:
Dr.ir. Dennis REIDSMA
Critical observer:
Daniel P. Msc. DAVISON

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Abstract

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by Babiche POMPE

Due to the ageing of society, the elderly care sector is struggling. Since social robots are emerging, they may be of help to the elderly care sector. Therefore, this study aims to discover what applications for a social robot, like the Cozmo robot by Anki, could support the elderly and their care givers. By researching existing work, literature, conducting interviews, designing prototypes and testing with the stakeholders, the research provides insight into the different possibilities for a social robot in the field of elderly care. Participants in this study were seniors and care experts. The research has shown that the elderly care robot activities should be focused on supporting independent living, social inclusion and the emotional health of seniors. For successful implementation of the robot in the elderly care sector, the care experts should be involved and informed in the process and the robot is given a supportive role to the activities of the experts. To increase the willingness to adopt a robot the experts should be informed about positive influence of the robot on their work.

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Chapter 1

Introduction

1.1 Context

Demographic trends all over the world show that society is ageing. The key statements from an article released by the United Nations (Department of Economic and Social Affairs) [1] show that all parts of the world will have an increased portion of elderly in the future, since the survival rate for people over 65 is rapidly increasing. In numbers; the population of elderly was 700 million in 2019, and will increase to 1.5 billion in 2050. This will put high pressure on the aged care support systems. However, the pressure on the elderly care sector is already high, with several studies suggesting that the elderly care sector needs support [2]. Often institutions in elderly care are understaffed, undervalued, and far too often insufficiently trained, states ABC News [3]. This may be due the lack of financial funding from governments, as stated by the Royal College of Nursing [4], which already raised attention to the issue of insufficient and poorly trained staff in England back in 2010. The decrease in funding, staff and training, in combination with an increasing population of elderly, results in unsustainable elderly care. To relieve the pressure on the staff, giving them more time for proper training and to execute daily care activities, social robots can be a viable solution [5].

After all, social robots are becoming increasingly present in our society, and social robots interact with humans in a social setting more than ever. They are already progressively adopted in the elderly care sector; robots as Paro, a cuddle seal for elderly, and Pepper, an all-round social robot, have been employed and tested for a few years already. However, the difficulty in implementing and designing new social robots lies in the understanding of what are useful and necessary applications in the field. This distinguishes whether a robot has a positive effect on the lives of the elderly or whether it is just another piece of failed technology. Therefore, it is crucial to do adequate research about the field before designing and implementing a social robot. In this research an existing robot platform will be used; Cozmo, which will be programmed with new behaviours to test possible applications. The field of interest of this research is the elderly care sector, a field in which many problems persevere for elderly as well as their caretakers.

Therefore, in my graduation project I will be researching the possible applications of a social robot in elderly care. This will be guided by research into both the needs of those involved in elderly care, as well as the possibilities of the social robot. The applications have to add value in this field, and improve the quality of life for elderly. While researching the possibilities, the challenges the professionals might face in the future when working with the robot will be addressed. Two direct stakeholders

FIGURE 1.1: The Cozmo robot.

taken into account when developing the new applications are the elderly who use the robot, and the professional caregivers of the elderly (this ranges from medical to everyday caregivers). In addition to this, opinions of experts in the field of social robots and previous research will be guiding in the design of new applications. Finally, this research will address the possible implications for the professionals in the domain when a robot is added to their work field.

1.2 Cozmo robot

In order to keep this research concise, a specific social robot is chosen. The social robot used in this research is the Cozmo robot (Figure 1.1), which is created by Anki Robotics. They originally designed the robot as a friend, play-buddy, and device that playfully teaches its users programming skills. Cozmo is also able to navigate itself around edges, recognize faces and pets, and develop its own behaviour. It used to sell [1] at a relatively low price (±€160[2]) compared to other social robots, such as the Paro robot (±€5,500[3]), making it an affordable and feasible possibility for actual usage by elderly or their caretakers. Moreover, this robot can be used for multiple applications giving it a wide variety of uses, including own programmed applications. This makes Cozmo suitable for the purpose of trying out multiple different applications, which is crucial in this research.

1.3 Goal

The goal of this report is to identify possible applications for a social robot such as Cozmo to improve the lives of the elderly and add value in the elderly care sector. The possible applications are based upon research into the problems experienced by the elderly and then connected to the possibilities with a social robot like Cozmo. Important problems in the lives of elderly discovered during the research will be reported and analysed, as inspiration for future research into new robot applications. In short, the main question of this research is:

[1] The company is shutdown, so currently the robot is not officially for sale anymore.
[2] https://anki.com/en-us/cozmo/shop-now.html
[3] https://www.paroseal.co.uk/purchase

- What are possible applications for a social robot like Cozmo to improve the quality of lives of elderly people?

In order to answer this question, first the problems encountered by elderly in their daily lives will be identified, by use of literature review and interviews. In addition to this, the state of the art will be explored and existing literature on the subject will be reviewed. Then, the possible applications with Cozmo are explored, through play-testing and online research. Combining the results of the aforementioned will lead to a fruitful and thorough insight into applications for Cozmo in elderly care.

Chapter 2

Methods and Techniques

2.1 Introduction

This chapter provides an outline of the methods and techniques used in my research to answer the research question. Also, an overview of the different stages in my project is given for clarity and transparency of my work. First, the sub-questions guiding this research are listed. Then, the method of acquiring an answer to these sub-questions are generally explained on the basis of the different steps in this research. The methods described in this chapter will be explained in further detail in their respective chapters.

2.2 Research questions

As discussed in the Introduction (Chapter 1) the guiding research question of this research is:

What are possible applications for a social robot like Cozmo to improve the quality of lives of elderly people?

In order to thoroughly answer this question, several sub-questions were formulated. These are used as help to guide and add clarity to my research. The sub-questions as follows:

1. **What do elderly do and why? How does this relate to their needs?**
2. **What are possible applications for Cozmo?**
3. **Where is the potential of effect in applications of Cozmo for the elderly?**
4. **What does the implementation of Cozmo in elderly care mean for the professional in the field?**

The first and second sub-question will result in a list of activities and applications, respectively. The third sub-question will explore how the applications for Cozmo can have a positive effect on the senior's life. Lastly, the fourth sub-question will address the implications for the professionals, and discover how to ensure the smooth adoption of care robots by experts. These four sub-questions are addressed by use of different methods, these will be explained in more depth in the next section.

2.3 Method

The methods used will be discussed in relation to to the different phases of my research. It therefore shows the general course of this graduation project.

2.3.1 State-of-the-Art

The first step of this research will be a state of the art analysis. In this phase the state-of-the-art related to this research will be reviewed. This will be done by checking various different products and methods which already exist in elderly care. Special focus will be on the existing social robots, but non-technical solutions will also be discussed.

The goal of this stage is to start giving an answer to the third sub-question, by looking at the successful and less successful implementations of social robots. The insights from this chapter will be part of the answer to sub question 3. While doing so, this stage will also provide more insight into the first and second sub-question. In addition, it gives a broad idea of the context of this research.

2.3.2 Literature

The second step of this research will be a literature research into the different types of activities for elderly, as well as the possible implementations of social care robots. Different literature sources will be compared and studied in this phase.

The goal of this stage is to answer the first sub-question in particular. There will also be a focus on sub-questions 2 and 3, but this will be focused on general applications for social robotics in elderly care, instead of applications for Cozmo specifically. At the end of this phase there will be a substantial range of background knowledge of the topics on which the rest of the research can be based.

2.3.3 Interviews

During this step of the research will be conducting interviews with the stakeholders in this project. The identified stakeholders are:

- **Seniors (65+, living alone)**
- **Care givers**

Both groups will be interviewed to gain more insight in their specific needs and wishes. The questions guiding the interviews will be largely based upon the results from the literature chapter.

The goal of this stage is to answer the first and fourth sub-questions in particular. However, all sub-questions will be addressed in this phase, since the interview questions range from questions about daily activities, to questions about technology in elderly care. In addition to gaining new insights, the interviews will also be used to verify the results from the literature research. At the end of this step there should be a clear understanding of the different types of activities for elderly, as well as added information about the implications of elderly care robots for the professionals.

2.3.4 Ideation

This phase will continue to build upon the previous phases. Now that it is clear what activities are problematic for elderly, more research needs to be done into the possibilities of Cozmo. The list of activities for seniors will be compared to the possible applications for Cozmo, and their overlap will be used as inspiration for new prototypes of applications, as shown in Figure 2.1. The overlap as shown in this figure will lead to possible ideas for prototypes, therefore determining the design space.

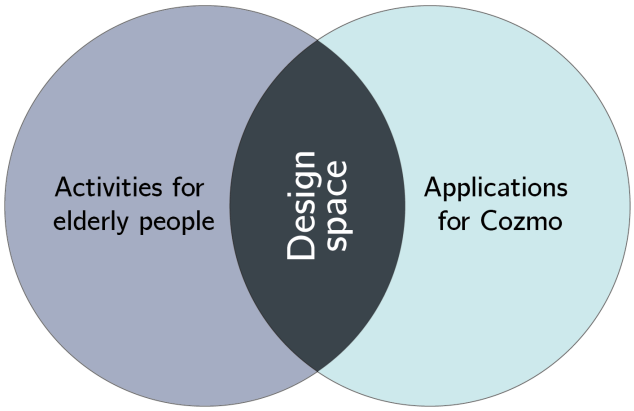


FIGURE 2.1: Venn diagram of first approach

The goal of this phase is to answer two sub-questions. First, it will find an answer to the second sub-question, through diverging research into Cozmo's possibilities. Then, several possible application ideas will be explored by combining the previously gained information as shown in Figure 2.1. These ideas will be discussed with the target group to further answer sub-question 3. At the end of this phase the ideas will be used to converge to a set of $\pm$ 5 ideas with enough potential which can then be realised in a prototype of Cozmo.

2.3.5 Conceptual Design

The final set of ideas still need to be worked out in more depth, so this phase will focus on the conceptual design of the prototypes. In this phase some scenarios with Cozmo will be sketched and each idea will be polished and made concrete before going to the next phase. In addition, this step looks into the way that everything becomes connected in the prototype.

The goal of this step is to make the ideas concrete so that the next phase can completely focus on implementing them. At the end of this phase there will be a list of 5 design ideas which are complete and only need to be converted into a real prototype.

2.3.6 Implementation

After finalising the application ideas, this phase will focus on realising them. Information about the process of creating the prototypes will be provided, and the framework of the used code will be explained to show the mechanism of the prototype.

The goal of this phase is to make the prototypes ready for user testing, taking into account difficulties which may occur due to the current Covid-19 crisis, as well as clarifying the process of building the prototype.

2.3.7 Evaluation

During this phase the user-testing will take place. The prototypes as created in the previous phase will be tested with the stakeholders. The feedback will be used to determine what applications are worth more investigation, which alterations there should be, and what parts should be removed. This phase is crucial to evaluate the ideas, and for future research.

During this phase it is important to discover the value (or lack of value) of the applications, thus answering sub-question 3. In addition to this, the prototype testing allows for a more specific answer to the fourth sub-question by the experts. Eventually, this phase will result in a list of fruitful applications and recommendations for designs in the field of elderly care with social robots.

2.4 Overview

The previously described steps will guide this research. However, it must be noted that this research will essentially be a feedback loop in which the input for design ideas is continuously updated as feedback is given. Eventually the iterations will lead to the final designs. An illustration of this design loop of this research can be seen in Figure 2.2.

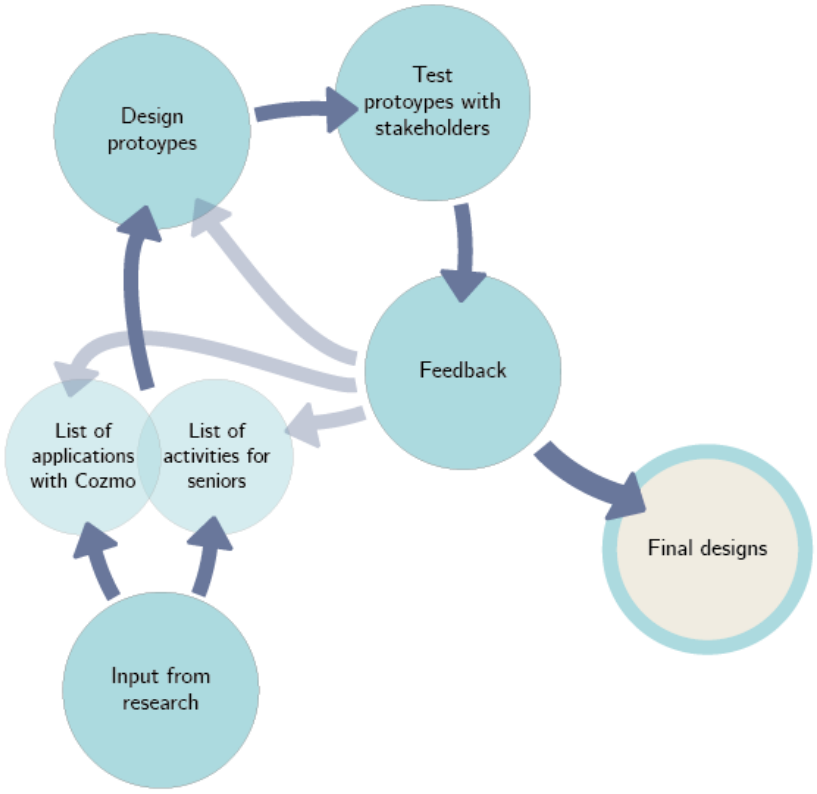


FIGURE 2.2: Feedback loop

Chapter 3

State of the Art

3.1 Introduction

First, it is important to look at what has already been done by others in this domain. This helps to better understand and analyze the topic, as well as spotting what parts could be reused. Therefore, in this chapter the state of the art on social robots for elderly care will be discussed to explore the field of interest. This is used as inspiration for new possible applications of Cozmo, and will also be used as a start to discover what applications are successful in the field.

3.2 Method

Different types of robots have been presented in the Literature chapter (Chapter 4), and a set of existing social robots will be investigated in further detail in this chapter. There are two parts in this phase; looking into existing robots for elderly, and looking at non-technical solutions for elderly. In order to find the state of the art solutions, different sources were considered; news articles, blogs, and scientific papers.

Existing robots in elderly care

Since the range of existing robots in elderly care is substantial, this state of the art analysis will be discussing only a limited amount of existing robots in detail. The robots which were deemed relevant for this state of the art analysis adhere to the following criteria:

- The robot has been reviewed by a variety of independent researches (n > 5)
- The robot has proven to have clear positive effects on its users
- The robot is/has been commercially available

The final requirement was added to exclude robots that are still under development or prototypes, since the chosen focus is on the established field of robots for this research. These requirements narrow the field of search, but still many robots remain. The robots chosen to discuss here were picked because they provide interesting insights into elderly care robots. The following social robots are discussed in more detail:

1. Paro
2. Care-o-Bot 3
3. Nao

4. * Buddy

A fourth robot, which does not meet the first two requirements and is recently developed, was chosen specifically to provide more insight into a flopped robot. It should be noted that little research has been done to him by experts in the field, but lots of media attention made the robot popular, and resulted in some negative feedback, which is useful for this project.

For each of the robots the main functionality was listed as well as their measured effects. This gave a clear overview of what robot functions are successful on the market, and what already exists. The analysis can also be used to discover what designs flopped, to avoid making such a mistake as well.

Non-technical solutions

It is also interesting to look at alternative methods of helping elderly. This broadens the scope of this research, and allows for a larger variety of insights. Furthermore, the products show what the demand is of the elderly. The non-technical solutions that were found were all chosen because they focused on a different sort of support. This diversity of non-technical solutions show the different aspects of possible elderly support, and can be used as input for applications developed in this research.

3.3 Existing social robots in elderly care

3.3.1 Paro

FIGURE 3.1: The Paro[1] robot

A well-known social robot in elderly care is the Paro robot, as shown in Figure 3.1 which is a cuddle seal for elderly (especially) with dementia. Paro is already used in elderly care for people with mental impairments, and proven to help with, for example, stress and communication [6]. The cute exterior makes the robot likeable, and due to sensors it is able to respond to touch, sounds and even to its name [7] [8]. In several experiments Paro has shown to have positive effects and is seen as a real companion by some patients with dementia [9], reducing stress and anxiety [8]. Besides this other studies suggest the improvement of Paro in physical activity, as many elderly are triggered to hug or pet the device [10]. Not only in elderly care,

but also in other social settings the robot shows to have a positive effect on its users, as shown by Wada et al. [8]. The main aspects of Paro are listed below [11]:

- Soft and approachable fur, making it possible to cuddle
- Responds to touch and sound
- Interacts and learns from interactions

The measured effects of Paro are [12]:

- Improves and triggers communication
- Decreases depression and improves mood
- More social interaction

3.3.2 Care-O-bot 3

FIGURE 3.2: The Care-o-bot 3[2]

There exist several versions of the Care-o-bot, and Care-o-bot 3 is the one developed especially for elderly [13]. For research the robot has been placed into people's homes for 3 years independently [14] and it is still frequently used for research. The Care-o-bot is commercially available, so it appears that it is currently in practice by some elderly or institutions. Care-o-bot 3 is a support robot for elderly people which can be seen as a service as well as a companion robot. It is able to help elderly with their daily activities, ranging from basic to instrumental; carrying, cleaning and navigating through a house. It is also able to communicate with the elderly person (social activities), remind them of medication, as well as monitoring their health [15]. In addition to this, the care-o-bot can help in emergency situations by calling emergency services and facilitating video and sound to the elderly [13]. So, this robot is not only a fetch-and-carry robot, but also a telepresence, and a humanoid robot (it does not look exactly human, but does have some human-like characteristics). This broad range of possibilities makes the robot a appealing solution for elderly with a variety of problematic activities. In short, the Care-o-robot 3 has the following characteristics:

- Technology-like exterior
- Able to support daily activities, fetch and carry objects
- Able to communicate with elderly

- Able to help in emergencies

The effects of using a Care-o-bot 3 are [16]:

- Longer and higher quality of independent living
- Cognitive improvement

3.3.3 NAO

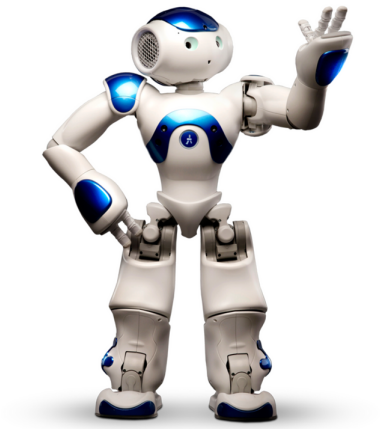


FIGURE 3.3: The NAO robot[3]

The NAO robot is a multi functional biped, able to walk and navigate through its environment. He can also talk with humans, learn new skills, and become personalized through interaction [17]. He is created by SoftBank Robotics, and has become a well known appearance for social robotics. Due to his variety of uses, NAO has also been used and tested in elderly care [18] [17]. He has already been implemented in a variety of scenarios [18], but usually this is done for testing. As NAO is for sale (and for lease), it seems fair to conclude that he is used independently in practice. It is a low height humanoid robot, even though the design of his exterior is not human like. An overview of NAO's possibilities is given below:

- Able to walk and navigate
- Able to speak and have conversations
- Able to entertain and motivate its users
- Able to recognize objects, faces etc.

Some measured effects in research are [17][18]:

- Improving mood (decreasing irritability)
- Improving physical activity of elderly
- Possible to help in care homes

FIGURE 3.4: The Buddy[4] robot

3.3.4 Buddy

Besides established robots, it is also useful to look at more recent developments for elderly peope. For example Buddy; Buddy is advertised as an emotional robot, coming down to the fact that he can express emotions with its face. There are many different uses to Buddy, ranging from education to detecting issues in a house. It has also been designed for elderly, and is able to monitor their health and keep them company or provide entertainment, as it can respond to sound and people's presence [19][20]. In addition to this, Buddy is able to make applications such as Skype easily accessible for elderly, which allows them to have more contact with their family or friends. Whereas the robot sounds promising, a lot of research still needs to be done, and an article by MIT Technology Review [21] is critical; the robot can only do simple tasks and is unable to have a real conversation. Due to difficulty in understanding commands, the user quickly felt tired from interacting with Buddy. It is for sale since 2016, but little is known about the actual functioning of the robot in practice. A quick overview of Buddy's characteristics:

- Technology-like exterior
- Able to accompany elderly
- Able to facilitate Skype interviews
- Able to monitor its surroundings

The responses to Buddy:

- Not useful, can only dance and tell the weather
- Unable to have real conversation
- Very bad at recognizing speech makes interaction tiring

3.4 Non-technical solutions

Besides social robots there are also many other solutions to support elderly in their problematic activities. These can be technical, but also non-technical solutions exist. A couple examples will be discussed below.

3.4.1 Daisy-player

FIGURE 3.5: Daisy Player[5]

This is a device for people with bad sight, it reads texts out loud, allowing them to listen to the text they are no longer able to read. This solution helps elderly people with deteriorating sight to continue to read important texts or stories for entertainment [22]. Daisy comes from 'Digital Accessible Information System' [22], as it stores texts in a clear way to enable the user to listen it back via audio. This functionally makes it a solution to support for enhanced daily activities, such as reading the news.

3.4.2 Student Aan Huis

Various initiatives exist to support elderly with their technical devices, such as the Dutch StudentAanHuis [6]. This organisation couples students to elderly people and allows them to help with technical issues. This may include remotely accessing laptops or other devices, as well as coming by to help in person. This kind of organisation indirectly helps the elderly to be more socially included and keep up their contacts with family and friends, therefore supporting problems in social activities.

3.4.3 Games for elderly

Different kinds of games exist to support elderly, including word, puzzle and strategy games [23]. These games have a proven positive effect on the cognitive capacities of the elderly [24]. Examples of such games are the crossword puzzles in the newspapers, but also applications such as WordFeud[7] support these activities. Besides the cognitive use of games, Ishmatova et al. [24] explain that multiplayer games allow for social interaction of the user, resulting in multiple positive aspects to games. In addition to this, games can be used to improve important skills for independent living for elderly, such as hand-eye coordination, balance and reaction speed.

3.4.4 Exercises for elderly

Different exercises have proven to be useful for elderly. It is important that elderly stay active, for their physical as well as mental health. It also enhances flexibility, which makes people able to live independently for longer time [25]. Many different

[6]https://www.studentaanhuis.nl/
[7]https://wordfeud.com/

(A) Soft weights

(B) Small bike

FIGURE 3.6: Exercise gadgets for elderly

gadgets can be used for elderly exercise. This includes small weights (Figure 3.6a), to train essential muscles, as well as a home trainer [26]. The home trainer is a frequently used device, as most (Dutch) elderly already know how to ride a bike, so no new information needs to be given. A variation on the home trainer would be a half-bike (see Figure3.6b), which can be used from a chair. In addition, activities which keep the elderly flexible are useful, an frequently mentioned example would be yoga [27][28].

3.5 Conclusion

To conclude, there are a variety of existing solutions to help the elderly care sector. The robots have shown that both simple and complex robots can positively affect the cognitive and physical state of the elderly. It has also shown that there is a significant focus on robots which help elderly age in place, and that the successful robots do so by being able to independently navigate, and use their arms. In addition, all the robots focus on the social interaction with their user. So these activities seem to have potential for elderly care and need to be taken into account in the rest of this research. Due to the positive responses to these particular robots it became clear that their design is also accepted by the users; a non-human look. This can be explained by the *uncanny valley* phenomena, which states that people feel eerie when confronted with a non-human that resembles a human being too much. One of the robots showed the importance of accurate speech recognition; when a robots lacks this, the interaction becomes tiring, and the user will quickly stop. This is important to keep in mind.

The non-technical solutions have shown that a wide variety of different products for elderly already exist. Judged by the amount of different products, the market for elderly games and exercises seem fruitful and useful for elderly. The different kind of games and exercises can be used in the design of a new social care robot. Reading support and technological help are also specifically designed for the older population, which shows that this is an issue that is worth addressing in the future. In short, exercises and games show potential for elderly care, as well as reading and support with technology.

Chapter 4

Literature

4.1 Introduction

The main goal of this chapter is get an overview of the different types of activities for elderly people, and look into possible ways that a social robot could play into that. In order to do so, a variety of literature will be used. First, a categorization of the types of activities for elderly will be provided, and the problematic activities are identified. Then, an overview of the types of social robots will be given and related to the aforementioned activity categories. Finally this chapter will conclude on a framework for the activities for seniors, and a broad idea of which activities are addressed by which type of social robots.

4.2 Method

The method used to find an answer to the sub-questions is described more in depth below. A systematic review approach was used to come to conclusions.

To start this process a literature matrix was created. The first sub-question was divided into two questions to be more generally answerable by literature. Besides this, two extra questions were added to be able to focus on the relation between robots and senior activities better. An example showing the initial literature matrix can be found in Table **??**. As illustrated in the table, each piece of literature is individually examined to answer the questions, and the final outcomes for each question will be based upon the answers given by each piece of literature. This setup makes it easy to compare and discuss the findings per literature source.

	Source A	Source B	Etc...	Outcomes
What do elderly do and why?				
What are important activities for elderly?				
What types of robots are currently used?				
How do these robots address the senior's needs?				

TABLE 4.1: Example of used literature matrix

After creating this empty literature matrix, different pieces of literature which concern the topic of activities for elderly were studied, and their answers to the questions were added to the literature matrix. The criteria for these literature sources was that they are peer reviewed, and have been published in a journal or paper. When a source did not comply with these criteria it was excluded from the review. Only one

paper ([29]) has been included despite not being published in a journal, as it was still under development at the time of my thesis. However, the information was deemed as being sufficiently reliable and interesting for this research that it was included in the review nevertheless.

The following sites were used to search for literature:

- Scopus[1]
- Web of Science[2]

Furthermore, the following search terms were used on these sites to find the papers. The results were ordered by relevance. After this process, 12 sources of literature were chosen for the literature review.

- **Search terms:** "elderly AND activities", "assistive AND technology AND older AND adults", "activities AND elderly AND robots", "seniors AND daily AND activities", ""ageing in place" AND robotics", "senior AND daily AND activities"

In some case the results were refined by adding (one of) the following limitations:

- Review type documents
- Journal

The resulting answers were discussed and organized as follows, to create a coherent story which answered sub-question 1, and generally 2 and 3.

1. **Activities for elderly:** Information about activities for elderly. Critical assessment and comparison of different sources lead to a framework for activities for seniors.
2. **Problematic activities:** The problematic activities for elderly were identified. This will be building upon the result of step 1, and further answers sub-question 1. The final result of the activities mentioned by literature will be given in a table which also includes their respective sources. All activities were put into a categorization, even if this was not explicitly done in the concerned literature.
3. **Social robots:** The research into possible uses of social robots in elderly care resulted in a categorization of different types of social robots. The problematic activities as have been found in step 2 were matched with the social robot categories of step 3. This resulted in a recommendation of what robot to use for each of the activity categories. Since Cozmo can be used for many different purposes, this will show what functions of Cozmo can be used to address which problems. This provides some insight into sub-question 2 and 3.

After concluding the steps described above, there should be a wide variety of input for the ideation space, and a good basis to build the interviews upon.

4.3 Activities for elderly

This section was taken from the course Academic Writing and parts have been changed to fit this thesis

[1] https://www-scopus-com.ezproxy2.utwente.nl/
[2] http://apps.webofknowledge.com.ezproxy2.utwente.nl/

In order to give a clear overview of the useful activities with elderly with the help of social robots, it is useful to identify what the elderly need and want in their lives. Since this has been the topic of many researches [30][31][16], existing literature will be used to define what possible problematic activities for elderly are. What comes forth from the literature is that there are different aspects to the life of elderly, and their daily activities can be subdivided over four categories; basic activities of daily living (**BADL**), instrumental activities of daily living (**IADL**), enhanced activities of daily living (**EADL**), and interpersonal interaction & relationships [31] [16]. Within this subdivision the most important activities to elderly are the activities which tackle the problems that come with independent living and social isolation [30].

Arguments for different categorizations have been given in the literature [32], [31], which result in the four aforementioned activity groups. Both Alves-Oliveira et al. [31] and Bedaf et al. [30] agree upon three categories over which activities of elderly people can be subdivided and the activities that these categories entail, being; activities which are basic and necessary for independent living (e.g. bathing), activities for successful independent living (e.g. taking medication), and activities that enhance living and are required to handle responsibilities (e.g. managing money). Respectively, these categories can be ordered from directly crucial for independent living to less important for independent living. These three groups set the basis of the framework of activities for elderly. In addition to these categories, Alves-Oliveira et al. [31] suggest a fourth category, which includes social activities. Similarly, other research suggests that social activities and interpersonal relations are important to the lives of elderly [32] and [16]. Even though these activities get different names in literature, such as interpersonal interaction & relationship related activities in [30], they contain the same activities.

These four groups seem to entail all daily activities for elderly but is not completely agreed upon in other literature. For example Shishehgar et al. [16] proposes different categories of activities for elderly, consisting of activities dealing with mobility, self-care, interpersonal interaction & relationships, and 'other' activities. The 'interpersonal interaction & relationships' - category resonates with the social category as mentioned by Alves-Oliveira et al. [31] and Bedaf et al. [30], but it provides more clarity about the included activities, which makes it a better indication for the social activity category. The first two subgroups as mentioned by [16] are specific and in combination with the social-category they seem to fail to entail all the possible activities, such as managing money (EADL). However, [30] also mentions these activities, but use them to define between problematic activities, rather than all activities. Other research also suggest mobility and self-care related activities as problematic categories [32], which indicates that it is important to include in this review. As they are indispensable in most parts of daily living, they need to be included in BADL. They are also necessary for more advanced daily activities, and need to be included in IADL and EADL as well, albeit in different levels of importance. Therefore, mobility and self-care related activities can be regarded as subcategories of the proposed categorization. Whereas there may be overlap between the different categories the basic, instrumental and enhanced activities of daily living are most focused on the physical aspect of daily life, while the social activities are more about the mental aspect. An overview of the resulting categorization is given in Figure 4.1.

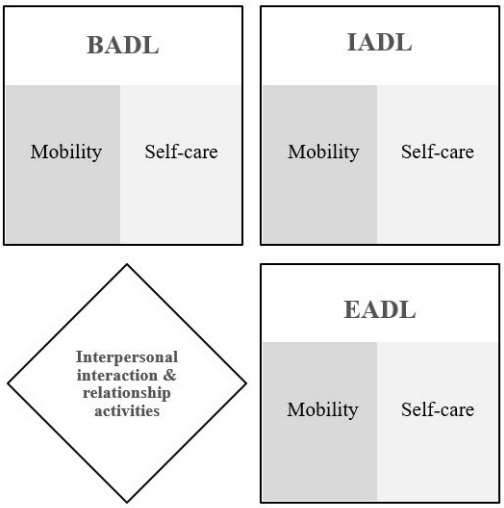


FIGURE 4.1: Overview of activities of daily living for seniors

4.4 Problematic activities

Due to the categorization shown in Figure 4.1, the problematic activities for elderly can be divided over the categories having to do with daily activities of increasing importance and social activities. Methods of identifying these problematic activities in literature range from directly asking elderly people [30] to counting research about a certain topic [16]. The most important activities for elderly include mobility and self-care related activities. Due to the fact that elderly find it important to age in their own places [33] the activities they consider important are focused on this. Also, the aging threatens these activities most, as they might be no longer able to bathe themselves or walk to the kitchen. Therefore the most important activities appointed by seniors often fall into the groups of basic daily activities as well as instrumental daily activities, as these entail the most crucial activities for independent living [30]. This concept is supported by Buhtz et al. [34] as well as Shishehgar et al. [16] who found that most existing literature deals with problems relating to independent living for elderly, and social isolation. Other problematic areas such as physical impairment, domestic, reminder, fall detection/prevention related activities, and reminding problems are also mentioned in literature, but addressed far less.

Next to activities dealing with aging in place, social related activities are problematic for elderly. This is widely discussed in the literature by [31][32][35][30][16][33][15], and is a well-known issue for elderly. Examples of activities in this domain are hanging out with family and friends, practicing hobbies, and going outside [36][30]. Besides the mental impact social isolation has on seniors, it has also been linked to physical impairments, such as dementia, higher blood pressure and cognitive decline [15]. In short, literature seems to agree that social activities are crucial and problematic for a successful life for seniors. This, and the problems accompanying independent living have been distinguished as most important activities for seniors.

An overview of the problematic activities mentioned by literature can be found in Table 4.2

Category	**Examples of activities**	
BADL	Eating	[31][32]
	Drinking	[30]
	Bathing	[31][32][30]
	Walking	[34][30]
	Changing body position	[30]
	Getting up (from bed, chair etc.)	[30]
	Toileting	[30]
	Getting (un)dressed	[30]
	Self maintenance (combing hair, clipping nails etc.)	[30][37]
IADL	Taking medication	[31][32]
	Remembering things	[32]
	Climbing stairs	[30]
	Putting on/off shoes	[30]
	Lifting and carrying objects	[30]
	Bending	[30]
	Reading	[30]
	Security (calling emergency numbers, avoid falling)	[32]
	Using household appliances	[32]
EADL	Managing money	[31][32]
	Doing groceries	[32]
	Shopping	[32]
	Doing household activities (washing clothes, vacuuming)	[30]
	Gardening	[37]
	Watching television	[37]
	Listening to the radio	[37]
	Exercising (strengthening muscles, balance)	[38]
	Managing diet	[32] [32]
Interpersonal interaction & relationship activities	Going outside	[30]
	Keeping in touch (with family/friends)	[30]
	Feeling safe	[30]
	Hobbies	[38][30]

TABLE 4.2: Activities mentioned in literature

4.5 Social robots

*This section was taken from the course Academic Writing and parts have been changed for this research. Parts indicated between * ... * have been added new.*

Now that the problematic activities for elderly have been adequately identified, it is necessary to identify the different types of social robots. Social robots are entities which interact with humans or other robots in a human-like manner [39] [35], while adhering to behavioural norms of communication. Socially assistive robots (SARs) have been extensively developed to address the problems of elderly, so for clarity it is meaningful to divide them into subgroups. When solely focusing on their purpose, social robots can be grouped into companion and service robots according to both Bedaf et al. [30] and Maalouf et al. [40]. The companion robots are meant to support the elderly in their mental needs, offering entertainment and company. On the other hand, the service robots are meant to support physically, by carrying, vacuuming etc. They could be used to help in basic and instrumental activities of daily living. To exemplify, some examples of existing robots are shown in Figure 4.2 and Figure 4.3.

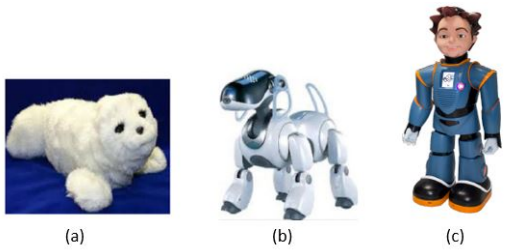


FIGURE 4.2: Examples of companion robots (a. Paro, b. Aibo, c. Alice)

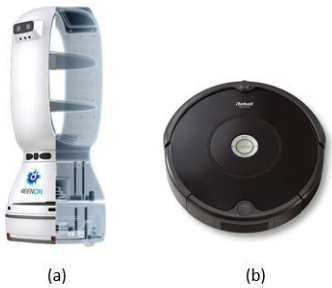


FIGURE 4.3: Examples of service robots (a. Peanut, b. Roomba)

The division into these two groups is also supported by multiple other sources of literature [17][15], and seems to be acknowledged as basic framework for SARs. However, this division is not clear-cut as many social robots have different purposes, for example the Care-O-Bot; which has both assistive and entertainment capacities [41].

* In order to create a clearer overview of existing robots, it is useful to look at a more specific scope. So, another categorization is given by Reidsma et al.[29], who propose a broader framework, which is not only based on purpose but also upon the appearance of the social robot. The suggested categories are:

- **Humanoid robots**: robots which look humanoid, as they have arms, legs and a face. It can be used for conversational purposes.

- **Pet robots**: robots which are intended as pets, and are designed for less conversational but more emotional value and purpose to the user (e.g. Paro[3]).
- **Skype robots**: a skype screen on wheels, allowing for telepresence of someone in another room.
- **Embodied voices**: focused on conversational power, they do not have a pet or humanlike form, but talk as if they were (e.g. Alexa[4]).
- **Fetch and carry robots**: robot which can execute a task in a social setting, but is not meant for social interaction (e.g. Roomba[5]).

Only the last category can be included in the service-category as proposed by [30] and [40], and the rest of them fit in the companion-group. Fetch-and-carry robots can be used for simple supportive tasks, by driving around medication or food. However, it has little interactive value, and no communication value. Therefore its main use for elderly would be by supporting in basic and instrumental activities of daily living. Humanoid robots are often designed to be capable of many different tasks, including conversation and simple repetitive tasks. Therefore robots of this category can also partially be seen as service robots, next to being a companion robot. Pet robots are primarily meant for emotional support without actual conversational function, whereas embodied voices only have conversational function. Therefore, robots in these categories can support elderly in their social activities. Lastly, Skype robots also help to solve problems with social activities, but rather than replacing human contact, they provide a way to have long distance human contact via technology [29].

For my research the humanoid, pet and embodied voices category seem most fitting interesting to use for inspiration, as they come closest to Cozmo's possibilities and my intended goals. After all, it is not supposed to do the work of a Roomba; it should have more sophisticated functions, and it is not able to show difficult images which are necessary for Skype. Some examples of existing robots in these categories will be worked out in further detail in Section 3.3. *

Both for social robots and in the activities of elderly a distinction can be made between physical and mentally related activities and purposes. Research has shown that elderly find it important to live independently and stay socially included. Therefore, most important activities for elderly are the basic and instrumental activities of daily life, which threaten independent living the most, and social activities which uphold interpersonal relations. Mobility and self-care are identified as critical subcategories in which elderly may need help and SARs can be used to address these issues. The mobility and self-care related problems in BADL and IADL can be supported mostly by service robots, which offer physical assistance. For example, supporting mobility and domestic robots can be used to support in self-care activities. Another important problem for elderly is social exclusion, thus activities related to social acts are crucial. A robot may help in this domain in the form of a companion robot, such as Paro, an pet robot, or an embodied voice robot.

[3]http://www.parorobots.com/
[4]https://developer.amazon.com/alexa/
[5]https://www.irobot.com/roomba

4.6 Conclusion

This chapter has used different sources of literature to answer the first three sub questions. It became clear that activities for elderly can be divided over four main categories. These four categories are BADL, IADL, EADL and interpersonal interaction relationship activities. This framework can be used to address the different types of activities for seniors in a systematic way. Research has shown that elderly find it important to live independently and stay socially included. Therefore, most important activities for elderly are the basic and instrumental activities of daily life, which threaten independent living the most, and social activities which uphold interpersonal relations. Mobility and self-care are identified as critical subcategories in which elderly may need help and SARs can be used to address these issues. The mobility and self-care related problems in BADL and IADL can be supported mostly by service robots, which offer physical assistance. Another important problem for elderly is social exclusion, thus activities related to social acts are crucial. A robot may help in this domain in the form of a companion robot, such as Paro, a humanoid or pet robot, or a Skype robot.

Chapter 5

Interviews

5.1 Introduction

Now that the activities of elderly people have been discussed in more detail, it will form the basis of this interview phase. The participants for the interviews in this phase can be divided into two sub-groups;

- Elderly people above the age of 65 who live alone and independently
- Experts in the field of elderly care

By combining the results from the interviews and the literature research, the overlapping activities can be identified, and a final list of important activities for elderly can be made. The contents of the list will then be categorized into sub-groups as proposed by literature, to keep the list concise and comprehensible. In addition to this, the interviews with the experts will be used to answer the third sub-question about the impact on the professional in the field.

5.2 Method

Due to the Covid-19 crisis all interviews were held online. The contacting of participants was done in accordance with the Ethics Committee. Permission was asked by sending in a form which described the research, and the taken precautions to avoid risks of spreading the virus. See Appendix B for a more detailed overview on the approach of the interviews with regard to the current Covid-19 crisis.

The conducted interviews were semi-structured interviews, which means that there are predetermined questions asked to the participant, but there was also room for spontaneously arising questions through conversation [42]. Each interview took around 30-45 minutes on the phone or via Skype (depending on the preference of the interviewee), sometimes longer, never shorter. The interview questions can be found in Appendix A, and were adjusted to the groups of participants (elderly, care workers). When a care worker had expert knowledge in a specific field, questions about this will be added and adjusted as well. For elderly participants, only the first sub-question of this research was addressed in the interview. For care workers, the first as well as the last sub-question was addressed in their interview. All interviewees were Dutch speakers, so the interviews were held in Dutch, and translated for purpose of this thesis. A more detailed overview of the interviews per group can be found below:

- **Elderly** - people above the age of 65 who live independently and alone, are asked about their daily activities and the obstacles in their everyday lives. In addition to this, they will be asked for input for a (technical) solution to their problems and asked about their wishes and requirements for a social robot.
- **Experts** - these people have experience in elderly care or in fields which have a direct and useful connection to the lives of elderly. They are asked about the daily activities and obstacles in the lives of the elderly, and about their expert view on the matter. They are additionally asked about their medical opinion on important activities for elderly people. Lastly, they will be asked about possible technical solutions for problems for the elderly as well as in elderly care. The interviewed experts will mostly be retired care professionals due to the current Covid-19 crisis.

The results from the interviews were then analysed and put into one of the four categories: *general activities for elderly*, *important activities for elderly*, *possibilities for technology*, and *implications for the professional*. The general activities were analysed as they enable better understanding of the daily lives of the participants, and their mentioned important activities. The important activities were then compared to the activities mentioned in literature, and categorized according to the proposed framework. The technical recommendations were used for inspiration for the ideation, and the implications for the professional answer the last sub-question of this research.

At the end of this chapter, in order to make a complete overview of activities for elderly, input from literature and interviews was combined. The the activities which were also mentioned in the interviews with the elderly participants were be indicated in this list with a cross and color. Then, the activities mentioned in the interviews with the experts were added in the same way. The resulting overview is given in Table 5.4.

5.2.1 Participants

For this research there are four elderly participants in the age category 65 - 86, who live independently and alone. The experts participants consist of people who used to work in elderly care, as well as some people who are still active in the sector. Their expertise vary widely from working in a hospice to working as a physiotherapist. The decision to interview ex-care workers was made due to the Covid-19 crisis and the interviews will therefore also be conducted via telephone or Skype, to avoid personal contact. The participants were recruited via e-mail or text message.

There are eight people taking part in this study, including both the four elderly and four expert participants. An overview of the senior and expert participants can be found in the Table 5.1 and Table 5.2 respectively.

ID	Age	Additional notes
A	78	Very active, little physical difficulties.
B	80	Very active, little physical difficulties
C	85	Visually impaired
D	82	Little to no physical difficulties. Vision is deteriorating.

TABLE 5.1: Participants above 65 (n=4)

ID	Currently active y/n	Field of expertise
1	No	Experience in care homes, home care, hospital, hospice care.
2	No	Experience in care homes, hospice care and 24-hour care.
3	No	Physiotherapy
4	Yes	Nurse at a general practitioner, experiences in senior care.

TABLE 5.2: Expert participants (n=4)

5.3 Results

5.3.1 General activities for elderly

The elderly participants were asked about their daily activities. All senior participants discussed the standard activities of waking up, eating, doing some sort of social/hobby related activity, and then going back to bed. Participant D and A both mentioned yoga as an activity they liked to do, as it kept them flexible. Furthermore, participants B, C and D all said that they liked to read (even though C mentioned that this has become very difficult) and all senior participants named some sort of social interaction activity that they do daily; playing golf with a group of friends, talking to neighbours, calling friends and family etc. This shows how important these interaction activities are to them.

When the experts where asked about daily activities of the elderly they said similar things. However, their reactions were based on experience with more care dependent elderly than the interviewed seniors. This caused that they mentioned more healthcare related activities, such as taking medication and putting on compression stockings. However, both 1 and 2 also mentioned the social interaction activities, or lack thereof.

5.3.2 Important activities for elderly

The important activities as result of the interviews have been provided in the following Table (5.4). This table shows what activities were mentioned as critical by literature and the elderly or experts. Only one of the basic activities of daily life (BADL) activities was described as problematic in the interviews with the elderly themselves, and this may be due to the fact that the interviewees were all very active and successfully living independently, so they did not encounter such problems.

Whereas the care professionals agreed with the importance of social activities, participant 2 and 4 both found physical health equally or more important. Participant 2 did add that they were aware that the elderly often found the social aspect more important. An interesting remark was done by participant 1, who said that it was difficult for some elderly to keep included in society, which means getting information about current events, and watching news or listening to the radio. This was crucial in order to "keep themselves up to date, otherwise you become dull and flat".

Furthermore, one of the frequently mentioned issues was that the memory of the elderly declines. Participant B mentioned; "All at once I seem to forget a word, and then you just need someone who can help you remember", a similar problem was encountered when shopping for groceries; "Young people are able to remember some groceries, but this is not the case when you become older.". This was supported by A and C, who experienced similar problems. The problem of forgetfulness

was not explicitly commented on by the experts, but it was inherent in remarks such as "We need to give them medication on the right time, as they are unable to do so themselves" - 2. This shows the importance of this problem. Participant 1, A, and D also noted that seniors tend to eat and drink less, since they "have less hunger and thirst feelings" - 1, and simply forget.

To continue, participant D said that all cognitive and physical processes go slower for elderly, and A added that people who become older usually need more time to comprehend and take in new things. A and D both explained that this was the reason that they find it hard to understand technology "There are so many options, and everything goes so fast" - A, which had also become clear from the SOTA (Chapter 3). Also, participant C, D and 3 named mobility as an issue for many elderly, both for simple tasks such as walking the stairs (3) and more advanced tasks such as hanging out with friends (C) or visiting museums (D).

Similar to results from the literature, participants 1 and 3 highlighted that many issues are related to the importance of ageing at home for many people. In addition, they explained the problems that came from this need; people are left at home and cared for by a equally care-needing spouse or friend, which leads to dangerous situations and takes its toll on their mental health. Whereas all experts agreed that more care givers where necessary, they saw that this was currently not achievable, and care would only happen at the very last moment.

5.3.3 Possibilities for technology

Due to the increasing pressure on the elderly care sector, all experts agreed that a robot would be useful addition to their field. It would "give me time to focus on more important tasks, and interaction with the client" - 1. Participants A, B and C agreed that a robot could help in certain tasks, such as reminding of tasks and entertaining (lonely) people. However, all participants noted that robots should not replace human contact, but that it could work as a facilitating device for human contact. Participant D gave the example that a friend in a care home got a robot, and that this caused the other residents to increasingly interact with each other "Oh what a cute dog, what's his name". Furthermore, participant A explained that a robot who could help setting up Skype would be really useful to allow her to have more video contact with family and friends.

Participants C and B noted that a care robot should have a cute and helpful appearance. This would make them feel more secure, as participant B said that they often felt "unsure whether I am actually doing it correctly", causing them to stop driving a car, or doing their own finances. The robot should be able to calm them down in their worries. Due to participant C's declining vision, they were very keen on a robot which could read things to them.

Participant 3 especially saw use in a robot as motivational device. It could help people be more motivated to do their exercises and stay mobile; an important aspect of ageing. On the other hand participant 2 said that even though they believed that technology could relieve the pressure on the care sector, they thought it was "sad that robots should be used to help". This was agreed upon by all participants, both elderly and care professionals.

5.3.4 Implications for professional

The experts all saw potential in a care robot. Especially since 1, 2, and 4 all experienced the increasing and unsustainable pressure on their work field. During the interviews participant 1 even said that "the care sector has to change, (because) this won't hold much longer". Participant 3 explained that in their field they had the luxury of having plenty of time, but that they saw that many colleagues in direct medical care struggled. Therefore, a care robot, taking on small tasks, could be a useful addition in the opinions of the experts. However, none of the experts thought it could or should replace the traditional care workers, but it could help relieve the pressure.

To ensure that robots are adopted by the experts, the experts came to one overlapping advice: **keep the experts informed and involved!** All expert participants agreed that the use of a social robot could have positive effects, however participants 1, 2 and 4 all explicitly mentioned that it **should not replace human contact**, as this would result in negative effects. According to participants 1, 2, and 3, a social robot will be accepted albeit that all new inventions will be met with skepticism by some. To avoid rejection, participant 4 highlights that people will be more likely to accept an idea if they feel **included** in the process. Participant 2 also adds that it is crucial to **listen** to the concerns and questions of the experts, and **avoid pushing** ideas through. Lastly, participant 4 reflects on a technology training in which no care experts were present, meaning that their care related questions could not be answered or understood adequately. Thus, the advice was to always have two people giving a training for a new technology; one person who knows all about the technology, and one person who can knows and relates everything to the care sector.

An interesting point is raised by participant 3, who explains that some people may feel frightened by the use of a new robot, as it takes away some of their **self-esteem** as the robot may appear 'better at their jobs'. This fear cannot be directly removed by a robot, but can be reduced through proper information sessions. An overview of the recommendations for the adoption of a social robot is given in Table 5.3.

Possibilities for social care robot	**Advice on gaining acceptance of experts**
- Supportive role - Allowing elderly to live independently for longer - Used for rewarding successful exercises and motivation - Provide instant feedback about movement	- Keep them informed and engaged from the start - Ensure that the technology is robust and working well - Make the technology easy to use - Ensure that the robot is flexible, to go to different locations - Inform about the possibilities and positive effects

TABLE 5.3: Results expert interviews

5.3.5 Final list of activities

After doing the interviews, the mentioned activities were compared to the literature and added to the table. This resulted in the final list of activities for seniors as shown in Table 5.4:

Category	Examples of activities	Literature	Elderly	Experts
BADL	Eating	[31][32]		
	Drinking	[30]		
	Bathing	[31][32][30]		X
	Walking	[34][30]	X	X
	Changing body position	[30]		X
	Getting up (from bed, chair etc.)	[30]		X
	Toileting	[30]		
	Getting (un)dressed	[30]		X
	Self maintenance (combing hair, clipping nails etc.)	[30][37]		
IADL	Taking medication	[31][32]	X	X
	Remembering things	[32]	X	X
	Climbing stairs	[30]	X	X
	Putting on/off shoes	[30]		
	Lifting and carrying objects	[30]	X	
	Bending	[30]	X	
	Reading	[30]	X	X
	Security (calling emergency numbers, avoid falling)	[32]		X
	Using household appliances	[32]	X	X
EADL	Managing money	[31][32]		
	Doing groceries	[32]		X
	Shopping	[32]		X
	Doing household activities (washing clothes, vacuuming)	[30]		X
	Gardening	[37]	X	X
	Watching television	[37]	X	X
	Listening to the radio	[37]	X	
	Exercising (strengthening muscles, balance)	[38]	X	X
	Managing diet	[32]		X
Interpersonal interaction & relationship activities	Going outside	[30]	X	X
	Keeping in touch (with family/friends)	[30]	X	
	Feeling safe	[30]		X
	Hobbies	[38][30]	X	X

TABLE 5.4: Activities mentioned by different sources

5.4 Conclusion

As discussed in the literature elderly find activities that allow them to live independently and socially included, important. Whereas elderly primarily focused on social interaction and relationship activities, the experts also shed light on the importance of physical and medical care. The results from the interviews show that all the activities mentioned in the literature also came forward in the interviews. In addition, a reoccurring comment by the participants from both groups was that a robot

should not replace human contact. Furthermore, the expert participants all agreed that there is great potential for a social care robot, and that the key to a positive implication for the expert in the elderly care field is *communication*. The results from this chapter will be used as a basis for the future chapters.

Chapter 6

Ideation

6.1 Introduction

As described in Chapter 2, the ideation will start by creating two lists of activities for seniors and possible applications for Cozmo. The list of activities for seniors has already been thoroughly discussed in the previous chapters, and during the ideation a list for activities for Cozmo will be completed.

6.2 Method

This ideation will work towards a few ideas for the final prototype. As explained in Chapter 2 this will be done by finding the overlap between the contents of both lists of applications and activities. These will be organized into different subgroups to keep a clear overview and make this process of ideation more generally applicable.

The ideation will start by systematically brainstorming about possible applications for Cozmo. This process is described in the steps below.

1. **Application - ideation:** different possible uses with Cozmo will be identified by play testing with Cozmo myself. This results in a list of possible applications with Cozmo, which will iteratively updated while testing and exploring new possibilities. This list can be used in the next step.
2. **Application - categorization:** a categorization will be made on the basis of the previous step. First, the different activities will be grouped based on the type of activity, colour coding each activity during the process. This will continue until all applications fit into a category and an adequate amount of categories is reached. Note that this is an iterative process, in which the colour-codings can continuously change. This will result in categories of applications for Cozmo. This step with answer sub-question 2.
3. **Specific applications for Cozmo:** per category a couple of activities will be designed and tested with Cozmo, as part of the ideation process. Where possible, for each application the fine tuned possibilities for future investigation will be shortly described, to make clear what the possibilities are with this applications. The implementation of several applications is done to explore the feasibility of such applications for Cozmo, as well as to give a clearer idea of what the different categories entail. Even though these ideas may not necessarily be used in the future implementations, it will provide insight in the possibilities. Therefore, this step will further answer sub-question 2.

After this, all the categories of the applications for Cozmo and the different categories for elderly activities will be matched with each other. This results in a large variety of applications coming from the match between a 'need' and a 'solution'. The large amount of applications is useful in the ideation phase to keep the design space large. Also, this way the brainstorm about different possibilities for Cozmo in elderly care happens in a systematic way. This process is illustrated in the following example:

Games + BADL = act1, act2, act3 etc.
Games + EADL = act1, act2, act3 etc.
...
Entertainment + BADL = act1, act2, act3 etc.
...

After coming up with 30+ ideas for prototypes for Cozmo, it is time to discover which ones have the most potential. This will be done by considering which activities have been mentioned in the literature or interviews the most, or have proven to be very effective in the state-of-the-art. Per activity category, one or more ideas will be chosen to realise in a prototype for evaluation.

6.3 Categorization of applications for Cozmo

In this part of the ideation the possible applications with Cozmo will be explored. As Cozmo is programmable in Python, there are countless possibilities, which makes it difficult and cumbersome to explore all possibilities in detail.

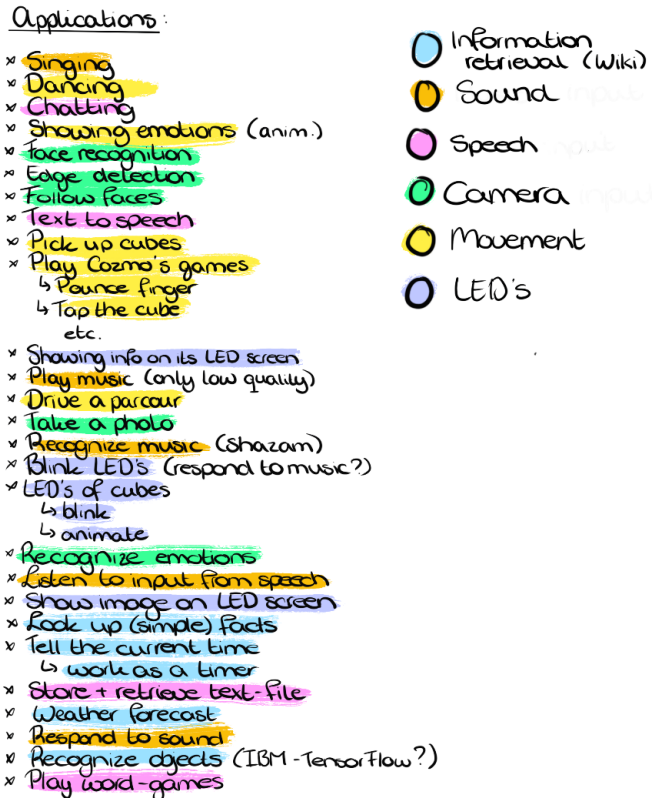
However, his design also has some restrictions. It is important to acknowledge these restrictions early in the ideation phase, so no wrong assumptions are made in the process. The restrictions of Cozmo will be discovered throughout this ideation phase. The resulting restrictions of Cozmo are given in Table 6.1.

Size-related	**Sensors**	**Output**
Cannot carry high weights	Can only listen through laptop microphone	No large music files
Cannot drive uneven territory	No tactile sensation	Only limited output via face
Cannot reach high or low	Not good at detecting edges	*Unable to speak another language than English
Cannot move large objects		
Cannot move very fast		

TABLE 6.1: Restrictions of Cozmo
* This restriction is overcome by using a separate Bluetooth speaker, as the ability of speaking Dutch is crucial for user testing in the future.

As there are many different types of applications and behaviour for Cozmo, it is useful to systematically divide the different activity types into categories. This was done by first creating a mind-map (Figure 6.1a) to brainstorm about the different possibilities of Cozmo, both related to its sensors and motors, and to different activities. This mind-map was used as inspiration for more research into different possibilities of Cozmo, and this was made into a list. Added to the list were applications that

(A) Brainstorm for inspiration mind-map



(B) List of applications

FIGURE 6.1: Brainstorm process

were discovered while testing with Cozmo, or by searching for existing scripts for the Cozmo functions. The complete list of possibilities was then colour-coded to group certain types of activities (see Figure 6.1b), which resulted into six different initial categories. All these categories resemble parts of Cozmo, either relating to its output or input. Whereas this categorization gives a good overview of the possible functions of Cozmo, it is more difficult to get a clear overview of the potential applications for Cozmo. Therefore another categorization was made, which divided the list items into different themes of activities (Figure 6.2). Each theme represents a goal, and its containing activities all have the same goal.

Even though some categories have slight overlap (e.g. the word games also need Cozmo to respond to its surroundings), they give a clear overview of what types of activities it entails. A short explanation of each of the four categories is given below for further understanding:

- **Games** - type of activities in which the user and Cozmo both engage in a playful competition. Activities in this category are games and functions which enhance games *(such as edge detection and driving a parcours)*.
- **Entertainment** - type of activities in which Cozmo entertains the user. The user is able to interact, but this is not mandatory for these activities to function properly.
- **Informational** - type of activities which retrieve information and convey this to the user.

FIGURE 6.2: Final categorization

- **Conversational** - type of activities which have to do with conversations; thus listening and responding to speech, but also expressing emotions etc.

6.4 Specific applications for Cozmo

These categories are used to be able to accurately distinguish between the different applications, which will simplify the process of matching the applications to elderly activities eventually. The following sub-sections will discuss a number of possible applications per category in more detail. These applications have been implemented in Cozmo during the ideation as a prototype, and their functionality was tested personally in the process as well. Because this way they were proven to work, they illustrate the feasibility of ideas as well as give a general idea of what Cozmo's possibilities are for each category.

6.4.1 Games

Two games have been tested with Cozmo by myself during the ideation, to test out the technical possibilities. Both will be discussed and small explanations of their methods and functioning is provided. A third game possibility is given by inclusion of Cozmo's cubes.

Holiday-memory game

This game is based upon a simple Dutch game "Ik ga op vakantie en ik neem mee..." ("I'm going on holiday and I bring with me..."), and is basically a memory game. The players of the game take turns naming an object they can bring with them on holiday, but before adding their own object they have to list all the previous objects.

Criteria for the new object is that it should not be in the list already. A small example is shown below:

> ***Player A:*** *I'm going on holiday, and I bring with me; ... sunscreen.*
> ***Player B:*** *I'm going on holiday, and I bring with me; sunscreen and ... a toothbrush.*
> ***Player A:*** *I'm going on holiday, and I bring with me; sunscreen, a toothbrush and ... a bathing suit.*
> *...*

Then as soon as one of the players is unable to say the complete list, they lose and the other player wins. This simple game can be implemented with Cozmo, where he is able to check whether the other player says the complete list, and adds his own words.

Possibilities for further investigation: add a random counting parameter to Cozmo, making it possible that Cozmo 'forgets' some of the words after a few rounds.

Animal-names game

This game is based upon another simple group game. Players take turns naming animals, and the name of the animal should start with the same letter as the last letter of the previous animal. Again, a small example is shown below to illustrate the idea of the game. No animals are allowed to be named more than once. The game ends when one of the players is unable to come up with a new animal with the correct letter.

> ***Player A:*** *Leopar**d***
> ***Player B:*** ***D**olphi**n***
> ***Player A:*** ***N**ighthaw**k***
> *...*

Possibilities for further investigation: enable Cozmo to learn from animals named in previous games, to update his dictionary. This will also make the player feel as if Cozmo is 'learning'.

Quick tap

FIGURE 6.3: Cozmo's cubes

Cozmo is able to communicate with three cubes, which can blink LED's. He is able to navigate towards them, pick up the cubes, and stack them on top of each other. In order to explore the wide variety of possibilities of Cozmo, it is important to look at the use of the included cubes.

A possible game with the cubes is the quick-tap game, which is integrated in Cozmo's software. In the game, players have to tap the cube when the LED's are lighting up, the player who taps the cube first wins. This simple reaction game can be easily enhanced by adding more animations, and speech.

Possibilities for further investigation: use the cubes for multiplayer games, or use the cubes to train reaction speed.

6.4.2 Entertainment

Dancing

Since all Cozmo's motors can be individually controlled, during the ideation it was tested in a prototype to see if it is possible to make Cozmo dance. In addition to doing this manually, there also exists a standard animation from the Anki SDK which lets Cozmo do a short dance. This combined with the Aubio library for Python by Pypi[1] would allow Cozmo to dance to the beat of the music.

Possibilities for further investigation: enable Cozmo to dance to the music currently played by another device. This could result in some laughter from his audience.

Singing

By connecting Cozmo to a speaker it is possible to make it appear as if he sings the audio file that is played. By using the thread-module of Python, it is possible to have Cozmo 'dance' and 'sing' at the same time. The singing should be recorded and pitched before sending it to Cozmo.

Possibilities for further investigation: enable Cozmo to listen whether someone is singing along, and stopping if they don't. Making it possible to 'sing together'.

Cubes

The LED's of the lightcubes can be programmed to give a specific colour. This can be used to allow the user to say a colour, and having the cube change colour with it. In this way the lights can be used for a variety of entertainment options.

Possibilities for further investigation: let the lights blink on the rhythm of the music. Or let the lights relate to Cozmo or the user's emotion.

6.4.3 Informational

The following applications have been programmed into a prototype to test the possibilities of Cozmo.

[1] https://pypi.org/project/aubio/description

Tell the time

Cozmo is able to tell the current time and date. This can be easily done by connecting it to the internet and using the datetime-module of Python. He can also show the time on his O-Led screen.

Weather forecast

Cozmo can also give the weather forecast through speech as well his O-Led screen. This makes it possible for him to give quick information.

Wikipedia

Cozmo can be connected to a Wikipedia module, making it possible for him to look up definitions of words and other fun facts.

6.4.4 Conversational

One of the possibilities of Cozmo is to function as a conversational partner. Some scripts have already been designed for this by other programmers, using the Speech Recognition[2] library for Python. The speech recognition in combination with a database of sentences for Cozmo results in a conversational robot. In addition, understanding speech also allows Cozmo to respond with accurate animations. Some examples are explained in more detail below.

Emotion

In one of the scripts Cozmo is programmed to respond to a conversation with emotions. The type of emotion is dependent on the sort of text that the user says. For example "Cozmo, I love you", would result in a happy animation from Cozmo, whereas "Cozmo, I hate you" would make him sad. The script used for this has been created by the WizardsOfCoz[3] and can be improved and adapted further to fit certain needs. An important possibility shown in this code is that it is possible to group the type of emotions (happy, sad, angry etc.) and call an animation from this group when necessary. This results in semi-random animations, which makes Cozmo more true-to-life.

Possibilities for further investigation: make Cozmo respond to the current emotions by asking how to help.

Chatterbot

Another function for Cozmo is to work as a chatterbot. This is a fun function to try out, and may be useful for Cozmo to engage in light conversation with its user. The script was found on Github (by user me00016)[4], and uses the existing library of the Chatterbot 0.7.6. This library is made for conversational robots, and this is implemented in the script so that Cozmo appears to 'talk'.

[2]https://pypi.org/project/SpeechRecognition/
[3]https://github.com/Wizards-of-Coz/react-to-speech
[4]https://gist.github.com/me00016/2643a9534ec4799fb301e8119c1abad6

6.4.5 Conclusion

The above steps have shown what possibilities there are for Cozmo. This has answered sub-question 2, and created a categorization which makes the rest of the ideation more systematic. The different categories of applications for Cozmo are *games*, *entertainment*, *informational*, and *conversational*.

6.5 Design ideas

Now that the different applications for Cozmo have been tested, it is clear what the possibilities are, and what each category holds in terms of applications. Thus, it is possible to match each activity-category to an application-category. The result of this matchmaking is visible in Figure 6.4. When an idea resonated with activities frequently or explicitly mentioned in the literature or interviews, they have been marked to have high potential with a red exclamation mark. The final list of activities after this brainstorm can be found in Table 6.2

Games	Entertainment	Informational	Conversational
Game to train essential muscles	Turn on the radio/tv	Keep track of expenses	Chat about things (chatbot)
Game to playfully cook + remember cooking skills	Read text out loud	Advice on cheap products	Calm down in stressful situations
Multiplayer games	Rewarding success	Give weather forecast	Read to the robot
Games which stimulate social interaction	Play music for a~ group of people (party DJ)	Track groceries and compare them to their diet	Teach the robot new words
Hobby related games	Making funny comments to things on tv	Advice on privacy settings~ and cookies from websites	Talk about topics discussed~ on radio or tv
Improve useful skills	Sing/dance as entertainment	Give tips about hobbies (fun facts)	Ask for opinion (possibly disagree to have a discussion)
News-related games (pub-quiz)	Make music together	Advice on exercises	Talk about memories~
Competitively exercising together		Remind of medication and other events	Monitor mental state
Memory games		Inform about news	Detect danger and act up it
Reading exercises		Call emergency numbers	
		Give tips on use of household appliances	
		Keep track of daily schedule,~ or create a schedule	
		Tell the time	
		Suggest possible activities	
		Inform about activities of friends	
		Help with words	
		Help memorize names and stories	

TABLE 6.2: Final list of design ideas

From each activity group one (or more) red exclamation-marked activities were chosen to create as a prototype for user testing. The chosen activities are highlighted light blue in the table. Together these activities cover all the Cozmo application categories, as well as the senior activity categories. Whereas some groups have multiple chosen activities, this does not mean they will always be separate activities in the prototype, as they sometimes can be connected. More about this process will be described in the next chapters.

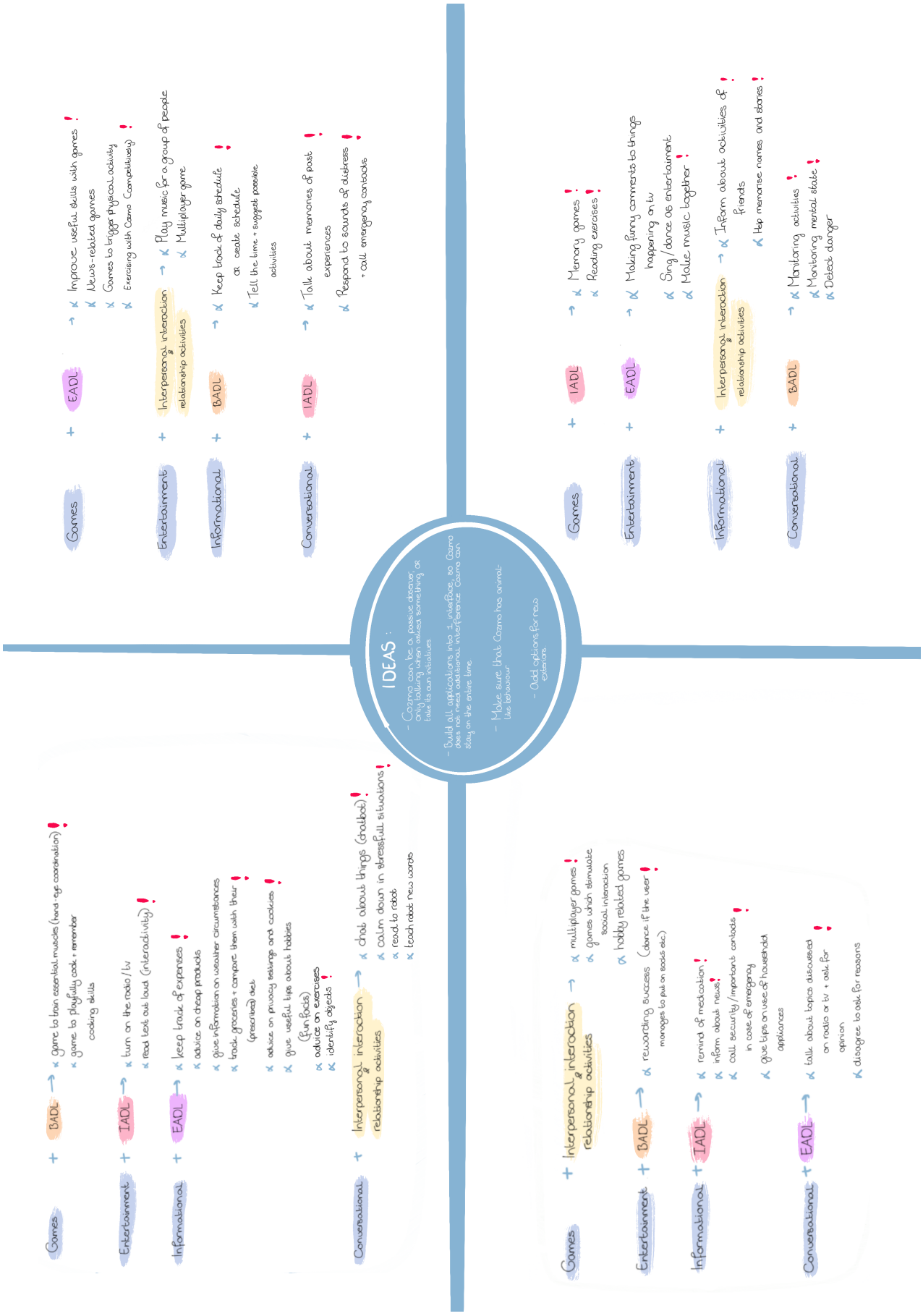


FIGURE 6.4: Combinations which lead to design ideas

6.6 Conclusion

This chapter has described the ideation phase of this project. It is important to keep in mind that this was is an iterative process, and new things were constantly added and removed to come to these possible applications. The final ideas from this phase are:

- Create a game/exercise which trains essential muscles
- Create a game / exercise which improves flexibility
- Create a game which can improve useful skills, such as reaction speed
- Create a memory game to train memory
- Let Cozmo sing/dance as entertainment
- Remind of medication
- Let Cozmo tell the time
- Give information about words
- Let Cozmo calm down the user in stressful situations
- Make Cozmo able to monitor the mental state/emotion of the user

These applications will be prototyped, and tested with the stakeholders. Details on the design of the prototype will be discussed in the next chapter.

Chapter 7

Conceptual design

7.1 Introduction

The final ideas from the Ideation (Chapter 6) need to be worked out in further detail before it can be made into a prototype. This chapter discusses the process of the specification towards different designed prototypes.

7.2 Method

Each idea from the Ideation was further worked out while keeping the information from the first few chapters in mind to base the final decisions on. Eventually, a complete prototype was created, which connected all the different parts.

First, the different ideas were compared to each other, and combined where possible, to avoid creating too many non-coherent applications. Then, the ideas were analysed and feasible ideas were chosen to make into prototypes. This was done ordered by activity type; games, conversational, entertainment, informational.

Then, besides focusing on the specification of the activities, additional attention was given to the final behaviour and speech of the robot, to make the prototype complete. Eventually, this phase led to a worked out prototype of Cozmo, which can be implemented for user testing.

7.3 Results

7.3.1 Games

Three game ideas came forward in the Ideation:

- Game for muscles
- Game for flexibility
- Game to improve reaction speed
- Game to train memory

Since independent living is important for elderly people, their muscles should be adequately functioning for them to do their BADL. This means that exercises should focus on training of arm muscles, which are necessary for eating, dressing etc. Also, I wanted to ensure that the exercise was accessible for all seniors, even with impaired mobility. Therefore, different exercises while sitting down were researched [43] [44],

and compared to Cozmo's possibilities a final one was chosen. The result is a simple activity in which the user should raise and lower their arms while carrying a small weight, meanwhile Cozmo accompanies them by doing the same with one of his cubes. This will make the user feel as if they are doing the exercise together and give them extra motivation to continue. At the end Cozmo asks whether they liked the exercise for future use, and to tap a cube for "yes". This makes it possible for Cozmo to become more personal to the user, and make the user feel validated.

Flexibility in seniors is also crucial to do their BADL and other activities. Therefore, a short exercise of yoga was added to the list, which also helps elderly to relax and wind down. By using a robot to do the exercise with the user, they feel less alone, and are given more assurance about their actions. Also, the robot helps if they feel scared to do yoga alone, or do not know where to start. The yoga exercise is based upon a video[1] "7-Minute Yoga Workout for Older Adults", and for testing purposes only the first two minutes were used. Additionally some music was added to complete the relaxed feel. An illustration of this activity is shown in Figure 7.1.

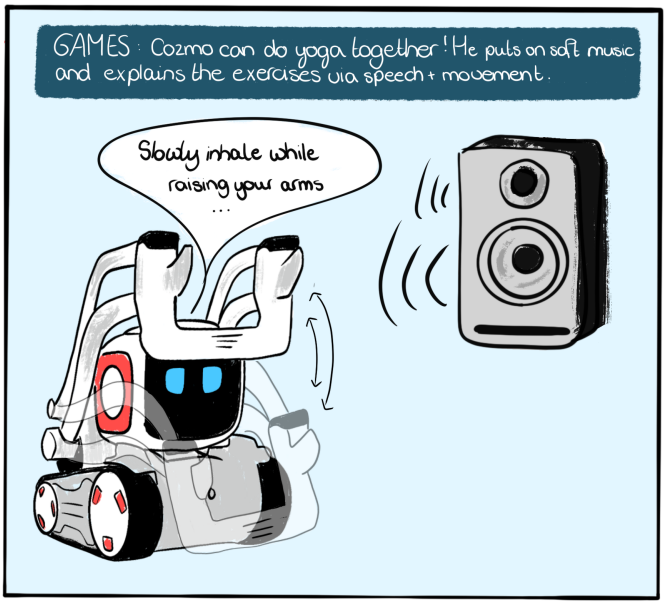


FIGURE 7.1: Cozmo doing yoga

A game for improving reaction speed was chosen from Cozmo's existing games from the SDK, as created by Anki and inherent in every Cozmo robot. This simple quick-tap game is safe and simple for seniors and other ages. Also, the blinking LED's make it possible for people to see it even when their vision is declining. The final reason for choosing this specific game is because it can easily be expanded to play with two people, supporting social interaction which is crucial as indicated by the interviews and research. A visualisation can be found in Figure 7.2.

Lastly, a game for memory was created. The criteria for this game was that it should be easy to understand, and even easier to play. Therefore, a verbal game was favored over any other game. In addition, the game had to speak to the senior users, so preferably the game was known to them from their childhood. This resulted in the well known Dutch game from the ideation phase "Ik ga op vakantie en ik neem

[1] https://www.youtube.com/watch?v=NDLad2vOHkU

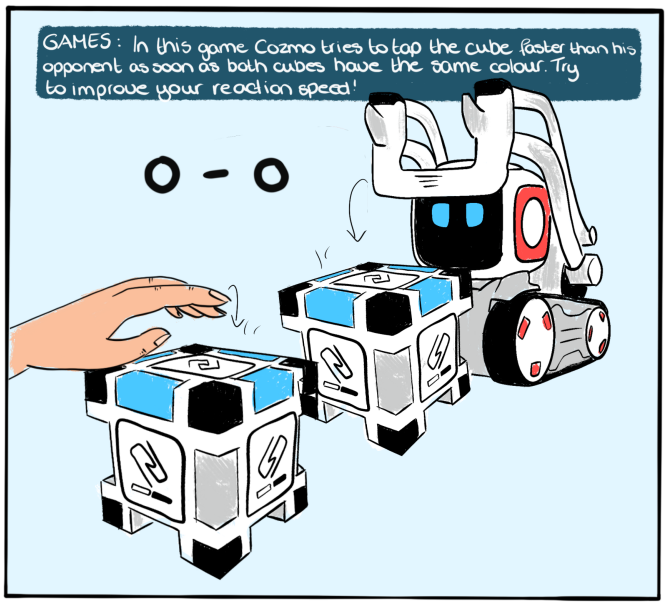


FIGURE 7.2: Cozmo doing quick-tap

mee". For this game Cozmo will be able to add and check the list which was said by the user. When their answer is wrong, or they repeat one of the words, they lose the game (Figure 7.3). In order to make the users feel necessary, the robot learns all the words which are said during the game, so the elderly user 'teaches' the robot.

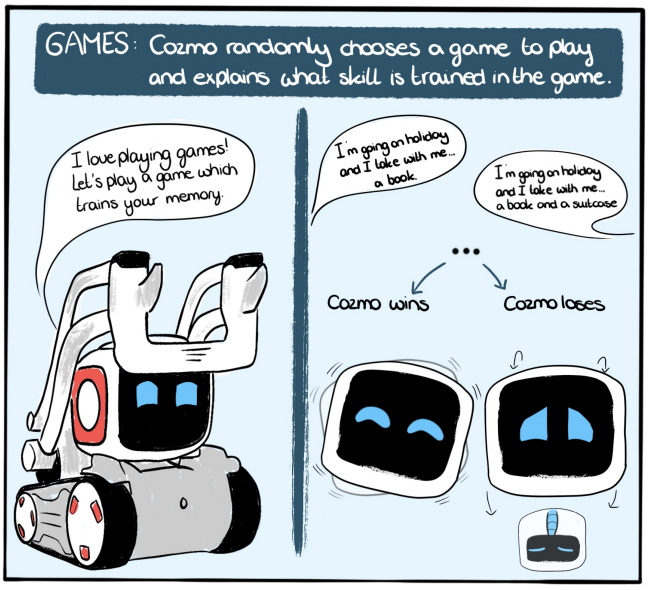


FIGURE 7.3: Cozmo playing the holiday game

In order to motivate the elderly to participate in the games, Cozmo should mention the beneficial effects beforehand. This was said to be useful as motivation in the interviews (Chapter 5).

7.3.2 Conversational

Two applications came forward in the ideation:

- Calm down the user in stressful situations
- Ability to monitor mental state/emotion of user

These two applications were combined, to make Cozmo able to respond to a perceived emotion. This was chosen as loneliness is a problem for many elderly, and a robot could aid them in expressing their emotions, so they do not have to do this alone and get the chance to ventilate their feelings. Therefore, the robot should be able to capture and 'understand' emotion and respond accordingly. The main difficulty is in responding to the emotions in a good way. The happy emotions can get a simple response, but Cozmo should respond more accurately to distressed emotions. For anger he should ask "what is wrong" and let the user blow of steam. For sadness a different approach should be used, so for this an entertainment application was chosen; singing. This will be discussed further in the next section.

7.3.3 Entertainment

For this category one activity was chosen:

- Singing

In the interviews it came forward that music could have positive effects on the mental states of elderly. Therefore, this was used to respond to emotions of sadness. The chosen song is a Dutch ballad, with a friendly melody, to calm down the user or cheer them up. In addition to singing the song, Cozmo will be dancing to the music.

7.3.4 Informational

For this category two activities were brought up during ideation:

- Remind of events / set alarm
- Give information about words
- Tell the time

Due to the decline in memory of most seniors, it is useful to let Cozmo remind them of events, such as medication. Since seniors who live alone do not have anyone to remind them, Cozmo could take this role. I chose to have him behave human-like; reminding the user with speech, instead of a ringing alarm, as to not scare the user.

For similar memory reasons the next application was made. Simple questions about meanings of words, which would normally be asked to a friend or spouse, can be asked to Cozmo, which has access to a database of definitions, so he can always help. Due to the decrease in memory, forgetting words and their definition, becomes more frequent. So Cozmo asks for the word and tells the user the definition. When Cozmo does not yet know the word, he asks the user to wait, and looks it up. As soon as he has looked up the word, he adds it to his dictionary so he knows it in the future. Besides increasing the speed of his answers, this also adds a teaching element for the elderly, boosting their feelings of usefulness; every word they ask to Cozmo he learns more.

To help seniors stay aware of their surroundings and schedule, Cozmo should be able to tell the time. This is a very small addition to the prototype, but implemented to increase his help as a reminder. This is especially practical for Cozmo, as him being a programmed robot means that he will never accidentally 'forget' to tell the time.

During the first two trials of the user testing it became clear that the possibility of Cozmo reading the news was also very interesting to keep elderly up to date and connected with the world. Therefore, this was added to the initial list of activities.

7.3.5 General

Since many applications and interactions require speech, Dutch speech has to be added to Cozmo. The details of the implementation of speech is discussed in Chapter 8. To make the users able to fully interact with Cozmo independently, all activities were connected, and made accessible via speaking to Cozmo.

In the beginning Cozmo wakes up and starts independently driving and looking; no interaction from the user is necessary. This makes it possible for the user to continue their activities while Cozmo is ready to help, without feeling lonely or pressured into interacting with Cozmo. When the user calls Cozmo, there is a possibility that he does one of three things before asking the user how to help: reminding them to drink water, telling them the time, analysing their emotion and acting upon it. However, he can also randomly do none of these things. Then he will (always) ask "how can I help?", and the user chooses between different categories: games, exercises, information, and setting an alarm. An illustration of this is shown in Figure 7.4. After finishing the activity Cozmo will go back to his free play mode, and the user can call him for more activities, or tell him to go to sleep. In the last case, Cozmo will start to look for his charger, drive onto it, and turn off.

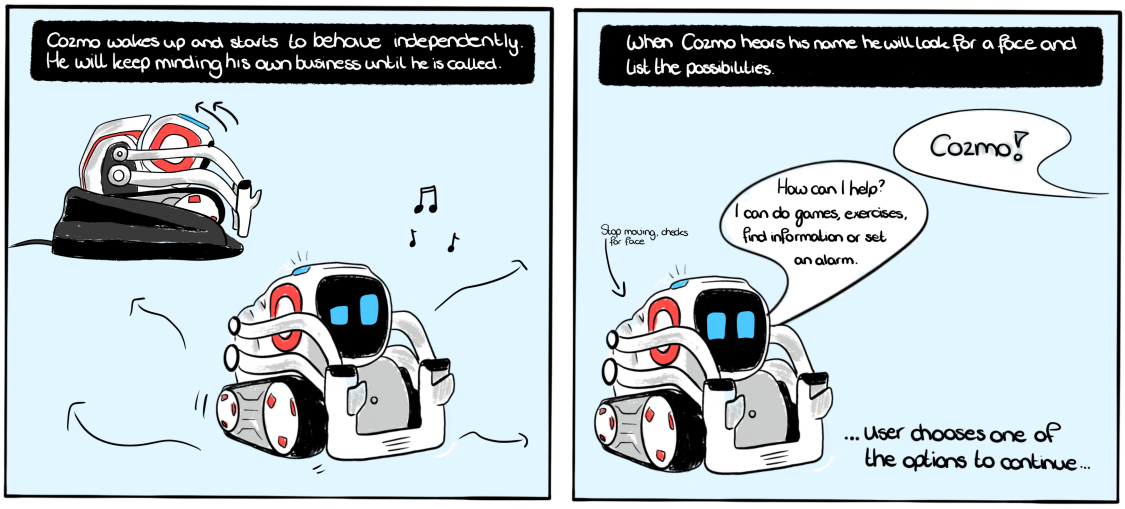


FIGURE 7.4: Cozmo starting up

Chapter 8

Implementation

8.1 Introduction

In this chapter the workings of the final prototype will be explained in more detail. More in depth information will be given about the used modules, existing scripts and overall functionality. The different parts will be explained in the order that they run when the prototype is started.

8.2 Method

The code handling the behaviour of the robot is all written in Python. Different libraries were used in the process of building the script. Moreover, all different parts were programmed in separate scripts at first to ensure that they all work independently. Later, all these scripts were added as packages to the main Python program.

After this, the main program was made to control all of the separate scripts, and make the whole experience more fluent. Lastly, some additional changes were made to the prototype to enable better user testing with regards to the current Covid-19 crisis.

8.3 Program

The general setup of the files is shown in Figure 8.1. This figure shows how the different files are connected and which parts call each other. Each colour box means a different type of file, so dark blue is python scripts, light blue are folders, and grey are text files. The 'pitchshifter' folder was downloaded from CWoodall on GitHub[1] and only used to pitch the speech, since the internal workings are not relevant for the scope of this paper, only the folder was added in the figure.

Orange: The main script is responsible for the basic behaviour of Cozmo, and for starting and maintaining the loop. This ensures that Cozmo behaves freely until he is called, this means that he is in free-play mode and navigates and responds to his surroundings independently (this is done by calling a standard function from the Anki SDK). When his name is called, a random boolean will determine whether the the choice_menu script is called, or randomly one of the three **sub-activities** will be played directly from main (reminding of water, time or recognizing emotions). The main.py script also ensures that Cozmo searches for a face before he continues to the choice menu, and that he goes back to sleep as soon as he is requested to.

[1] https://github.com/cwoodall/pitch-shifter-py

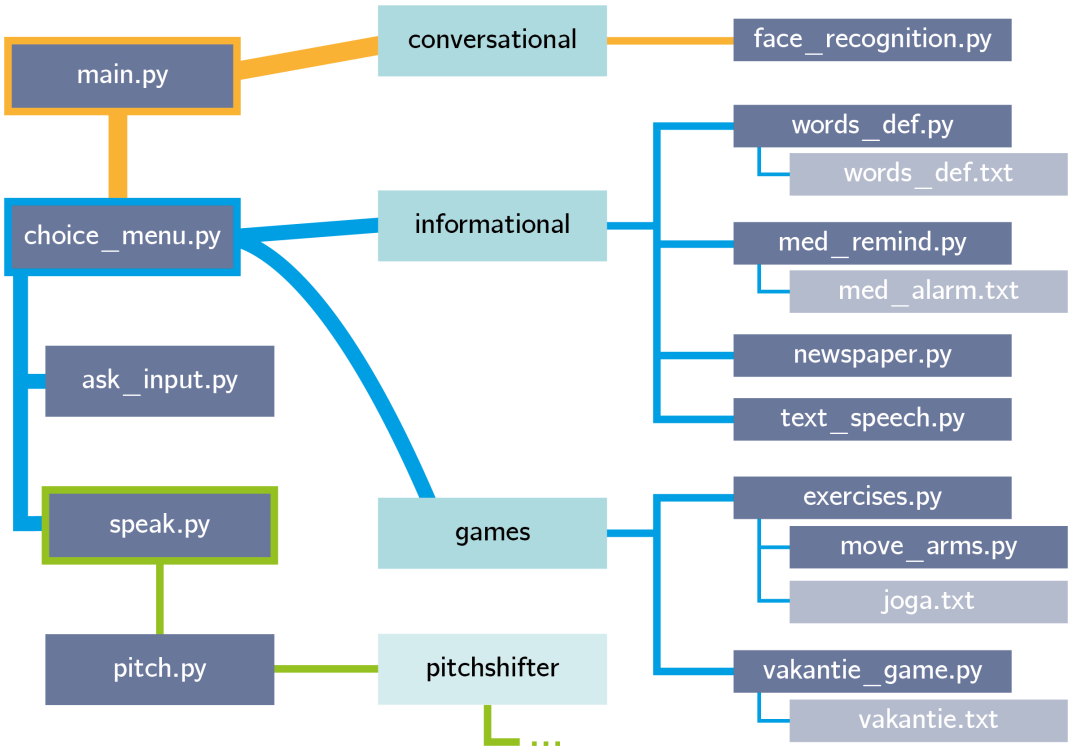


FIGURE 8.1: Overview of workflow of program

To make the conversational aspect of Cozmo feel natural and more spontaneous, this will be randomly called from main, instead of being chosen in a choice menu. This means that every so often Cozmo will ask the user how they are doing, and respond to their emotion, which is closer to the random nature of actual human interaction.

Blue: The next step is the choice menu which handles the input from the user to choose the according subcategory. The input is done via Speech Recognition, while using Google's API, and allows the user to 'speak' directly to Cozmo. However, since Cozmo does not have a microphone, this was actually captured by the connected laptop. To exemplify, when the user says any of the words ['info', 'help', 'information'] the word_def file will be called from the choice menu. The same holds for all the other possible categories. The choice menu is also responsible for passing imported arguments to the rest of the program, to avoid multiple imports. After finishing the activity of the chosen script, the user goes back to main.py.

For informational, both files words_def.py and med_remind.py add their information to a text file, to make it possible for Cozmo to do some basic 'learning' while interacting, which he remembers for future cases. The words_def and text_speech have been fully developed and can be executed in full, however, the newspaper and med_remind only have the functionality which was necessary for prototype testing. Meaning that as to now Cozmo cannot read all newspapers by himself, and the alarms will not actually go off in time.

For games, the exercises.py file handles the different kinds of exercises that Cozmo can do. The yoga.txt is called from the yoga method in exercises.py, and makes it possible to quickly add or change the yoga exercise. The vakantie_game.py stores all the used words to vakantie.txt which allows Cozmo to learn new words while

interacting. Besides the fact that this takes away the workload of adding all holiday-related words to his vocabulary, this also makes Cozmo appear as if he is learning, as he can now say words previously said by the user. Both scripts have been fully developed to a working prototype, all based upon speech recognition.

Green: These files are responsible for giving Cozmo his Dutch voice. All the other files import the speak.py package so it is easy to make Cozmo speak. The command would be as simple as "sp.speak('Hello, I am Cozmo')". Furthermore, the speak.py file handles the removal and creation of new audio files, which will be discussed in further detail in the next section.

The text_speech.py is not used directly in the prototype, but was added to make it possible to have a 'conversation' with the user, if wanted, by typing responses which Cozmo would say. Also, the quick_tap.py file was not included in this framework as it was already existing, thus for testing the existing file was called directly from the command prompt, as this proved to work more efficiently and correct.

8.4 General

It is crucial to enable Cozmo to speak Dutch for user testing. Unfortunately this was not possible by accessing his own sound module, so a workaround was made. This meant using the Google Text to Speech API, which saved the audio files as MP3 files. Then, the MP3 files were converted to WAV files, which made it possible to shift their pitch with the pitch-shifter program. This choice was made to avoid the *uncanny valley* by using a human-like voice. The chosen pitch shift was between 3-5 semitones, this resulted in a higher voice which was still recognisable to the user. Then, the new WAV file was saved as to a specific name and played via a bluetooth speaker located closely to Cozmo. For optimization of speed, the first MP3 and WAV file are deleted after they have been used. Also, before creating a new audio file, the program checks whether or not the file exists already. To avoid situations in which the save-names of the files correspond, but their contents do not, a bool was added which indicated that a file should always be added new (used in face_recognition.py and vakantie_game.py).

8.5 User testing adaptations

In pre-trials it became clear that speech recognition did not work (accurately) through video-call sound. Unfortunately, this was the setting due to the Covid-19 crisis which meant that the only possibility was online testing. Since the state of the art has shown the importance of such a functionality for adequate interaction, additional code was added to make it possible to type all the commands into the command prompt. This way it would feel as if the user was directly giving Cozmo commands, while also ensuring that the prototype functioned properly.

Moreover, after the first two trials, it became clear that the voice of Cozmo was hard to follow for elderly via the added distortion of a video-call. Therefore, all 'standard' texts were recorded again by myself, making it possible to add correct intonations, and the recordings were then pitched slightly. Also, the recordings were stretched to be longer, as during the interviews it showed that the elderly had trouble with the speed of the speech as well. This same process was done for the song that Cozmo 'sings'. First my singing was recorded normally, and then it was pitched slightly

to become Cozmo's voice. Basically, this process resulted in his voice being a mix between a small child and a robot.

8.6 Video of prototype

In addition to the user testing, a video was made to show the prototype to the participants who were unable to join for the evaluation session, and for interested family and friends. When interested in this research, please watch the video for more in depth visuals on the prototype. The video can be found on YouTube via the following link (*https://youtu.be/A6pJnvpV1nQ*).

Chapter 9

Evaluation

9.1 Introduction

After the final prototypes were realised, the ideas were evaluated with the stakeholders. This evaluation aims to show which ideas can potentially work well and which ideas have little potential according to the responses to the robot of the stakeholders. This is done specifically in order to get an answer to sub-question 3 and 4; what activities have potential for a positive effect on the lives of the elderly, and what are the implications for the professional if such a robot is implemented in their field? In addition, the evaluation will provide insight into the implications of the ideas for care professionals. During this phase several interviews will be held for user testing.

9.2 Method

The prototype was tested via online services. Due to the Covid-19 crisis and the vulnerability of some of the participants no risks were taken, so all communication was via phone or video call. This was all done in accordance with the ethical committee. Dependent on the possibilities per participant the following services where used:

- WhatsApp video-call
- Skype

Note: The first test with WhatsApp video-call showed that the sound transfer of Cozmo's voice was very bad. Therefore, a new setup with a YouTube live stream was created as this allowed me to use a high quality microphone which could only be attached to my computer. This was tested with one of the participants who did not have access to Skype, which was common for the elderly participants. Unfortunately, this live stream was banned by YouTube, as Cozmo received a copyright claim. The interview was completed via the initial WhatsApp video-call service, by placing a small microphone next to the speaker for better sound.

So, for the testing the participants were shown Cozmo and his attributes over a video connection, an example of what they saw during testing is shown in Figure 9.1. They were able to give commands to Cozmo via the call. Since the microphone used for speech recognition was not able to accurately pick up the speech outputted via a phone or computer speaker, a text input possibility was added, so all commands were typed according to what they said by the researcher. This was unknown to the participants. This way the participants were able to 'control' and play with Cozmo. In addition, a short demonstration of the rest of the applications they did not explore was given by the researcher. Since the testing was difficult in this online session for

some of the participants, sometimes a few ideas were discussed without them interacting with the prototype. However, the prototype was used as much as possible.

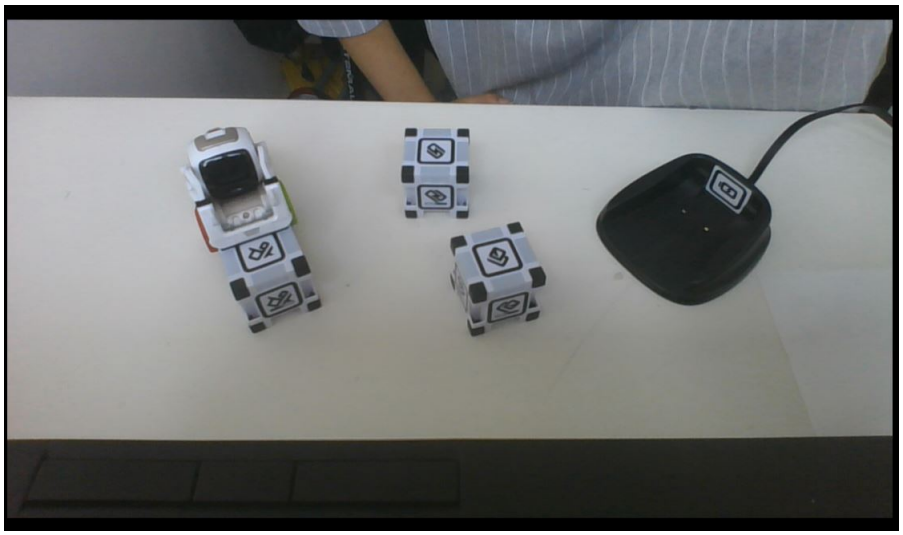


FIGURE 9.1: Set up of Cozmo as seen via video call

After this initial play-round the participants were asked questions about their experiences and invited to give feedback. The questions can be found in Appendix C. In general the questions covered the participants' opinion about the activities of Cozmo, about what parts they thought were useful and which parts were not. They were also asked for possible additions and their general opinion on Cozmo and its behaviour. Similar to the previous interview phase (Chapter 5) the experts were asked additional questions relating to their perceived impact of such a robot on the care professionals. The rest of the interview was similar for both stakeholder groups. During the interview there was also room for questions from the participants, to help them understand the workings of the robot better. Again, the interviews were held in Dutch, and the findings were later translated for this thesis.

9.2.1 Participants

For this phase some of the previous participants were interviewed again. However, some new participants also contacted me to join as they had heard about this research via some of the previous participants and found the topic very interesting. Similar to the first interviews there are two groups of participants; seniors and experts. The total number of participants for the user testing is 8.

ID	Age	Additional notes
A	78	Very active, little physical difficulties.
B	80	Very active, little physical difficulties
C	85	Visually impaired
D	82	Little to no physical difficulties. Vision is deteriorating.
E	78	Reduced mobility

TABLE 9.1: Participants above 65 (n=5)

ID	Currently active y/n	Field of expertise
1	No	Experience in care homes, home care, hospital, hospice care
2	No	Physiotherapy

TABLE 9.2: Expert participants (n=2)

9.3 Results

During the user testing it became clear that the participants who found it difficult to imagine possibilities for a care robot at first, were now eager to come up with new possibilities for the robot, after seeing Cozmo. This shows the importance of using a tangible prototype for user testing. The remarks gave new insights, and some of them were even implemented between trials, to test with new participants (as discussed in Chapter 8). The results of the user testing will be discussed in three different themes; first, the general comments on Cozmo and his behaviour will be discussed. Then, the specific remarks on his activities will be reviewed. Finally, the additional comments of the users on new possibilities for Cozmo will be discussed.

9.3.1 General

The general reaction to Cozmo was surprised amusement and endearment. When participant C first saw Cozmo move they immediately starting talking to him in a friendly manner, as if one were talking to a child. Participant A also thought he was a funny guy, and could not stop laughing at his free play behaviour. The following quotes show how Cozmo caused amusement in his audience, all quotes have been translated to English.

"Oh, look at that little guy! Come on, good boy!" - C
"*Laughter* look at him go with those cubes! He is amusing himself clearly! *Laughing continues*" - A

The participants did not all agree; A liked that Cozmo's voice and look were be robot-like as "a robot is a robot", but B found him "too mechanical" for 'normal elderly'. Nevertheless, B thought that he would do great in a care home, as he is cute and likeable, while supporting crucial activities for elderly.

Animations

Furthermore, participants A, B, C, and D all found Cozmo's animations very amusing, and said more should be added to the prototype to make it more human-like. Participant B even attributed human emotions to Comzo, saying that he was"being very excited". All of them agreed that more animations would make him more human-like to interact with. Participant B went on to say that his self-willed behaviour made him amusing and entertaining.

Speech

Nevertheless, there were also some points of improvement. Both participant A and B found it difficult to understand Cozmo's speech, both due to technical disturbances and to his voice. Therefore, the speech of Cozmo was changed after two trials, as discussed in Chapter 8. Whereas participants A, 1, and 2 said it did not matter if Cozmo had a childlike or a human like voice, both B and E said that his childlike

voice make him more likeable to interact with - “His cute voice makes people more likely to treat him nicely, as he sounds like a small child” - B. On the other hand, participant 2 noted that seniors with deteriorating mental health might be frightened by the robot; “we know that it is a robot, programmed by [researcher], but I can imagine that it may be frightening if you don’t understand it, and an object suddenly starts moving and talking”.

Also, the experts thought that the manner of speaking should be changed to a more respectful (saying “u” instead of “jij” in Dutch) and serious manner at first. Participant 1 explained that in their job they would “always use the "u"-way of addressing clients, and speak in an adult-manner to make them feel taken seriously”. However, after interacting with Cozmo participant 1 and 2 came to the conclusion that when Cozmo is seen as a buddy rather than a carer for the user, his manner of speaking is not bothersome. Participant 2 did add that it was useful if the robot could ask for the user’s preference, to ensure that they do not feel disrespected.

Spontaneous interaction

Furthermore, when the participants were interacting with Cozmo it became clear that they expected more direct responses from him. For example participant C told Cozmo that he “did a great job!” when he explained the meaning of a word. Then they waited patiently for a response, asking “Oh, did he not hear that?” when Cozmo remained quiet. Adding ’spontaneous’ communication interactivity appears crucial after experiencing similar cases with participant A and D.

Possibilities for Cozmo

In short, Cozmo was described in a variety of ways. He was called a cute companion, which could help with everything; an amusement robot; useful for lonely and bored seniors; a trigger for people to stay included; a carer; and a buddy. More specifically, participant 1 said that Cozmo would work particularly well to motivate people to be more active, and participant D said that “it would be great for lonely people to have as a person who is close to them”. Participant E agreed, since “life becomes more quiet when you grow older and live alone. (...) You miss a companion in your life”, she repeatedly expressed “how many people would have been helped by this robot. Especially now during Corona...”. An interesting description was given by participant 2, who said “Cozmo would work well, as he helps to make the day a little bit more appealing to his users”. This remark was backed up by participant 1.

9.3.2 Activities

To continue, the trials showed that several activities proved useful. The results will be discussed per category; sub-activities (emotion recognition, water and time reminders), and main applications (games, exercises, information and alarms).

Sub-activities

All participants except participant 2 thought the emotion recognition had potential, but 1 and D also noted that Cozmo’s ability to respond accordingly was important. This would make lonely people “feel seen or cared for” - 1, and enables you to “blow of steam” - A. However, participant 2 thought it would be best left out, as the robot could not “do anything with the information on their emotions, and it will only bring

up feelings and leave them to deal with it alone". This statement was contradicted by participants D and E, "when you feel sad, you don't want a solution, you just want someone to listen to you. In the end you will always have to find the solution yourself. You just need to be consoled" - E. E also added that they could definitely use some distraction when they were distressed, since "many terrible things happen when you grow older". Participant 1 suggested that Cozmo could ask "how do you feel?", as an open question would make it less intrusive, and allow the user to not reveal their true feelings while the question would still let them feel cared for.

During testing, all of the participants spontaneously smiled when Cozmo started to sing, showing that this was working to bring joy to peoples lives or console them. In addition, the reminder to drink water was received very well, and all(!) of the participants im- or explicitly mentioned that seniors often forget to drink enough water, as their thirst-feelings fade. During the trial participant 2 even got up to get a glass of water themselves after Cozmo previously reminded them, and came back saying "look Cozmo, I just got a glass of water", while showing the glass in front of the camera. This revealed that a simple reminder could work for everyone, and also that the users expected some kind of a response from Cozmo after they followed his advice. The participants also saw a lot of potential in Cozmo telling of the time to keep the user reminded of their daily schedules. Participant E mentioned it is "very hard to maintain a structure when you are living all by yourself, so this could definitely help", which participants C and D agreed with.

Main applications

Participant D was especially enthusiastic about the reaction games, explaining how the high speed of Cozmo's reaction was a good challenge to "keep the seniors on their toes". When asked whether they would personally like to play this particular game, participant B explained that they did not personally like to interact with a robot, but participants A, C, D and E all said yes, as they clearly saw how it would benefit them.

The same reaction was towards the memory games and exercises, and the possibility to customize the activities by pressing the button was regarded as a good addition by both experts. The option to teach the robot new words in the holiday game got positive replies especially by D and E, "definitely keep that part!" - D, and E explaining that "you just want to feel needed". Another interesting insight came while doing the arm exercise; participant A tested whether Cozmo would continue his exercise when they were not participating, explaining that it would make more sense if he could check and point out when someone was not participating. Participant 2 agreed, and explained that the robot had to give some specific feedback and monitor the movements, otherwise there would be little added value, but needed to do so in a friendly manner as to not scare the user. Also, participant D was skeptical towards doing yoga with a robot personally, but saw potential for others. On the other hand participants A, D and 1 were all very happy with the option to do yoga, to keep the elderly active and flexible.

The informational activities also got positive feedback. Participant A kept asking Cozmo for difficult words, saying "I am sure he does not know this!", and was surprised when Cozmo did find a definition. Participant D pointed out that often they would know the definition, but not the word, so the functionality should be the other way around. The alarm functionality was regarded as useful, but participant

	Activity	**Positive points**	**Negative points**
Games	Quick-tap	Good for reaction speed, useful for elderly	Difficulty should be adaptable to user's needs
	Holiday game	Good for memory, useful as seniors become more forgetful	
	Yoga	Fun, good to relax and not be alone	Not everyone likes yoga
	Arm-exercise	Fun exercise, cute that~ Cozmo uses his cube	Should monitor the activity, and give specific advice
Conversational	Respond to emotion	Nice feature, good to feel cared about	Should be more lifelike, more additions and responses
Entertainment	Singing	Very nice, brings a smile to faces	More songs, especially children's songs
Informational	News	Good to stay informed	Add customization possibility of what you want to hear about. And tell this on robot's initiative
	Word Alarm	Good, useful when you forget a word Useful, nice to get gentle reminders	Works best the other way around Already many possibilities for this
Extra	Water	Very useful to ensure that elderly drink	
	Time	Helps staying aware of schedule when alone	Should be given every hour, so it's less random and more clear for the user

TABLE 9.3: Evaluation of activities

C and D rightfully noted that there are already many existing systems for that, so they were unsure if they would use it. The experts and E however, thought Cozmo's friendly alarm/reminder would have added value, as it feel more "like buddy who reminds you" - E.

Furthermore, C especially liked the possibility of reading news flashes, as this was difficult for them due to visual impairment. According to participant 1 the news of Cozmo should be given "on the robot's initiative (...) I can see that the elderly will become more excluded from society if they don't get information easily, so they should be 'given' it without effort from their side. To ensure that they keep connected.", they recommended using a function similar to the one used for the sub-activities to randomly tell the news. In addition, participant 1 and 2 suggested using local news as this "speaks more to their imagination." - 1.

A short overview of the results of the evaluation on the applications for Cozmo is shown in Table 9.3

9.3.3 Additional possibilities

During testing many new ideas were presented from the elderly, as the working robot made it more understandable. Some suggestions have been listed below in Table 9.4, with the participant(s) who mentioned it and the application category. After the first two trials, the ability for Cozmo to inform about the news was added, so this has been excluded from the table.

Category	**Idea**	**Participant(s)**
Games	'Finish the song' - game	C
	Exercises for mobility of hand muscles	A, C, E
	Challenge in knowing trivia	1, D
	Play checkers	C
Conversational	Ask questions about the news	C
	Direct responses	A, B, C, 1, 2
	Talk about their past	1, E
	Notice if someone is sitting for long, and motivate them to get up	2
Entertainment	Add more childhood songs	A, B, C, E
	Make music together	A
	Play music during exercise	2
Informational	Give synonyms of words	A
	Answer simple fact-questions	1, 2
	Remind of location of objects, happenings, phone numbers etc.	D, E
	Read stories	C

TABLE 9.4: Recommended additional activities

9.3.4 Implications for professional

Both professionals were interviewed in the earlier stage of this project as well. Some overlapping comments have been excluded from this result section. Since both experts have experience in different aspects of elderly care, the results will be discussed per field. Lastly, the general remarks on implementing such a robot will be discussed.

Personal elderly care

Participant 1 said that the robot could be a great help especially in "monitoring and managing medication use". After all, the robot would be with the senior all the time, where the experts usually have tight schedules and cannot remind a person every few hours. In addition, participant 1 commented that the robot would be useful to keep the seniors active, "for example (Cozmo) could say: you have been sitting in that chair for a while now, let's get up and walk a bit". Even though robots should not replace humans, the addition of a robot could improve the quality of life of the elderly according to participant 1, "even if it is just because now they can talk to someone about the robot".

Physiotherapy

In this domain participant 2 saw potential in Cozmo as "an extension of the physiotherapist". Cozmo could activate and stimulate the elderly to move, by reminding them, or playing music to motivate them in their activities. As mentioned before, participant 2 emphasized the importance of Cozmo being able to monitor the activities and his surroundings to give specific comments.

To be used in this domain, it would be "useful if there were packages of exercises installed on Cozmo" - 2. This way, the therapist could choose one of the packages (e.g. exercises for arms) and Cozmo would do these with the client.

General remarks

Both experts emphasized that Cozmo should be personalized for each client and their needs. They suggested that an intake would suffice after which the robot could be programmed to fit the user's needs. For example, if client X always watches the news, it makes no difference for Cozmo to randomly give updates as well, or if client Y cannot move their arms, the exercises which are proposed should take this into account. Participant 1 called this "customized care", which was a big part of their profession. The experts proposed that the caregivers would inventory the needs of a senior, and if they are eligible for a robot, I (the researcher) would be called to do the intake and set the correct settings on Cozmo. This means that the care workers would not have direct contact in managing Cozmo. As explained before, this direct contact is wanted for the physiotherapists. Participant 2 stated that it should be clear that the robot is an addition/extension, and not a replacement. If the robot becomes part of the care sector and functions as an extension, both 1 and 2 do not expect the work field to change negatively.

9.4 Conclusion

To conclude, the users greatly enjoyed Cozmo as a prototype, but this may be due to the novelty effect. It became clear that multiple activities have potential for an elderly audience, even though not all participants agreed on the target group; "Oh no not yet for me, I can do all that myself. But my sister who used to be in a care home ..." - B, or "Oh I would love to have someone like him during lonely times" - E. Especially activities which helped with social inclusion (news), and health (remind to drink water and take medication) received positive feedback. The games and exercises were regarded less crucial, but useful to motivate elderly to keep up their skills. Some activities could be added, and importantly the users wanted Cozmo to be more equipped to directly respond to his surroundings (recognize when someone is not doing an exercise, respond to conversation directly etc.). The testing has also given insight in a key criteria for elderly users; they want the robot to act life-like, meaning that he should express, understand and directly respond to emotion and conversations. The experts both gave their opinions on the possibilities of Cozmo in their field, and again highlighted the importance of communication with the care professionals during implementation. They also showed that different fields of care have vastly different wishes for operating the robot, which should be taken into account during development. However, they said that most experts would be willing

to accept a care robot as long as they know what advantages it brings to their profession. If implemented correctly, the experts expect little trouble or changes in their field by the implementation of an elderly care robot.

Chapter 10

Conclusion and discussion

This research was done to find out what activities are useful for seniors, and how this could affect the elderly professionals. In order to find an answer first literature and state-of-the-art was researched, and interviews were conducted with the stakeholders. Based upon this, promising new ideas were developed and implemented in a prototype, which was tested with the stakeholders for evaluation. This research has shown that activities supporting independent living (especially BADL), and social inclusion and interaction, have the highest potential. Additionally instrumental activities (e.g. games and exercises) would be useful to keep the seniors active in a meaningful way. The care professionals suggest that the key to successful implementation is communication, and if this is done correctly, conclude that their professions could benefit from use of a social robot.

10.1 Contributions

The ways that this research has contributed to the field of robots for seniors can be discussed in three groups; the systematic approach of the ideation to create new ideas, the multiple application ideas, insights in the potential of these ideas in the opinions of elderly and experts.

First, the systematic way of creating new ideas by combining two frameworks on the wishes and possible solutions of a problem. In this case this was done by first creating an overview of the different activities for elderly, and matching the overview of different types of applications of Cozmo to it. However, this way of ideation can be used for other robots or brainstorm purposes as well. The value of this method is that it allows the researcher to cover a large ideation space, while staying within the boundaries and possibilities of the project.

The resulting richness in new ideas is a contribution to the field in itself. Through systematic ideation many new fruitful ideas were created, and analysed in terms of potential based on the research (literature, SOTA, interviews). Only a limited number of ideas was realised in a prototype, and the longer list of (unimplemented) ideas could have value for other research. Even more, product developers could just take an application from this list and immediately start user testing, making the whole process faster. Also, other researchers could use the list of ideas to investigate new areas they had not yet considered, or as inspiration for new research. In short, the carefully composed list of new ideas is fruitful for new research and even product development.

Lastly, the feedback of the stakeholders on the ideas provide information to experts in the elderly robotics field. Whereas the prototype in itself is no main contribution,

the insights it triggered is a valuable contribution. After all, it shows what ideas the stakeholders find interesting, where they see potential and why. This evaluation is useful for future research, as it shows the opinions of the stakeholders on a variety of ideas. In addition, this feedback in combination with the results from the interviews yielded new insights in the possible effects of a social robot on the professionals in the field. Which resulted in another fruitful list of possible applications to be explored in the future. Since a prototype enables a fluent conversation about different possibilities and allows for new and more precise insights [45], by confronting the experts with a tangible prototype, the advice on implementation and the potential effects in the work field became specific. This made it possible to have an in depth conversation about their needs and wishes for a social robots, and showed that they were rather willing to accept such a robot, if it was taking into account their tips. This is another part of my research that may have additional value for researchers, but also for people who wish to implement or sell their product to the care sector.

10.2 Limitations

Of course every research has its limitations, as so does this research. The effects of these limitations will be discussed in further detail in this section.

A large limitation of circumstances in this work is due to the Covid-19 crisis, which made it impossible to do live interviews, and more importantly live user testing. Because of this limitation I do not know how people would have reacted to the prototype in real life, as they were not able to interact with the prototype themselves. Perhaps, the quick movement and speaking of a robot could have scared them, or they may have showed particular interest in touching the robot to comfort, greet, or praise him, which should be acted upon. In addition, the new way of testing was difficult for the elderly participants, because the only way of showing the prototype was via a method that could not accurately capture the sound. However, workarounds for this problem were created, and the basic workings of the prototype were visible to the user. Despite this limitation of circumstances, I tried my best to do a fun and fruitful user testing, by adding new parts to my prototype to make the testing possible via online services. This type of testing did mean that the stakeholders only saw and interacted with Cozmo for a limited time. In the end, the work around (personally operating Cozmo and typing in the commands from the users) was fine, but this can be regarded as the main limitation of this research.

Due to the Covid-19 crisis it was also not possible to contact people in care homes or current care workers. As a result, the criteria for the participants was changed, and the senior participants that I could contact were mostly still fit and living independently. This made that the interviewees did not always feel the direct need for such a robot themselves, but in that case they were explicitly asked who, in their opinion, could use such a robot. So the target group became more defined nevertheless. Also, they had a lot of information about elderly activities, and many of them had friends or family in care homes which they could relate their ideas to. This limitation also made that most of the experts were (shortly) retired experts, meaning that they had less experience with technologies in the field than the current experts. However, most of them were interested and open to technologies and more importantly, they had a lot of experience in their fields, and seen certain technologies come and go in their time.

Another limitation of this work was the choice of robot. By choosing Cozmo as platform for prototyping the design space became limited to his abilities. Therefore, few ideas have to do with carrying large objects or activities with larger robots. This means that only a specific part of the design space is covered by Cozmo, and more possibilities should be explored to make this research final. However, since it was possible to program Cozmo myself, a lot of different options were testable with Cozmo, thus the design space is rather large despite the limitations. Because of this, the results from this research are adequately thorough and broadly oriented for future purposes. Anyhow, it is interesting to look at different types of robots to make the research more complete.

Chapter 11

Future work

Based upon the topics discussed in the previous chapter, there are a few recommendations for future work that I would like to make.

First and foremost, it would be interesting to do all the interviews and user testing in real life, to capture real reactions, and allowing actual interaction between human and robot. This would also give the participants more time to play and interact with Cozmo. In addition, the participants could be broadened to include people in care homes, and currently working care experts. This extension would give more in depth results about the users and impact on professionals.

Furthermore, the same sort of research can be done with a variety of different robots, to further define the design space, and to come up with ideas which cover a large scope of activities. While doing so, the first five chapters of my work could be reused, and only the last few chapters, starting at the Ideation (Chapter 6) would have to be repeated.

Also, Cozmo could be enhanced with some (basic) machine learning and artificial intelligence algorithms. This makes it easier to interact and customize Cozmo. In this research I already made a start by allowing Cozmo how to learn words through interaction, for example in his games and when he gives the definition of a word. The positive responses have shown that this is an interesting aspect which should be further developed.

Lastly, it would be interesting to completely finalize the ideas which showed great potential in the user testing. Not only in Cozmo, but also in different types of robots, to test which type of robot works best for which particular purpose. This research could compare the different robots while keeping the activities and test people similar.

To conclude, there are many new paths we still need to explore when it comes to robots in elderly care, but as this research showed, there is a lot of potential. If we just keep combining knowledge with other researchers, experts and elderly people, we may be closer to the next elderly care robot than we think!

Appendix A

Interview questions

A.1 Interview questions elderly

1. Do you live independently? And alone or with a partner?
2. What are your daily activities?
3. Which of these activities are indispensible for you? Why?
4. Are any of your daily activities problematic or starting to become problematic? Which ones, and what is difficult about them?
5. What kind of help do you need for these activities?
6. With which other activities could you use help?
7. Do you think technical solutions can help you with these activities?
8. What is your opinion on technology? Why?
9. How could a robot help senior people in your opinion?
10. How could a robot help you? Why?
11. Do you have acquaintances which may need help with activities you personally have no issues with? If yes, which activities are problematic to them?

A.2 Interview questions experts

1. In which functions did you work while you were working in the elderly care sector? Could you elaborate on your activities in these occupations?
2. In what ways do you have experience with elderly care?
3. What are daily activities of elderly people?
4. What activities are problematic?
5. How could you help with this? What do you think is the best way to provide this help?
6. What is the most important while giving care in your opinion?
7. What do you think is the most important according to elderly?
8. How do you think that technology can help with important activities? What about robots?

9. How do you think a care robot could change the elderly care as we know it? Why?
10. What implications do you think a social care robot has for the care workers?
11. Would you advice looking into the use of care robots?

A.2.1 Additional questions for physiotherapist

1. What activities are useful to do for elderly?
2. How could you motivate the elderly to do their exercises?
3. What methods work best as motivation?

Appendix B

Ethical approval form

On the next pages please find the consent form. Due to the current Covid-19 crisis and the inclusion of less technically savy participants, they were asked to give written or spoken consent to the consent form if they were not able to sign it digitally.

COZMO ROBOT IN OUDEREN ZORG

Context: bachelor eind opdracht Creative Technology

Contact gegevens student: Babiche Pompe

Contact gegevens begeleider: Dennis Reidsma

HET ONDERZOEK

Mijn onderzoek gaat over het vraagstuk hoe een robot iets kan betekenen voor mensen op leeftijd. Hiervoor ga ik kijken naar dagelijkse activiteiten, en mogelijke problemen in de levens van ouderen. Ook zal ik onderzoek doen naar de verschillende activiteiten en functies die mogelijk zijn bij sociale robots, om te kijken hoe dit het beste gecombineerd kan worden.

Om meer informatie te krijgen over de doelgroep houd ik interviews met mensen uit de doelgroep en professionals uit de zorg. Vandaar dat het doel van dit interview is om zo veel mogelijk informatie te verkrijgen over de situatie in de ouderenzorg, en wat er nodig kan zijn als hulp. Voor de zorgprofessionals wil ik ook uitvinden wat zij denken dat de invloed van een hulp-robot op hun werkzaamheden zal zijn. Dit interview zal zijn aan de hand van een aantal vragen, en er is voldoende ruimte voor eigen invullingen en vervolgvragen.

Het interview zal ongeveer 30 – 45 minuten van uw tijd in beslag nemen. De verkregen informatie zal anoniem gebruikt worden als informatie die mij in mijn onderzoek leidt.

TOESTEMMINGSVERKLARING

- Ik heb de informatie gelezen. Ik kon aanvullende vragen stellen. Mijn vragen zijn genoeg beantwoord. Ik snap waar ik aan mee doe.

- Ik weet dat meedoen helemaal vrijwillig is. Ik weet dat ik op ieder moment kan beslissen om toch niet mee te doen of te stoppen. Daarvoor hoef ik geen reden te geven.

- Mijn gegeven gegevens worden anoniem / gecodeerd verwerkt

- Ik geef toestemming om mijn gegevens te gebruiken, voor de doelen die in de informatiebrief staan.

Ik geef toestemming om aan dit onderzoek mee te doen.

Naam proefpersoon:

Handtekening:

Datum : __ / __ / __

Appendix C

User Testing Questions

There are four different categories of activities for Cozmo. We will discuss the categories piece by piece. Every category has one or more possible activities which can be done with Cozmo.

The categories are:

- Games
- Entertainment
- Conversational
- Informational

General questions:

1. What is your first impression of the prototype?
2. Could you describe in your own words what he did? Why did he do this?
3. What do you like about the prototype, why?
4. What parts would you change, why?
5. What parts would you remove completely, why?

Questions per category:

1. What activities do you think could potentially work, and why?
2. For what people would these activities work well?
3. What can be added to the activities so it fits the user's needs better?
4. Which activities do you think have little potential to work?
5. Are there people or circumstances in which these activities do have potential?
6. How can we adapt so it is useful for these people?
7. What parts of this activity do you like, why? (e.g. use of speech, sound)
8. What parts need to be changed, why? (e.g. no sound/speech)

Extra - for care professionals

1. How would you use this robot in the elderly care? Where do you see possibilities?
2. Do you think the robot has added value? If yes, why and where?

3. How do you think care professionals will respond to this robot?
4. What do care professionals need when such a robot is implemented? (e.g. training, information etc.)
5. How could we ensure a smooth implementation of such a robot in the elderly care sector?

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