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KeepsakeBox: Insertion and Validation of Images in the Platform

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Mestrado em Engenharia Informática

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2023

Acknowledgments

First of all I want to thank my teacher and thesis advisor Prof. Doctor Manuel João Caneira de Monteiro Fonseca, as well as Prof. Doctor Soraia Alarcão, for always being available to help me and answering all my questions and accompanying me during the course of this project. They showed immense flexibility which helped me immensely due to me studying and working at the same time.

Special thanks goes to my parents and brother, who were always my rock and supported and believed in me every step of the way.

Thank you to my friends who for helping me whenever I needed. I also want to thank my work colleagues, who were very helpful and understanding during the duration of this project. Special thanks to my friends and university colleagues Brian Marques and José Domingues.

Lastly, thank you to the caregivers who kindly took time out of their schedules to help us during this project, their contribution was invaluable in assuring the quality of this work.

To my parents and brother

Abstract

Dementia is a disease that affects mostly older people and gets worse with age. It is most commonly associated with memory impairments, behavioral changes and other forms of cognitive deficiencies. There is currently no cure for dementia. However, there are treatments that can prove effective in improving the overall health and well-being of people with dementia. One of those treatments is Reminiscence Therapy. It consists of exposing patients to stimuli such as photos, audio and videos, with the aim of helping them relive past experiences and evoke pleasant memories about those events. The objective of this work is to reduce the burden of caregivers preparing reminiscence therapy sessions, since finding media that is relevant to each person with dementia can be time consuming. We built upon the existing KeepsakeBox platform, developed by Santana et al. [16]. It is an application that allows caregivers to register themselves and their patients and conduct reminiscence therapy sessions, among other features. We developed a solution to help caregivers more easily find meaningful images for each individual person with dementia, thus reducing their burden and improving the effectiveness of sessions, since more personalized images are more likely to evoke stronger emotions in people. The mechanisms developed can be divided into three main groups: 1) Requesting images to users outside the platform; 2) Searching for images online using categories; 3) Validating the retrieved images. This will allow caregivers to ask for images directly to friends and family of patients, search for semi-personalized images online automatically, and validate the images retrieved in case any of them are deemed unsafe or inappropriate. We tested the solutions with caregivers and found that the new mechanisms developed were very useful and easy to use for them. Caregivers also showed interest in following the development of the application and using it in the future.

Keywords: Dementia; Reminiscence Therapy; Caregiver; Web Application; Images

Resumo

A demência é uma doença incurável que afeta maioritariamente pessoas de idades mais avançadas. Com o aumento da esperança média de vida os casos têm vindo a aumentar ao longo do último século. Esta doença está geralmente associada com perdas de memória (Alzheimer's por exemplo), mudanças de comportamento e outras formas de défice cognitivo. Apesar de não existir atualmente uma cura para a demência, existem vários tratamentos que podem ser eficazes no que toca a melhorar a saúde e bem-estar geral dos pacientes. Existem vários tipos de medicamentos que ajudam a aliviar alguns sintomas de demência, como a perda de memória, depressão, distúrbios do sono entre outros. Também existem outros tipos de terapia não farmacológica que ajudam a tratar sintomas de demência, especialmente em pacientes ainda em fases iniciais da doença. Uma destas terapias é a terapia de reminiscência. Consiste em expor as pessoas com demência a vários estímulos, como fotos, vídeos, sons, cheiros, entre outros, com o objetivo de ajudar estas pessoas a reviver experiências passadas e relembrar memórias agradáveis, por exemplo, ao observar imagens de eventos antigos e conversar com os cuidadores sobre os mesmos.

Apesar de a terapia de reminiscência poder ser um método eficaz de melhorar o bem-estar das pessoas com demência, o trabalho de preparar as sessões cabe aos cuidadores. Encontrar imagens que sejam realmente úteis para cada pessoa nas sessões de terapia de reminiscência pode muitas vezes ser muito trabalhoso para os cuidadores, especialmente aqueles que cuidam de vários pacientes. Uma alternativa seria usar imagens genéricas, mas estas não são tão eficazes nas sessões como as imagens personalizadas a cada pessoa com demência.

Os requisitos recolhidos no trabalho desenvolvido por Soraia Alarcão et al. [1] comprovam o problema referido anteriormente. Em estudos realizados com cuidadores foi identificada a necessidade de reduzir o fardo e o stress que cai sobre estes no que toca a preparar sessões de terapia de reminiscência para os seus pacientes. Os requisitos funcionais recolhidos que apontavam para a resolução deste problema e que são o foco deste trabalho são: a procura automática de imagens, a recolha de imagens personalizadas e a personalização das sessões. Com isto em mente o objetivo deste trabalho foi definido baseado nos requisitos recolhidos previamente, sendo este reduzir a carga de trabalho dos cuidadores ao preparar sessões de terapia de reminiscência.

Para isso, realizámos o nosso trabalho com base no trabalho desenvolvido por André Santana et al. [16] onde foi criada uma aplicação web para apoio a cuidadores de pessoas com demência e realização de sessões de terapia de reminiscência. Esta aplicação chama-se KeepsakeBox e é uma aplicação web desenvolvida usando a framework Angular para as componentes frontend e Java Springboot para backend e PostgreSQL para a base de dados. Ela permite o registo de cuidadores e dos seus pacientes, assim como a partilha de cuidados de pessoas com demência entre cuidadores. Permite também adicionar imagens na plataforma que depois podem ser usadas em sessões de terapia de reminiscência que são realizadas usando também a aplicação.

Neste trabalho, desenvolvemos uma solução com o objetivo de reduzir a carga de trabalho dos cuidadores. Esta pode ser dividida em três grupos principais: 1) Geração de pedidos para pessoas fora da aplicação fazerem upload de imagens; 2) Procura de imagens online usando categorias; 3) Validação das imagens recolhidas.

Com o pedido para outras pessoas fazerem upload de imagens os cuidadores podem gerar e enviar pedidos de imagens diretamente às famílias e amigos dos seus pacientes, permitindo assim um acesso mais fácil a imagens relevantes na vida da pessoa com demência. Este pedido consiste num link gerado pela aplicação que os cuidadores podem enviar para outras pessoas. Por sua vez na interface que lhes é apresentada após acederem ao link, estas pessoas podem fazer upload de imagens e categorizá-las ao atribuir uma descrição e selecionar as categorias nas quais as imagens se inserem. Após inserirem o seu nome podem submeter as imagens para serem validadas por parte do cuidador responsável.

A pesquisa online permite usar várias categorias como por exemplo animais, cidades, desportos, etc, para encontrar imagens que, apesar de serem um bocado mais genéricas, podem ainda ser bastante úteis nas sessões de terapia e do interesse das pessoas com demência. O sistema sugere categorias para serem usadas na pesquisa. Por omissão estas são categorias que fazem parte da lista de categorias padrão do sistema. No entanto, foi adicionada uma funcionalidade para no momento do registo de novos pacientes registar para além do nome, nível de educação, etc, registar também os interesses do mesmo. Focámo-nos em cidades de interesse porque são facilmente personalizáveis e fáceis de pesquisar, mas também podem ser adicionados outros interesses. As sugestões do sistema são personalizadas para cada paciente que possua estes interesses registados, com a lista de categorias sugeridas a apresentar em primeiro lugar os hobbies/interesses e cidades relevantes para a pessoa com demência. Desenvolvemos um rastreador de imagens que procura imagens no website Flickr, que pesquisa as imagens baseando-se na informação que a API deste website nos dá sobre elas, neste caso as suas categorias.

A validação das imagens procura assegurar que as imagens inseridas na plataforma são apropriadas e seguras para serem usadas nas sessões de terapia de reminiscência. O pedido de imagens a outras pessoas assim como a procura online podem levar a que sejam

submetidas ou encontradas imagens com conteúdo explícito, violente ou de outras formas inapropriado para pessoas com demência. Por sua vez na solução desenvolvida nenhuma imagem recolhida usando esses métodos será inserida no sistema sem antes ser validada pelo cuidador. Na interface de validação existem duas abas contendo as imagens que irão ser incluídas e as que serão rejeitadas respetivamente. O cuidador pode mover as imagens livremente entre as duas abas, sendo que as que estão no grupo das imagens a rejeitar serão descartadas e as outras serão incluídas no sistema. No caso da submissão por parte de outras pessoas as imagens vêm já categorizadas e com descrições associadas, enquanto as resultantes de uma pesquisa automática online necessitam que o cuidador categorize e descreva cada imagem encontrada que pretenda incluir. Isto pode dar algum trabalho dependendo do número de imagens que o cuidador escolheu procurar, mas é importante ter esta informação sobre as imagens para no futuro os cuidadores conseguirem selecionar melhor as imagens a incluir nas novas sessões e ver quais produziram melhores resultados nas sessões de terapia de reminiscência já realizadas.

Antes da validação por parte do cuidador as imagens são analisadas pelo sistema, usando a informação extraída pela API do Clarifai. Esta API de classificação de imagens permite recolher dados e identificar o conteúdo presente em imagens e vídeos. Baseado na informação identificada pelo Clarifai conseguimos avaliar as imagens a priori e classificá-las como sendo seguras ou não para serem inseridas na plataforma. No entanto, a decisão final sobre se uma imagem é inserida ou não cabe sempre ao cuidador, tendo este a possibilidade de rejeitar imagens classificadas como seguras ou aceitar imagens classificadas como inseguras, em casos onde, por exemplo, o sistema classificou erradamente uma imagem segura como sendo insegura.

Desenvolvemos protótipos de baixa e média fidelidade para as primeiras duas fases de teste. Os resultados dos mesmos ajudaram a melhorar o desenvolvimento da versão que foi testada com cuidadores.

Procurámos testar a aplicação com cuidadores, pois estes são os principais utilizadores da mesma. No entanto, os protótipos e a interface de upload de imagens para pessoas fora da aplicação foram testadas com utilizadores que não são cuidadores de pessoas com demência. Uma das dificuldades da avaliação das soluções desenvolvidas foi encontrar cuidadores para testar a aplicação, no entanto ainda foram feitos alguns testes com cuidadores formais.

Apesar das limitações, os cuidadores que testaram a aplicação acharam os novos mecanismos muito úteis e fáceis de usar. O feedback das sessões de testes de observação e nos questionários foi em geral bastante positivo. Estes cuidadores também demonstraram interesse em seguir o desenvolvimento da aplicação e em usá-la no futuro.

Foram identificadas algumas melhorias na fase final de testes que poderão ser um ponto de partida para trabalhos futuros, como permitir que os cuidadores validem imagens no contexto do perfil dos pacientes e não apenas no seu perfil. Importante para o futuro

seria também realizar testes com mais cuidadores, tanto formais como informais, para identificar mais melhorias para a aplicação.

Este trabalho provou ser útil no objetivo que procurava cumprir, com os cuidadores considerando que as novas funcionalidades são úteis e fáceis de usar, assim como capazes de permitir mais facilidade na preparação das sessões de terapia de reminiscência e de aumentar a eficácia das mesmas.

Palavras-chave: Demência; Terapia de Reminiscência; Cuidador; Aplicação Web; Imagens

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Chapter 1

Introduction

In this chapter, we present the motivation behind this work, as well as its main objectives, while also providing a brief description of the solution that was developed, before explaining the contributions of this work. Finally, we present the structure of the document.

1.1 Motivation

Dementia is an incurable disease that is associated with old age and has seen an increase in the number of cases over the last century, given that people are reaching very advanced ages. Memory loss, changes in behaviour, disorientation, among others, are characteristics of dementia. There is currently no cure for this disease, although there are several effective treatments, being one of them reminiscence therapy.

Reminiscence therapy aims to evoke pleasant memories and feelings by exposing patients to different types of media that might be significant to them. Ideally the media should be relevant and personalized for each individual. However, sometimes this is not possible, due to relevant media being hard to find or the system being used does not support personalized media. Images of familiar people or places are among the most common types of media shown in reminiscence therapy sessions, as well as video and audio content.

Technological solutions have proved helpful in conducting reminiscence therapy sessions, with some of them allowing users to upload several types of media relevant to the people with dementia. This ease of use helps caregivers that typically do not have enough time to properly prepare sessions, since informal caregivers usually have full-time jobs or other occupations and formal caregivers usually care for a lot of people with dementia, which can make it hard to focus on every one of them individually.

Acquiring media relevant to each patient is crucial in order to improving the effectiveness of reminiscence therapy. Therefore, providing ways for caregivers to more easily access media customized to each person with dementia is important.

1.2 Objectives

The main goal of the solutions developed as part of this work was to ease the burden of caregivers preparing therapy sessions, by providing them new ways to acquire media to be used in said sessions.

The media used in reminiscence therapy sessions should, ideally, be personalized for each individual person with dementia, in order to allow them to evoke more significant memories and thoughts, thus increasing the effectiveness of reminiscence therapy in increasing mood and overall well-being.

One way to allow caregivers to readily access relevant media to the people with dementia they care for, is to develop ways to communicate with their friends and family, allowing them to provide images that have more personal meaning to the patient to be used in reminiscence therapy sessions, thus increasing their effectiveness. This is especially important for formal caregivers, that typically do not have a previous personal relationship with their patients, thus making it hard to find images and other media that can be effective in therapy sessions. Though informal caregivers can also benefit from it.

Communicating with family and requesting information from them is an effective way to acquire relevant media for people with dementia. However, if for whatever reason this is not possible, other mechanisms other than manual upload may be employed. Another way is to make use of the several websites that host a wide variety of images. Although not as personalized as the images uploaded by friends and family, they are still relevant to the person with dementia. We could for example take advantage of the image data, such as tags and descriptions, to find, for example images of cities or activities, that are generic but could still be able to evoke significant memories in the person with dementia.

Although, these ways that do not require the caregiver to upload the images manually could be very useful, they have the risk that these outside parties could upload media that is not relevant, or that is harmful to the patients. For example, if images of explicit or violent content are uploaded. This creates a need for the images to be validated by the caregivers before they enter the system database and can be used in sessions.

1.3 Developed Solution

The solution developed was built upon the existing KeepsakeBox application [16], that allows caregivers, both formal and informal, to register and store information about themselves as well as register and store information about the people with dementia that they care for. The existing application supports uploading images to the platform and using them in reminiscence therapy sessions that can be conducted using the application. It is also possible to view information about previous sessions and share the person with dementia care between different caregivers. The solution developed in this work focused mainly on the acquisition and validation of the images to be inserted into the platform.

Taking into account the objectives described previously, the developed solution provides easier ways for caregivers to acquire relevant images to be used with their patients in their reminiscence therapy sessions, as well as to validate said images. With this information, we implemented several useful mechanisms in the application, to allow caregivers to request image uploads to patient's family members and friends, allow caregivers to search online for images automatically using certain categories, and to allow them to validate all the images that were retrieved by either the online search or the request sent to the family and friends.

These mechanisms were designed with the users in mind, with the expectation that many users of this platform will be people of older age that are caring, for example, for their similarly aged relatives or partners that are living with dementia. With that in mind we focused on making the system easy and intuitive to use, providing clear descriptions for several elements present on the interface to inform the user of what would happen when interacting with said elements. We followed a user-centered design approach where we developed low fidelity prototypes that were used in initial testing of the application's new mechanisms, followed by the actual implementation of a working version of said mechanisms into the platform.

The solution consists of three components: the front-end that was developed using Angular, a TypeScript HTML and CSS based web-development framework; the back-end, consisting of a RESTful API web service, using Java; the database, developed using PostgreSQL. These components and their implementation will be explained in further detail in Chapter 3.

1.4 Document Structure

Chapter 1 serves as an introduction to the work, that explains the objectives and motivation behind these developments, as well as providing a small explanation of what was developed during this time.

Chapter 2 provides some background about dementia, how it affects people and those around them, as well as explaining in more detail what reminiscence therapy is and how it helps people with dementia. It also presents a few studies done previously that also used technology based solutions to aid reminiscence therapy for people with dementia. This information provides additional context as for why the work developed is important. It also explains in detail the KeepsakeBox application, how it works, and what it is used for.

Chapter 3 explains in detail what requirements were gathered, what are its main functionalities and what mechanisms were implemented and added onto it as part of this work. We explain how the mechanisms were developed, the architecture behind the system and the technology used. We also explain a couple of optimizations that were made to the platform, particularly in the back-end and database components.

Chapter 4 addresses the evaluation of the application. For the early prototype testing, we specify the test structure, the results and design improvements that were derived from the analysis of the data acquired from said testing. For the final round of testing, we also explain the structure data analysis and results that helped us draw some conclusions about the work that was developed.

Chapter 5 serves as the conclusion to this document, elaborating upon what was concluded from the results obtained from user testing, acknowledging some of the platforms limitations and providing some insight into what could be done in the future to further improve the KeepsakeBox application.

Chapter 2

Background and Related Work

Before describing the solution that will be implemented as part of this work, it is important to understand some context behind what dementia is, how it affects people and those close to them, how reminiscence therapy can help patients.

This chapter also presents the existing KeepsakeBox application and other current technological solutions to support reminiscence therapy sessions.

2.1 Dementia

The increase in life expectancy over the last century across the world has led to a large number of people reaching very old ages [11] [3]. Diseases associated with old age, like dementia, have consequently, seen a steady increase in their number of cases. A study conducted by the Center for Disease Control and Prevention [12] projects the number of dementia patients in America to increase to nearly 14 million by 2060, from the 5 million reported in 2014. This increase is also likely to be reflected in the rest of the world.

Age is the most common risk factor for dementia. However, other factors such as having relatives who developed it, race/ethnicity, high blood pressure, smoking, high cholesterol and different types of brain injuries can all increase the risk of developing this disease. To diagnose a patient with dementia, a series of cognitive tests are performed to test the patient's memory, problem solving, attention and other cognitive abilities.

There is currently no known cure for dementia. It gets worse with age and there are several types of this disease. The term dementia does not refer to a specific disease, but it is rather a generalized term for cognitive impairments, like the inability to remember or think effectively, that affects everyday activities. The most common form of dementia is Alzheimer's disease, commonly associated with severe long and short term memory loss, though it also affects thinking and reasoning skills. There are also other types of dementia where other symptoms such as tremors, slowed movement, hallucinations and changes in behavior are more prominent.

Even though there is currently no cure for dementia, there are medications to help

protect the brain and ease symptoms that arise from this condition, such as anxiety and behavioral changes. Living a healthy lifestyle is the primary way to prevent dementia from developing as well as other chronic diseases.

Other forms of dementia treatment include different types of therapies, such as occupational therapy, that aims to make the patient's home safer to prevent accidents, pet therapy, which involves the use of animals to improve the mood of the patients, reminiscence therapy, which aims to help the patients evoke pleasant memories about past experiences, among others.

2.2 Reminiscence Therapy

Reminiscence therapy is a type of treatment that is used in dementia patients that aims to improve their mood and overall well-being by helping them relive past memories and experiences by exposing them to different types of stimuli, such as photos, videos, music, smells and even tactile activities like painting, in order to help them think back to those past events better and evoke pleasant thoughts and decrease stress.

This type of therapy has several benefits [17] [9], with the mental abilities of the patients decreasing over time, being able to remember past events and reminiscing about them can make patients feel more confident and improve their mental well-being as well. Having meaningful conversations with family members, or other carers, can decrease symptoms of stress and depression [10], and it helps pass on these family stories to future generations.

Several applications have been developed to allow carers to conduct sessions easily by allowing them to use personalized photos and display them on a screen in order to have conversations about them. KeepsakeBox [16] is an example of this type of application. Other studies presented similar applications and showed promising results. In the next section we discuss some of them.

2.3 KeepsakeBox

The KeepsakeBox application was developed as part of a work carried out by Santana et al. [16]. Built upon the work of Alarcão et al. [1], this platform was made for the carers of dementia patients, with the objective of providing support in reminiscence therapy.

It allows caregivers to create a personal profile, as well as patient's profiles and add them to their patient list in order to easily access their information and conduct personalized reminiscence therapy sessions. It also allows carers to share the care of people with dementia between them.

The platform allows carers to create a personal profile, containing their email address, phone number, date of birth, a picture and the type of care they provide (informal or

formal). They can also check therapy sessions they conducted previously and add images to be used in said sessions (see Figure 2.1).

In the main page carers can check all the patients that are registered in their profile, they can add new patients if necessary, check existing patient's profiles and start therapy sessions for a specific patient (see Figure 2.2).

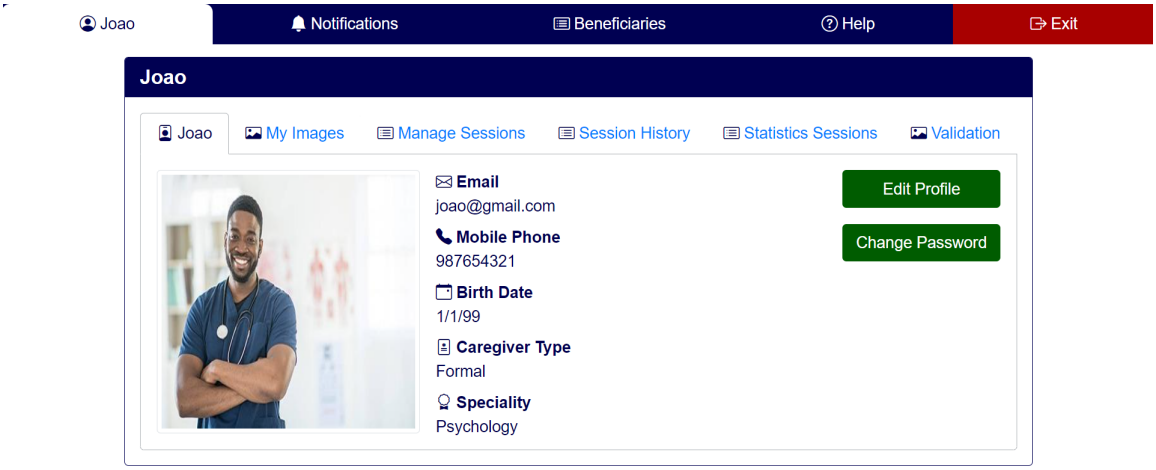

Figure 2.1: Caregiver page, containing all the information entered upon registering

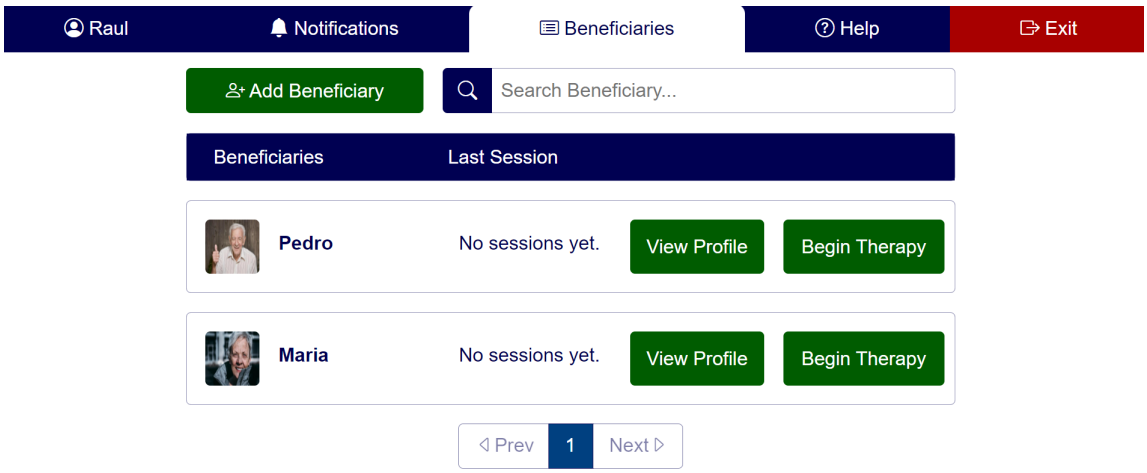

Figure 2.2: Main application page that the user is redirected to after logging in, presenting all the people with dementia that they care for

When adding patients/family members, carers insert their information, specifically their full name, display name (name that will be displayed in the patient list), date of birth, education level, and relation to the carer, for example, grandmother, grandfather, etc.

In the profile page of the person with dementia all the previously entered information is available, as well as which carers are registered to that person. There are also options to edit the information, share the patient with other carers, start new therapy sessions or check previous ones, and add images to be used in the future.

In the images tab the carers can check and add new images that can be utilized in reminiscence therapy sessions, by clicking on an image they can also check the information regarding it, such as who uploaded it and when, some information describing the image, such as the categories (nature, city,or others) and description, as well as whether it is favorite or not and whether it is public or not (see Figures 2.3 and 2.4).

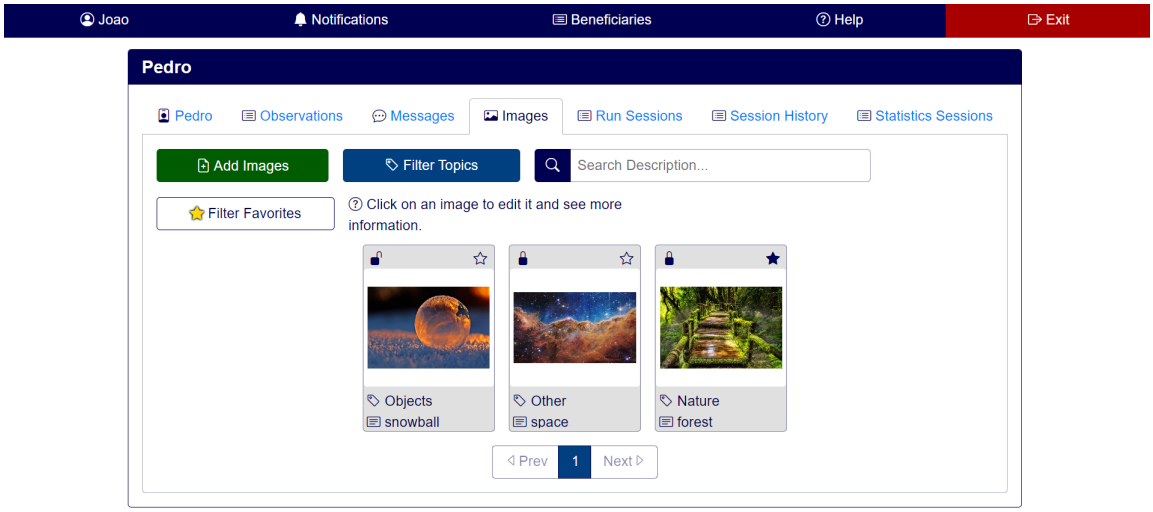

Figure 2.3: Images in the profile of the person with dementia

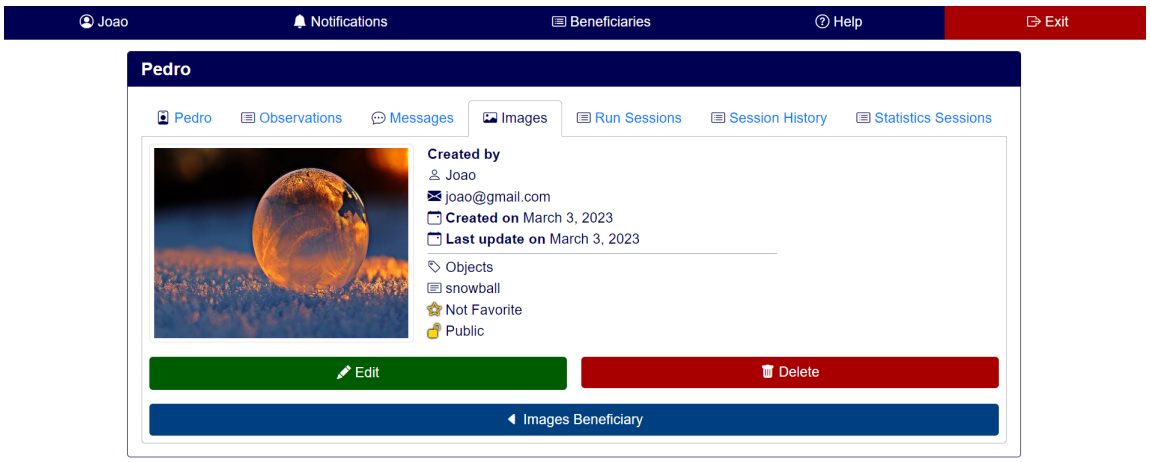

Figure 2.4: Details of one of the images in the profile of the person with dementia

2.4 Other Existing Technological Solutions for Reminiscence Therapy

This section highlights some studies performed over the last decade where several solutions were developed to help dementia patients. Different approaches were taken, from developing applications where images and audio files can be uploaded and displayed to the patient, to other systems making use of multiple screens, physical objects to stimulate other senses like smell, and even systems that attempt to use artificial intelligence to talk with the patient about the media being presented in the therapy session.

2.4.1 Artificial Intelligence for Therapy Assistance

Carós et al. presented a solution consisting of using AI to assist reminiscence therapy sessions [2]. Their system analyses images and asks related questions to the patient in order to better help them evoke pleasant memories about relevant moments in their life (see Figure 2.5).

The images are provided by the patient, the AI then randomly selects a picture and generates a question related to it, such as "Who are the people in this photo" for a picture containing people. After the patient answers the AI then analyses the answer and provides feedback in the form of a comment, and proceeds to ask another question. After the patient answers again, the image is changed and the cycle repeats until the session is over.

There were two datasets used to train the AI chatbot model, the Persona-chat dataset that contains dialogues between two people trying to know each other and the Cornell-movie dataset which contains a collection of fictional dialogues from movies.

To evaluate the performance of the chatbot in conversation the authors used human evaluation, since metrics such as BLEU score, which measures the similarity between the text generated by the system and text generated by humans, were considered not adequate. This is because the BLEU metric assumes that the responses generated by the system are considered valid when they are similar to ground truth responses, with the chatbot only having one ground truth reference when generating a response, the authors considered this metric not adequate given that responses can have the same meaning while not having any words in common.

The interface used was the Telegram application, where a bot would send messages and pictures to the patients.

This approach has a lot of potential to be used as a viable option for patients who need or want to participate in reminiscence therapy without needing much assistance. However, current AI limitations lead to the questions and comments generated sometimes being not specific or meaningful enough, and not always consistent with the images presented. The results of the study also showed that in order for these therapy sessions to produce proper results, the presence of someone supporting the patient was necessary, in order to better

Figure 2.5: AI Chatbot interface [2]

help them remember the images presented and answer appropriately. Patients in more advanced stages of this disease can also find these types of applications very difficult to use.

2.4.2 User-Centered Design

O'Connor presented a solution that consisted of allowing patients and carers to take part in designing a mobile health application to conduct reminiscence therapy sessions [14]. This study was a collaboration between a museum, a software company and a hospital.

Workshops were conducted at the museum, where patients and carers discussed the current design of the application with the development team and suggested improvements.

The app was first preloaded with pictures of objects, mainly city buildings and historical locations of the region, provided by the museum. Sounds, music and simple descriptions were also preloaded. Patients could browse the app and have conversations with their family and carers about the local region. Users of the application also had the option to add personal photos, videos and music to the app, to make the experience of browsing the app more personal, allowing users to also add electronic notes to describe these objects and their meaning. There was also a memory tree functionality, that was generated by the app, in order to create a story format with a timeline by combining the digital content present.

This study focused more on the effect that including the patients and carers in the design of the app had on them, with the results showing that they felt a sense of pride and achievement and allowing them to have new meaningful experiences and learn new skills (see Figure 2.6 for a visualization of the approach used in this study).

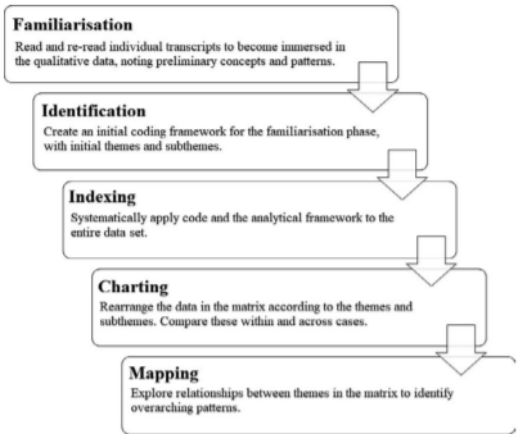

Figure 2.6: Framework approach used in the study [14]

From the application development standpoint, the presented solution had some interesting functionalities such as having pictures of the local region preloaded by the museum, which makes it easier to jump into the app and have meaningful conversations about the imagery and music presented without users having to load the objects themselves, and the timeline functionality, which allows patients to view the objects in a story format in order to better help them evoke meaningful memories. This study only used two patients (both male) and two carers (both female), leading to the contribution in the development of the application being limited by the small sample size.

Edmeads and Metatla investigated the use of technology in supporting dementia patients engaging in reminiscence therapy by using a participatory design approach that resulted in two prototypes being designed and developed [5].

The authors worked with a nursing home and conducted participatory design sessions with its residents, four women and one man aged 86 to 94 participated. The caretakers were also included in the process in order to help the authors better understand the current technology practices of the group.

The sessions were analyzed and three major themes were outlined: Personalization, given the lack of personal memorabilia present in the nursing home for each patient; Lack of control, patients were unable to initiate therapy sessions by themselves; Difference in professional and participants focus, with caregivers trying to avoid sensitive subjects to the patients that might elicit negative memories.

The first of the two prototypes developed consisted of an app called MyStory, which was an interactive photo album that provided pages with a single picture and the ability to record stories and play sounds. The other prototype developed was called SharedMemories, consisting of a web-based digital photo frame where, similarly to the other prototype, each picture could record stories and play sounds, it also allowed other users to upload media like images and audio, in order to further personalize the experience.

Most of the participants were able to use the MyStory system without much help.

However, the touch based interface proved to be somewhat difficult to use for some users. This prototype was also viewed more positively by the users, after analyzing responses provided by them after the sessions. SharedMemories was preferred by a few users however, claiming that it provided a better and more accessible visual experience.

Including users in the design of systems targeted towards them is always a valuable exercise, as it provides the development team with important insights into what is actually important for them. None of the prototypes was particularly groundbreaking in its functionalities, but the study was more aimed at the approach used in designing said prototypes. However, once again we see that visual imagery and audio are the preferred mediums used in reminiscence therapy sessions, as both can easily help evoke meaningful memories and can be easily personalized by the participants, by allowing them to directly upload personal photos and sounds to the application.

2.4.3 Exploring Less Used Senses

Mertl et al. developed a device called Traumreise that aimed to provide sensory experiences beyond the typical video and audio media provided during reminiscence therapy sessions [13]. For example, the use of smell during sessions is very rare and there is little research targeted towards the use of this sense to help people with dementia. The research team designed a device that uses this sense as well as the other more common ones, to provide a more complete sensory experience to the patients.

The device was designed with caregiver usability in mind, as well as patient usability, so that people with dementia could use this device easily.

Traumreise consisted of an interactive picture frame with three large buttons that would each start a different scenery which included animated images or videos, sound and little bags under the buttons with objects enriched with scents so that the patient could grab them and smell them in order to help them evoke more pleasant memories by having a more complete sensory experience (see Figures 2.7 and 2.8).

The device was not particularly personalized to each user's needs and wants. However, the three sceneries were carefully chosen in collaboration with the volunteers who led the two dementia groups, each consisting of four people, that would take part in testing. The topics were winter and fairy tales, and each topic would have three sceneries available. The device was loaded with these scenarios consisting of relatively generic topic related imagery and sounds, as well as scented objects, that the research team selected. For example, for the winter topic a forest scenery, which showed imagery of snow huts and played wind sounds while also providing pinecones and branches to be smelled, was used.

Two sessions were held each with four people with dementia and three volunteers and the results showed that the patients enjoyed using the device and that it brought something meaningful to group therapy sessions.

Figure 2.7: Traumreise welcome screen [13]

Figure 2.8: Traumreise and group session and setup [13]

This solution brings something new to the table in its usage of smell to enrich reminiscence therapy sessions. This sense is heavily underused for this purpose even though it is one of the more effective ways to help evoke nostalgia in people, this is perhaps because of the logistics associated with including this sensorial experience in therapy sessions, a smell can't be loaded into an application like a video or a sound. The easiest way is to bring physical objects that can be smelled directly by the patient. This can cause a problem that is the lack of patient-based personalization. The sceneries, although carefully chosen, were mostly generic images, sounds as well as objects and the lack of personalized media and scents can hinder the patient's ability to evoke meaningful memories. Many applications allow users to easily load personalized images, videos and sounds to aid therapy sessions, however, bringing personalized scented objects for every patient is not feasible. So, despite the use of smell being very helpful in aiding reminiscence therapy sessions, we consider that the lack of a convenient way to provide personal meaningful objects to be used as scents negatively impacts the effectiveness of this device.

2.4.4 Advanced Specialized Systems

Watson et al. published a research article displaying a device used to aid in reminiscence therapy sessions [19]. The team conducted two research studies in nursing homes, using this device as part of the TTT (Time Travelling with Technology) project.

The device in question is the Google Liquid Galaxy. Originally developed as a panoramic,

multi-display Google Earth viewer, it has evolved to become a more generalized data visualization tool for marketing and research purposes. Screens wrap around the users and high-definition images surround them, images that can move and can provide the user with the sense of travelling through space and time (see Figure 2.9). For the purpose of the study the device was adapted, with locations relevant to the participants being uploaded to the system, which displays them as life-size and hyper-realistic images, while also making them navigable in space and time.

The use of large immersive screens that wrap around the user allowed the participants to have a unique experience, traveling to familiar places in this setting can be a very effective way to help patients remember past events. Of the two conducted experiments, one used the fully immersive setting, with five screens wrapping around the user and moving images being displayed, while the other, considered the control experiment, used only 3 screens and static images.

Figure 2.9: Google Liquid Galaxy setup in the TTT project [19]

The results showed that patients using the five-screen setup displayed more responsive behaviors (behaviors associated with responses to something important in their personal life) than patients using the three-screen control setup.

Being originally developed to navigate through Google Earth, this system is more than suited for this purpose of allowing dementia patients to navigate through familiar locations to evoke meaningful memories. Using the Google Earth application means that there is theoretically no limit to where the patients can travel, allowing the experience to be extremely personalized by simply selecting any location and experiencing it in the life-size screens. This device comes with some obvious disadvantages, since it is expensive and not a commercially available, it is not readily accessible to any institution that wants to make it a part of their therapy sessions. It also requires a lot of assistance to use. However, the experience this device provides is unique and very effective for the reminiscence therapy. Making a similar but cheaper, more accessible system could be an interesting venture moving forward.

The study presented by Sørgaard et al. talked about the SENSE-GARDEN room, a

system with the aim of creating multi-sensory experience consisting not only of images and sounds but also smells and movements [18]. There was also a focus on making the experience strongly linked to the individual patient's personal history and experiences in order to help them better reconnect with their past and present. The media present in the room were provided by the family and caretakers of the patients.

This was a large-scale project, involving public and private partners from Belgium, Norway, Portugal and Romania, with teams consisting of caretakers, medical professionals, technicians, law experts, research experts etc. The wide range of competencies available came with a large range of perspectives and ideas on what the project should aim to achieve and how to achieve it.

Qualitative and quantitative data was gathered by using surveys, statistics, interviews, observations and discussions. An approach called the "Yellow Sticker Approach" was used to find common ground between the members of the project. Yellow stickers were used to collect information about the participants view of the SENSE-GARDEN project, like concepts and strategies. Afterwards, the content of the stickers was discussed so that the individual perspectives could be processed by the group and help in reaching a consensus.

This consensus seeking process led to several keywords being found, such as "emotions", "reconnected" and "relations". There was also an expression that was agreed upon as the best at capturing the goal of the project: "Emotions reconnect us". These keywords show that the aim of the system should be to allow patients to experience emotions and relive memories that they lived in the past by introducing images and videos as well as sounds that are relevant to them, in a realistic setting, as this would be a very effective way of helping them evoke those memories and emotions.

This study did not go into great detail about how the system actually worked, but the approach used was very effective in finding out what is most important in developing reminiscence therapy systems. By gathering the opinions of different people with different views and perspectives allowed for a more informed and sounder conclusion.

The paper published by Filoteo et al. presents an evaluation of ReminX, and online-based story-sharing platform that allows users to record audio over photos and share them with family members suffering from dementia [6]. ReminX was developed with the intention of being readily accessible, as well as easily and regularly used by patients.

The system allows multiple people, like family members, to collaborate on stories in only a few minutes a day. Users upload photos and audio files to the application, which converts them into documentary-like stories. The app includes an AI chatbot to be used by the users uploading the media. Its function is to request story information about the photos being uploaded, which the user can provide by recording voice files and uploading them to the app's server.

In total the system utilizes three components: an iOS app that is used by the family

members, a cloud server and a tablet that is to be used by the patient engaging in the reminiscence therapy sessions (see Figure 2.10). The software creates the videos automatically in a documentary style, and the patient can then play them on demand using the custom-made tablet.

Figure 2.10: ReminX platform, shown on caregiver's mobile device and on patient's tablet [6]

The study conducted involved 14 patients with early to moderate dementia and their caretakers, recruited from a neuropsychological clinic at UC San Diego. All patients were 60 years or older and had adequate vision and hearing in order to use the tablet. Patients were evaluated at home, initially with questionnaires about their mental health, afterwards the patients and caregivers were taught how to use the application. The caregivers would then upload the files needed and the patients would view the created videos on the tablet. After viewing, the patients were re-assessed with the same questionnaires about their mental health.

Results showed that patients reported less anxiety, depression and overall distress after watching their stories. This was also backed up by caregiver observations, who noted that patients appeared less distressed after using the system.

This showed some positive results, with the family members being able to add content to the dementia patient's stories from anywhere in the world by simply uploading it to the application's server. This also reduces the burden on caregivers, since family members can upload files online, thus allowing them to become more involved in the care of the patient. This approach has a lot of promise, and the system requesting voice recordings to tell the story was a different, yet very effective functionality.

Wilkinson et al. published a paper where they discuss different non-pharmacological approaches to dementia care [20]. These approaches include different types of therapy like Music Therapy, Art Therapy, Light Therapy as well as Physical Exercise and other personalized activities.

In this study the authors presented the Ambient Activity Technology (AAT) system. With the goal of making the previously mentioned activities more accessible, without re-

stricting them to certain times, the AAT is a wall mounted system, available at all times, built to support individuals of different ages as well as different levels of dementia severity.

Early in the study the authors understood that it was important for the AAT system to be able to be used by the dementia patients independently, and also as a tool used by the family or caregivers to provide help to patients. The main goals of the system were: Encourage meaningful engagement through access to personalized experiences, reinforce familiarity and personal identity, promote physical activity, improve confidence, make the system able to adapt to changing in patient's cognitive abilities.

The system itself resembles an old radio/TV, the authors chose this device specifically to help older patients increase their sense of familiarity and comfort with it (see Figure 2.11). Despite the classic looks, the system used wireless Bluetooth technology to connect to a certain item that a patient would be carrying, in order to load the personalized content automatically. This content would have been created by the resident and family members, and sometimes even staff. The content present consisted of the patient's favorite music, family photos and even slideshows. There were also games that could played, with the difficulty level being also personalized for each patient in order to accommodate their cognitive needs.

Figure 2.11: AAT unit installed on a wall [20]

The authors presented a really unique device that shows good promise in aiding dementia patients. The familiar look of the system can be very effective in making the patients immediately more comfortable approaching it. Also the personalized content being loaded automatically through Bluetooth connection is something that makes this much easier to use for the patients. However, the cost and real-life practicality of the system can be limiting factors in its usage. More studies would be needed to test the usability of this device past short term periods.

2.4.5 Mobile Applications

Ryan et al. conducted a research study with the aim of measuring the effect that technology has on mutuality (level of closeness) between a dementia patient and their carer during reminiscence therapy sessions [8].

The number of participants was 60, recruited from a cognitive rehabilitation team in a UK health care organization. The recruited patients had early to moderate dementia, and each had their own family member or carer that would participate with them.

An iPad application was sent to the patients that would use it to participate in the study. The app, called InspireD, was developed with reminiscence therapy as its focus, and with help from other development teams. The user interface (UI) consisted of a simple screen that allowed people with dementia and their carers to upload files (see Figure 2.12). After uploading, the users could access a multiscreen layout that allowed them to choose which media they would want to access, in order to watch videos or view photos and listen to audio files. The system also incorporated ecological momentary assessment (EMA) quizzes, as a small series of questions were directly delivered to the patients using the app. The design was minimalistic in order to make the app simple to use for dementia patients and user data was stored in local SQLite database, making the resources present in it easily accessible.

Figure 2.12: InspireD Interface [8]

The study involved 30 caretakers and 30 patients with early to moderate dementia who were able to have conversations and communicate. To measure the outcomes of the study two measures were defined. The Primary Outcome Measure, which was mutuality, meaning the quality of the relationship between the patient and the carer. The Secondary Outcome Measure included QCPR (Quality of Carer-Patient Relationship), a scale used to measure the quality of relationships between carers and their patient. WHO-5 was also included in the Secondary Outcome Measure, which is a short self-reported measure of the mental well-being of an individual.

For people living with dementia, using the Primary Outcome Measure and calculating the mean of all the answers, the mutuality score at baseline was 3.24 (SD: 0.54). With the Secondary Outcome Measure the mean for the QCPR score was 58.07 (SD: 7.12) and for WHO-5 it was 60.8 (SD: 26.2). After the experiment period there were statistically

significant increases in mutuality scores, from a mean of 3.24 to 3.64, as well as QCPR scores, from 58.07 to 63.2, and WHO-5 scores, from 60.8 to 70.6.

For the carers the results were different, with none of the measures increasing or decreasing in a statistically significant manner, with mutuality increasing from 3.02 to 3.07, QCPR also increasing from 56.7 to 57.9, and WHO-5 decreasing from 61.2 to 60.2.

This study provided some valuable insight about the effect that reminiscence therapies have in patient carer relationships, with results showing that using the application the mutuality between them increased, as well as the overall well being of the patients. There were some limitations to the study, thus the results cannot be interpreted at face value. The app was well developed, with the use of EMA questions providing an interesting way of analyzing the patient's behavior while they were using the application. Also, allowing the users to upload their own files once again proved to be effective. The recruitment process was not ideal as the vast majority of participants were male (67%) and the vast majority of carers were female (80%). The authors also acknowledge the possible presence of Hawthorne effect given the design of the study.

Imtiaz et al. presented a study that aimed to develop an innovative mobile solution to address behavioral and cognitive changes in dementia patients [7]. The proposed solution allows a caregiver to conduct reminiscence therapy sessions with several patients, without requiring the presence of all the members on each session.

The app was built for Android with a focus on being user friendly to the caregiver to allow them to easily set up and create multimedia episodic happy memory presentations for each patient. Caregivers could add patients to the application and customize reminiscence therapy sessions for each of them, by adding images and music. Sessions could be created by selecting several pictures that would be presented, choosing how long they would display for and adding several audio files to play in the background (see Figure 2.13).

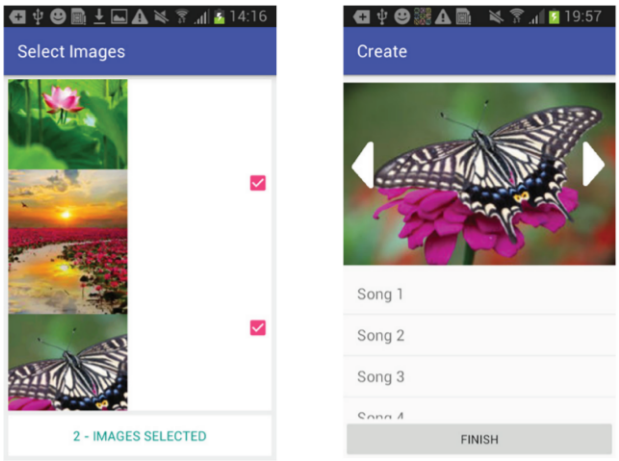

Figure 2.13: Music and photo selection [7]

This paper only included the first phase of the study, which was the development of the application. The experiments with the results would be published at a later date in phase 2. However, we can see that the approach used was similar to a lot of other studies in this field, by using an app that allows patients and carers to load their own pictures and audios we can easily create competent and effective reminiscence therapy sessions. This particular app allowed carers to manage several patients at a time, which can be very useful for carers that work in care homes, or any carer that works with multiple patients at the same time. The dynamic presentations that the app supports is a very useful and seemingly intuitive functionality.

2.4.6 Web Image Search

In the context of this work we should also look at some studies that aimed to provide some solutions to automatize online image retrieval, since automatic image searching is part of the solution developed during this work.

In a survey done by Datta et al. [4] they divide image search into three categories: i) Search by association, where the user has no specific image in mind when searching initially so the search goes on by adjusting it iteratively during browsing; ii) Aimed search, which is where a user is trying to find a specific image; iii) Category search, where pictures that fit into a specific category are sought after. The solution developed in this work fits in to this category search. We use categories as text input to find images that have matching tags to said input.

This study also mentions the need for the presence of reliable tags when searching for images using text-based retrieval. Images without tags that accurately describe them will likely not be found by users that are searching for them using what they perceive to be the correct tags for the kinds of images they want.

Rajkumar et al. [15] developed work that aimed to narrow down images found search engines using text-base image retrieval. They claimed that to find more relevant images there is a need to filter unwanted data. They developed an image crawler that aimed to retrieve relevant images with appropriate keywords. The images retrieved by this system are meant to be used in the future to build CBIR (Content-based image retrieval) systems. These are systems that can use images as input to search for other images.

The crawler uses the keyword inputs from the user and searches for images in standard text based search engines like Google, Bing or Yahoo. The crawler then downloads the images and associated metadata of the URLs found during the search. The URLs are parsed to make sure they are relevant and unique. Every time the crawler searches for an image the database is checked for redundancy to ensure the uniqueness of the URLs.

The web crawler is implemented as a client-server model with a GUI deployed in a web server which invokes the crawler module (see Figure 2.14).

The solution developed in this work aims to provide a similar online image retrieval

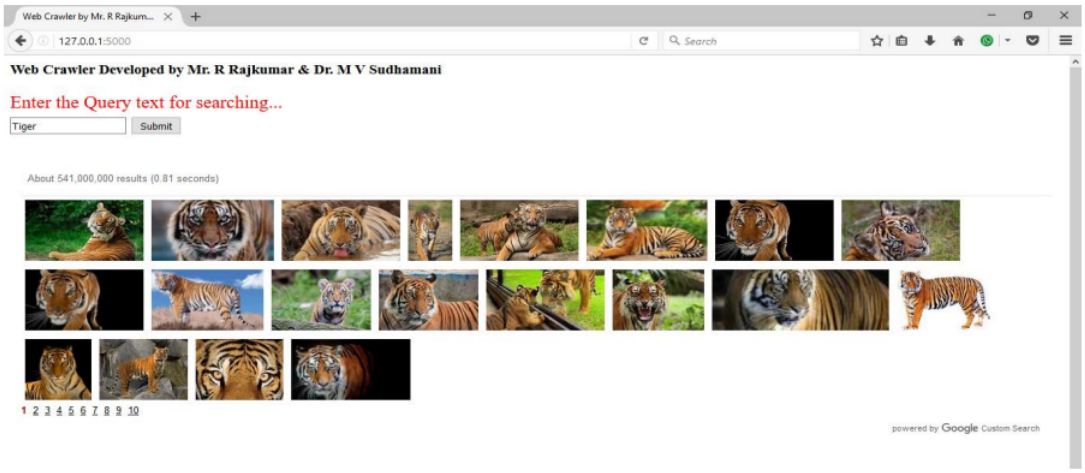

Figure 2.14: Sample results for a search query

system to the caregivers. They will be able to use categories that will serve as input for an online image search.

2.5 Discussion

After analyzing the previous works we can see that technology can prove useful in helping carers conduct reminiscence therapy sessions. The use of applications where we can upload meaningful images, videos and audios seems to be the more common approach. In this type of systems we can easily present the uploaded media to the patient and have conversations about it. This is what the KeepsakeBox application aims to do, provide an easier way to conduct reminiscence therapy sessions as well as review them. Some less common but interesting features presented in the studies also show a lot of promise, such as using AI to have conversations about the images or using specialized devices like tablets that can be controlled with mobile applications.

There was also a focus on making the design of the application user-centered and actively having patients and carers provide input and feedback during the development process. This is important because carers know the specific needs that the patients require.

However, there are still some problems in these applications. Having meaningful and personalized material being presented in the therapy sessions is a key component in making it effective. This means that carers have to be able to find media that is of relevance to the patient. This can be problematic because it can lead to a lot of work, especially for caregivers that care for multiple people with dementia, since they are tasked with finding relevant images themselves. This can be very difficult, for example if they have to ask family members or friends that can be unavailable at a given moment. Not being able to easily access media relevant to the people with dementia means that a lot of times caregivers will have to use more generic images or videos. These are less likely to

evoke strong pleasant emotions in the patients, reducing the effectiveness of sessions.

This problem is the main focus of our work and the features being developed will help tackle this limitation and help caregivers better prepare their sessions by providing them with easier ways to obtain meaningful, personalized images for their patients. With these new mechanisms there is also the need to allow caregivers to ensure that the media retrieved is adequate to be used in reminiscence therapy sessions. This means that caregivers must also be able to validate the gathered images and decide which one will be added to the platform.

Other problems include the fact that some of the systems presented were expensive and not readily available, and the fact that some patients had difficulty using applications that were meant to be used without much help.

2.6 Summary

Dementia is an incurable disease that gets worse with age. However, despite there being no cure, there are some effective treatments. One of those treatments is reminiscence therapy. This is a form of therapy consisting of showing patients relevant images, videos, audio, etc, in order to help evoke pleasant memories from their past. This helps improve their overall health and well-being.

The KeepsakeBox application allows caregivers to manage their patients, register their information, share care with other caregivers and conduct reminiscence therapy sessions using the application.

There are other existing technological solutions to aid in conducting reminiscence therapy sessions. By presenting and analyzing some of them we were able to conclude that these types of solutions can prove very useful in providing caregivers with assistance when conducting reminiscence therapy sessions. By allowing them to easily upload and use images and videos to use with their patients, the load on caregivers when preparing and conducting sessions can be reduced.

There are however some problems and limitations, such as the fact that finding personalized media for each patient can mean a lot of work for caregivers at times. With this work we provide ways to lessen this burden by allowing them easier ways to insert and validate personalized images on the KeepsakeBox platform.

Chapter 3

KeepsakeBox: Insertion and Validation of Images to the Platform

This chapter presents the new solutions developed as part of this work and built upon the existing KeepsakeBox application [16], developed by André Santana. We added new mechanisms to provide different ways to upload images to the platform and to allow carers to validate them.

3.1 Requirements

Before developing our solution it is important to understand the problem at hand and why there is a need for these new mechanisms.

The study conducted by Alarcão et al. [1] provided a lot of insight into the daily lives of caregivers that work with patients with dementia.

She performed a survey, that lasted 18 months and was distributed using Facebook groups and institutions that worked with dementia patient and their caregivers. When the survey was finished there were 603 responses from 39 different countries. After the results were analyzed using all the data, functional requirements for the application, along with primary and secondary outcomes that were expected from the solution, were identified (see Figure 3.1).

As we can see in Figure 3.1, from the gathered requirements, it was expected that Automatic image retrieval would reduce caregivers' stress and burden while preparing the sessions. Moreover, gathering personalized images was also important to reduce said burden as well as improving the session's effectiveness by reducing behavioural symptoms exhibited by the patients. These two functional requirements are the focus of this work: 1) Developing new mechanisms to allow caregivers to find more personalized images; 2) Finding images automatically online, with the ability to validate all the images they find before being submitted to the system.

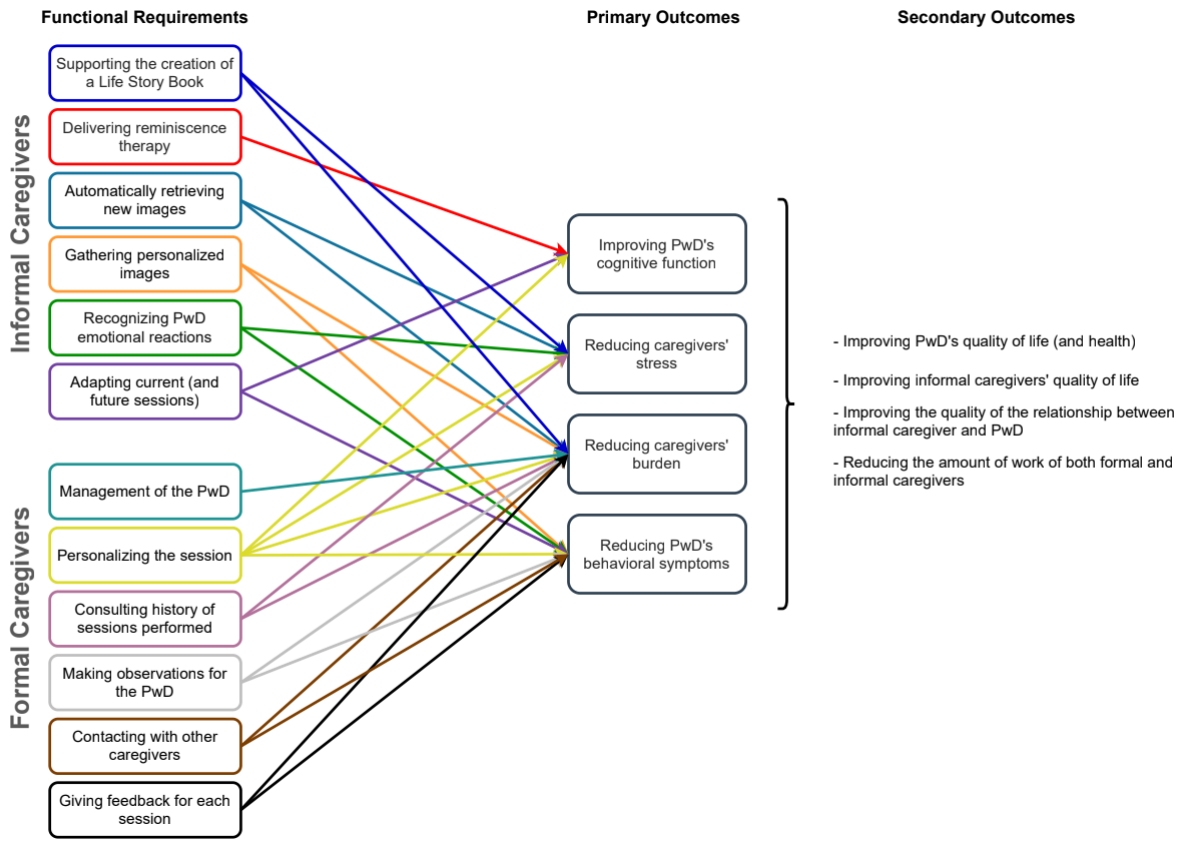

Figure 3.1: Functional requirements and expected primary and secondary outcomes for caregivers identified by Alarcao et al. for their solution [1] (best seen in colour).

3.2 Solution Design

With the primary objective being reducing the burden on the caregivers by helping them prepare sessions more easily, mechanisms were designed to be implemented onto the existing application. Taking into account the functional requirements that were gathered and shown previously, the focus was on developing functionalities that allowed for searching images online and finding more personalized images by requesting images from other people outside the application. These could be, for example, family members or friends of the people with dementia. There was also a need for a mechanism that allowed caregivers to validate the images before they were uploaded to the platform. Until now, the only way to insert images into the platform was to have caregivers adding them manually by selecting the files from the file explorer on the device that was running the application.

Images can be added to the caregivers' profile as well as to the profile of the person with dementia. The new mechanisms were developed so that images could be searched online or requested also for each of these two profiles. The validation of the images would take place in the context of the caregivers' profile since they are the ones responsible for

validating all the images received for themselves as well as for all their patients.

In regards to the mechanism that allows the caregiver to request images to outside users, we included an expiration date on these requests. It can be defined by the caregiver, as a security measure to prevent people from uploading more images outside the time-frame desired by the caregiver. This would avoid, for instance, a flooding of requests to validate uploaded images when the caregiver did not need or want them.

The online image search is based on image tags and is performed on the image hosting website Flickr. The platform provides a list of tags, which by default contains common themes and interests such as music, cinema, food, etc, with the caregivers also being able to write their own. There is a risk that the images found are not personal enough, especially when using online search for a specific patient. So, we added a new feature where caregivers can register patient's interests such as favorite cities and hobbies, which will later on be used as tags for searching online. There was an emphasis on cities of interest because they are easily personalized to each patient thus making images of them likely to prove effective in a session and it is relatively easy to find images of just about every city online.

When it comes to validating the images found online or submitted through the request for images, the system itself would analyze and suggest, based on the image content, which images should be accepted and which should be rejected before presenting them to the caregiver. However, the final decision is always made by the caregivers.

While designing the solution there were also other aspects which were kept in mind. The interface had to be easy and intuitive for people of older ages that might not be as adept at using technology. The average age of a caregiver, which are the primary users of the application, is close to 50 years old and 34% of caregivers are over the age of 65. Technological terms that might be considered technical jargon were avoided wherever possible. There was also a focus of providing somewhat detailed descriptions on the available options so that the user could immediately see what the action they are about to perform will do.

3.3 Technology Used

The application consists of three main components: front-end, back-end and database. All of them were developed while keeping in mind carer's needs when managing their patients, media and performing reminiscence therapy sessions.

The database was developed using PostgreSQL, which is a powerful object-relational database system that works as a more advanced version of SQL (database management system commonly used for e-commerce and other types of data storage), that provides support for useful features like foreign keys, sub-queries, triggers as well as user-defined functions and types.

For the back-end, consisting of a REST service, Spring Boot using Java language was used. REST or Representational State Transfer, is an architectural style that consists of, upon receiving requests from a client for a resource using a REST API, the server will answer back with the current state of the resource in a standardized representation, meaning all the relevant information about the resource will be translated and returned in a format that the client that performed the request can easily understand.

The front-end was developed using Angular, a popular HTML and TypeScript (a programming language that builds on JavaScript, with features such as static typing that make it more object oriented, while regular JavaScript is more of a scripting language) based web development framework that is component-based, providing good scalability, performance and also having a lot of useful and powerful libraries that lead to a faster and more streamlined development process.

Certain API's were also used, such as Clarifai for automatic image classification, and the Flickr API for automatic image search.

3.4 Architecture

Alarcão et al. proposed a system architecture that considers two users: Caregivers and dementia patients, with caregivers being the primary users and patients only interacting with the application when performing reminiscence therapy sessions by viewing the images and reacting to them. Their study focused on using patient's emotional information to improve reminiscence therapy sessions so features like estimated arousal and valence are extracted during sessions, represented by the Physiological-based Emotional Extraction in figure 3.2, that provides a visual representation of the architecture of the current KeepsakeBox system.

With the new solutions that were designed, another type of user was considered, that being Family and Friends. These users are the ones that will upload images to the platform using the caregivers request for image submissions.

The images presented during a therapy session are selected by an Information Decision Support System. After a session is completed, the reactions to the images and other information about it, such as feedback provided by the caregiver, is stored in a Knowledge Base, with emotion values attached to images also being kept, represented by Image-Based Emotion Extraction in figure 3.2. The Automatic Content Selection part of the architecture represents this automatic image selection with a connection between the Session Manager and the Images in the Data Storage. The new solution for automatic image searching online is also represented with a connection between the Retrieval component and Images, since images retrieved using this mechanism will be stored in the Data Storage.

In figure 3.2 we can also see the front-end, back-end and database components that

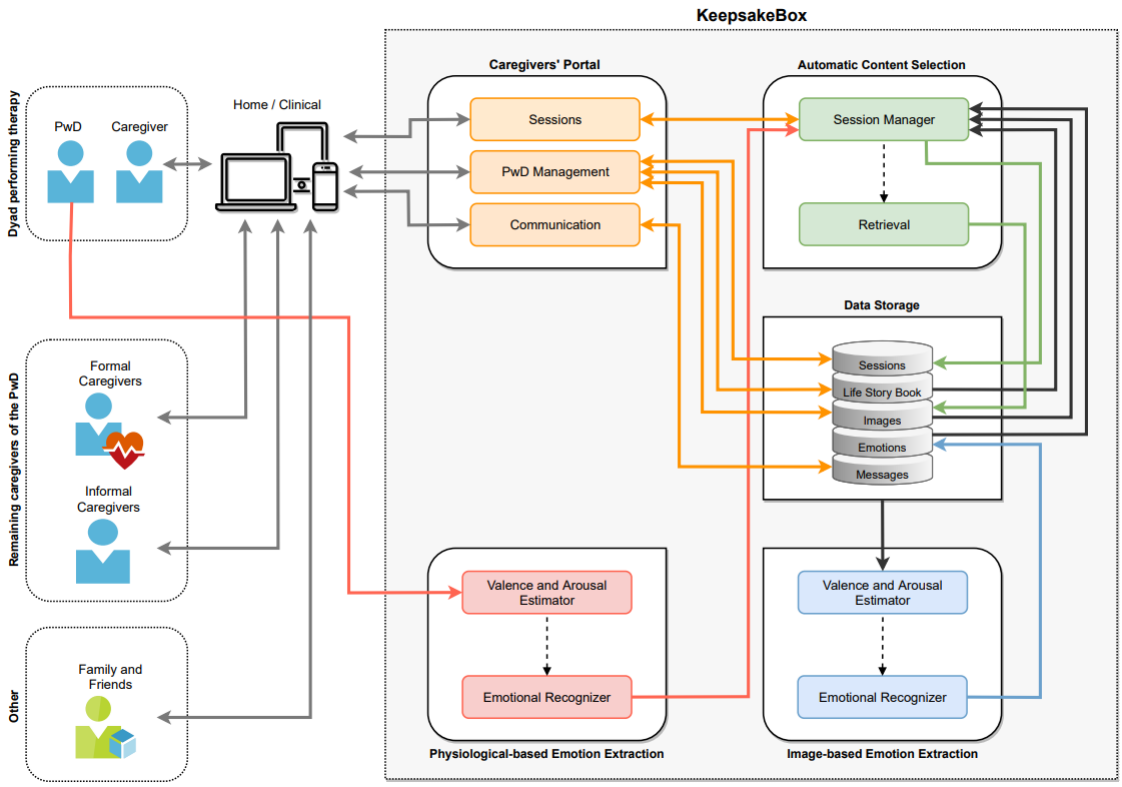

Figure 3.2: KeepsakeBox system architecture

were previously mentioned. The Data Storage represents the database, containing all the information about caregivers, patients, media and therapy sessions. The front-end is represented by the Caregiver's Portal. The back-end is represented as the connection between the front-end and the database, as well as the Automatic Content Selection portion of the architecture.

The front-end is the interface used by the platform that will be used by the caregivers, containing all the features that allow caregivers to manage sessions, information, media and patients. Previous work on the application, such as the one developed by André Santana, mainly focused on developing functions for the Data Storage part of the system, with functions related to the management of patients and their data, as well as allowing different carers to conduct therapies for the same patient. With our new work the front-end components were more developed to include the new functionalities and mechanisms for adding and searching new images.

3.5 Functionalities

In this section we describe in detail the functionalities and mechanisms developed for the existing KeepsakeBox application as part of this work.

3.5.1 Generating Requests for Outside Users to Upload Images

When adding a new image to either the caregiver profile or a patient profile, the caregiver can choose one of three options, each corresponding with a different way of searching for images (see Figure 3.3).

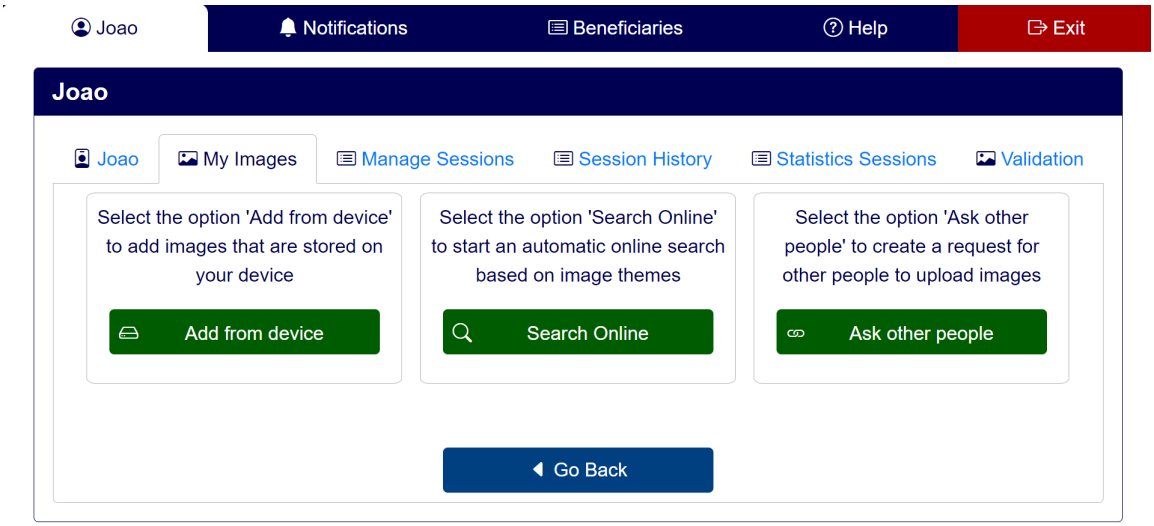

Figure 3.3: Options to add new images to the platform

The first mechanism we discuss is the one that provides caregivers with a way of requesting images to outside users, such as friends and family of the patient they are caring for. The objective here is to provide caregivers with an easier way to access personalized images to be used in sessions, by communicating with people close to the patient and asking them for images directly.

Request Generation

After selecting the option ”Ask other people” the caregiver is presented with a brief description of the what this option consists of and a select box where they can then select how long until the generated request expires.

After pressing the ”Generate request” button it will generate a link that is presented to the caregiver (see Figure 3.4). It is meant for them to copy and send to the people that they wish. They will then have to insert the link in a web browser where they can access an interface to upload images.

In the database, images submitted by outside users have the id of the caregiver that generated the request associated. This defines who has access to the validation interface to reject or accept those images. It also stores the id of the person that those images were meant for, patient or caregiver. The username of the submitter is also stored, along with other image attributes such as description, categories, submission date and privacy setting.

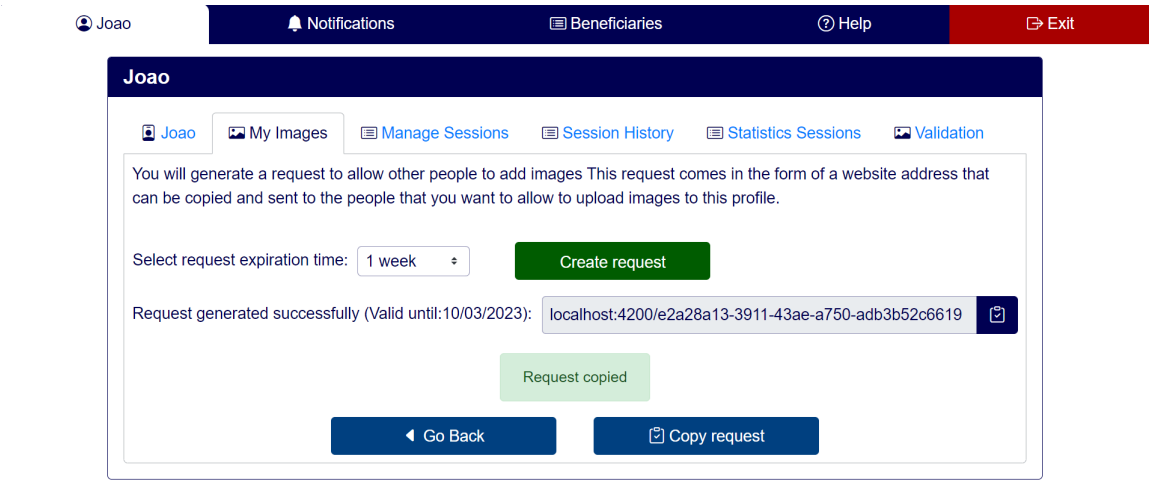

Figure 3.4: Request for outside user uploads

Image Upload Interface for Outside Users

Accessing the generated link with a browser brings the user to an image upload interface, where they can drag or use the button to select images saved on their device.

After selecting which images they want to upload, there is then a prompt for the users to add descriptions and categories to the images, as well as selecting if they are private, which is the default setting, or public.

The user also has to submit their name, so that the caregiver can know which images were submitted by the user in question (see Figure 3.5).

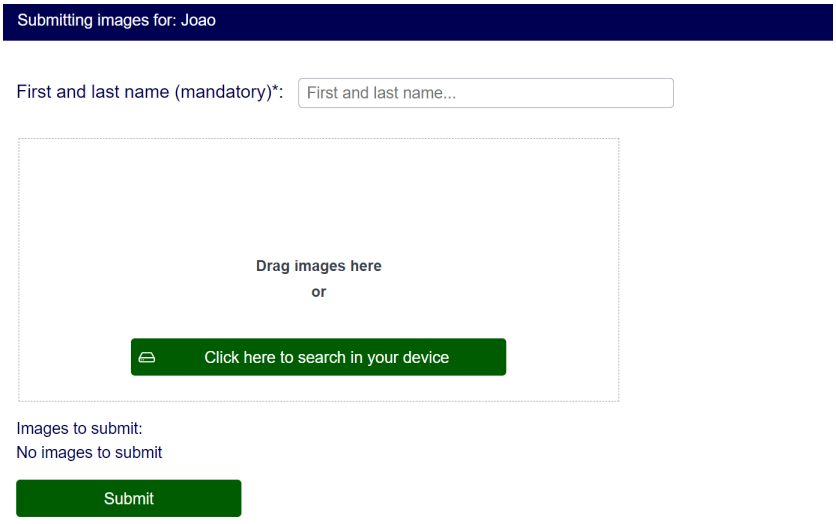

Figure 3.5: Interface for outside user uploads

The KeepsakeBox application was developed mainly as a desktop or laptop computer based web application. However, in this context, there is a high probability that users

using this image upload interface are going to be using their mobile devices to upload images, and with this in mid the interface was developed with mobile devices in mind as well as desktop and laptop computers (see Figure 3.6).

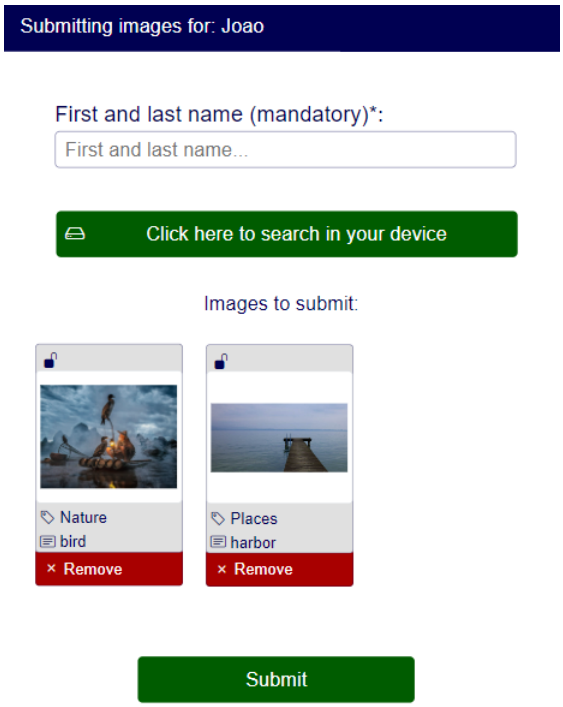

Figure 3.6: Mobile interface for outside user uploads

3.5.2 Online Image Searches Based on Image Categories

Selecting the option ”Search online” presents the user with a screen where they can select from a list of categories those they want the search to be based on. They can also write their own categories to allow for a more personalized approach. There is also an option to choose how many images are meant to be found (see Figure 3.7).

For the back-end we developed an image crawler that uses the API of the image hosting website Flickr to find images based on categories. Images hosted on this website have tags associated with them, that make it easier for users to find the images using the Flickr search bar. The categories selected by the caregiver serve as the keywords for a search on the Flickr website that finds images with tags corresponding to the categories.

Unlike the images submitted by outside users, images found using the online search do not have descriptions, categories from the list predefined in the application, or privacy settings. Thus, the caregivers need to add a description and categories to the found images

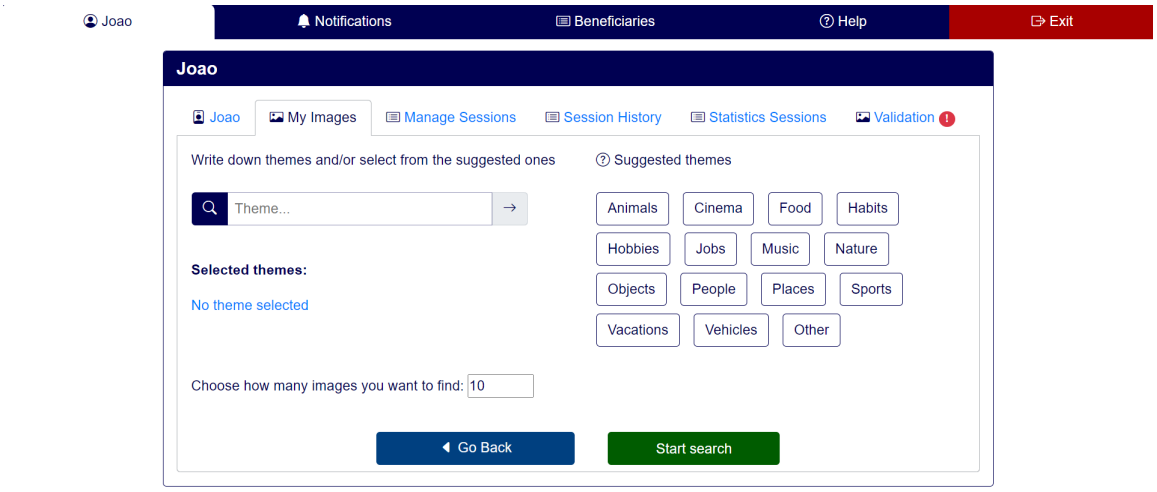

Figure 3.7: Online search screen

after validating them. After that, they are uploaded to the system like any other image. A downside to this approach is that the process of categorizing the images can take a while depending on the caregiver and the number of images that were searched for. However, it is important to have this information about the images so that in the future the caregiver can better choose the images that will be used when creating a new session and analyze what types of images were most effective during previous sessions.

Using patient information to search images automatically

One of the problems associated with this online search feature is that using the categories present in the list defined by default in the system may result in a lack of personalized images found by the image crawler. To mitigate this we allow caregivers to write their own categories to be used as keywords in the search.

Since it might be hard to keep track of what categories are relevant to each patient, we developed a new feature that consists of allowing caregivers to register patient's interests when adding them to the platform (see Figures 3.8 and 3.9). Now, when entering a new patient profile we can see what interests they have, that might prove as useful search keywords when searching online. The "Suggested themes" section in the online search for the patients will now present the patient's interest before the default categories already in the system. This allows caregivers to more easily find personalized images in an online search that wouldn't have much personalization from the get go.

As explained previously, the patient's interests are divided into "Cities of interest" and "Other interests" because although the interests are personalized to each patient, the images found online will still be somewhat generic, so using cities can prove useful because it is very personalized to each patient and it is easy to find images of most cities,

with said images likely to prove useful in helping the patient evoke pleasant memories. Opinions given by the caregivers also pointed to the fact that, in general, cities are a good conversation topic with their patients.

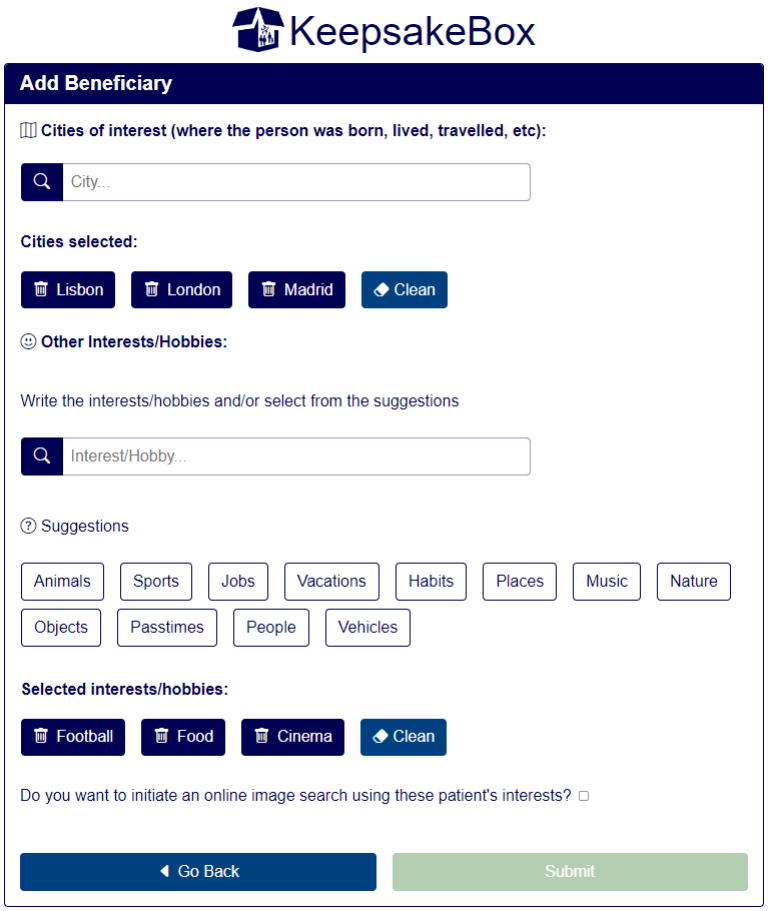

Figure 3.8: Registering patient interests

3.5.3 Validating Retrieved Images

In order to prevent images with dangerous or inappropriate content, such as violence or pornography, from being uploaded to the platform we need a way of controlling what users are submitting and what images found online are actually going to be available for use in sessions.

To that end, caregivers need to validate the images, either submitted by outside users or found as part of an online search using categories.

Clarifai Automatic Image Validation

In order to help caregivers in validating the images, we used the Clarifai system. It is an automatic image validation system that can detect different types of content present in images.

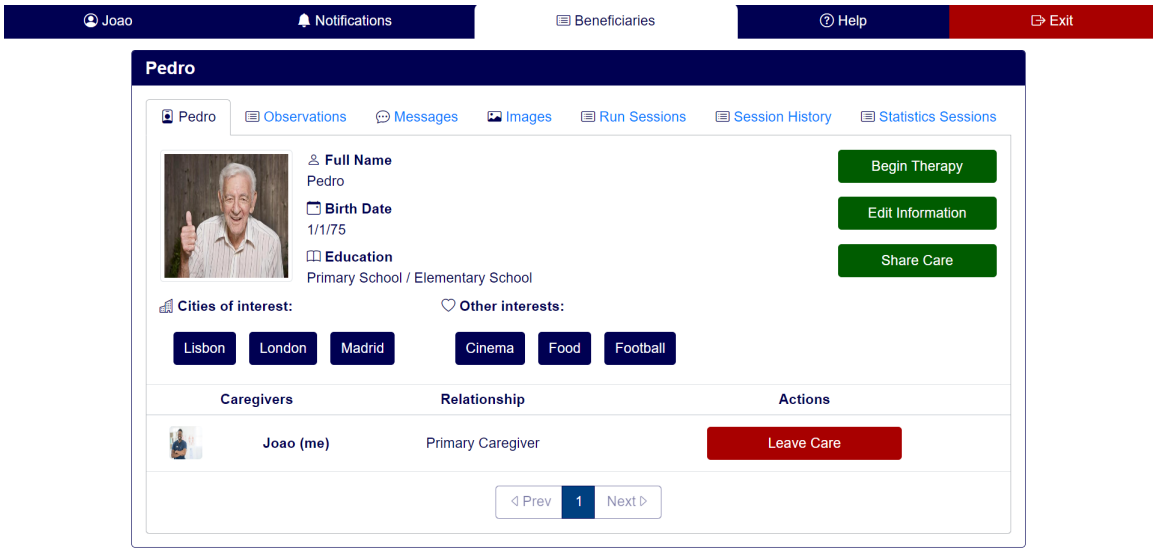

Figure 3.9: Patient profile

Clarifai is a system that can automatically analyze and classify different types of content. Computer Vision Services are services developed by the Clarifai team that provide classification of different types of content such as images, text, audio and video by using deep learning AI models that aim to mimic human interpretation.

For this work we used the Clarifai API for image recognition. It uses pre-trained models to identify several types of content present in an image, such as logos, people, vehicles, weapons, hate symbols, etc.

The Clarifai Image Moderation Classifier, that serves as a model used for content moderation, can be used to classify images as safe or unsafe. For every image analyzed it outputs a probability distribution among five different labels:

- Drug
- Explicit
- Gore
- Safe
- Suggestive

Based on these probabilities it determines whether an image can be deemed safe or not. Every label has a probability ranging from 0 to 1 and only if the label with the highest probability is ”Safe” is the image deemed safe for use.

In our image validation interface, we have a message at the top indicating how many images the Clarifai system suggested should be included and how many should be excluded from the system (see Figure 3.11). Images deemed safe are grouped into a tab containing the images that will be uploaded to the system, while images deemed unsafe will be grouped into another tab with images that will be discarded. Unsafe images also have a warning icon on the corner of the card containing the image that informs the user

that the Clarifai system has deemed it unsafe. However, the final decision on what images are added and discarded falls on the caregiver, as they can move the images between the tabs as they wish, giving them the ability to accept images that were deemed unsafe by the Clarifai system, and reject images that were deemed safe, if they so choose to.

Validating images retrieved using the request for user uploads

Upon entering the caregiver profile the user can access the validation tab where they can validate images submitted by outside users. If there are submissions that were not validated yet, a notification is displayed on the validation tab, as well as on the notifications tab (see Figure 3.10).

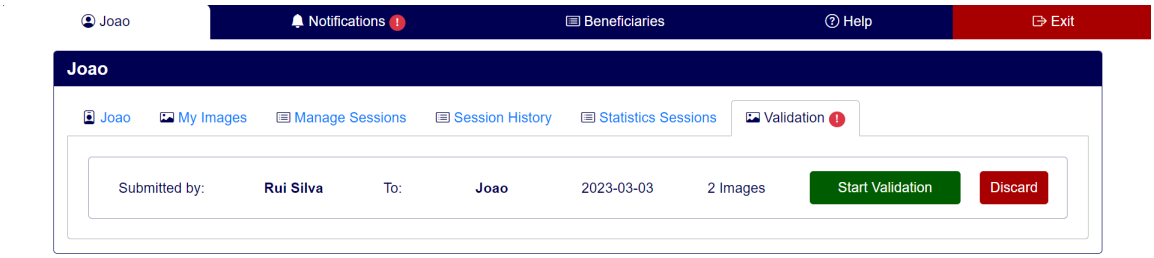

Figure 3.10: Selecting which submission to validate

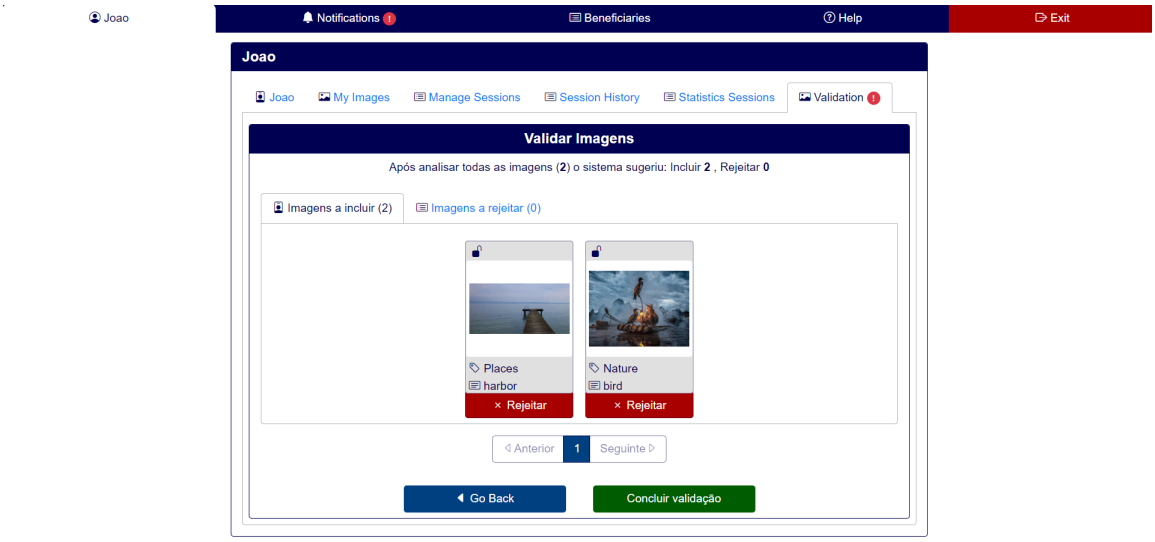

Figure 3.11: Validation interface

In this tab the caregiver choose to start the validation process for each submission, or discard the images without validating. The images submitted are divided into groups corresponding to a single submission of one or more images by a user. For each submission the caregiver can check the username of the submitter, the number of images, date of submission and who the images are destined for (see Figure 3.10).

If the caregiver chooses to validate the images a subsequent page appears where the submitted images are presented and where the caregiver can decide which ones to add to the system and which ones should be discarded (see Figure 3.11). Prior to the caregiver deciding which images are to be included, the system automatically groups them in two tabs, one containing the images considered safe and which will be added and one with the images considered unsafe that will be discarded, based on their Clarifai classification. The caregiver can then move images from either tab to the other, meaning that the final decision as to whether an image will be included or not always falls on the caregiver. Images grouped automatically in the rejection tab will always have a warning icon to indicate that the system has classified them as unsafe.

After the images are organized as the caregiver wants them, pressing the submit button will add the images in the included tab to the system, while discarding the other ones.

Validating images retrieved using online search

The process to validate images retrieved using online search is similar to the previous one with a few differences. After the online search is concluded by the system the user is automatically redirected to the validation page where the images are presented.

After selecting the images that will be included and pressing the submit button, the caregiver has the task of categorizing the images, since the online search does not categorize them prior to presenting them to the user. After the categorizing process is done, the images are added to the system and are made available for use in reminiscence therapy sessions.

3.5.4 Back-end Optimization

This section discusses some improvements made on the back-end components of the KeepsakeBox application, to improve performance and help optimize other functionalities.

Thumbnails

When allowing users to upload their own media to an application some precautions need to be taken when it comes to preventing users from uploading files that are so large that their size could strain the application's servers.

With the prospect of many images being uploaded by a lot of different users, some improvements needed to be made in order to help reduce any potential strain on the servers. For this work, all images uploaded to the platform are resized to a maximum of 2560x2560 pixels (if they exceed those measurements in height or width) and have a thumbnail generated of them that is a maximum of 400x400 pixels. The thumbnail is presented in the "Images" tab on the caregiver's and patient's profile. Checking the image

details by pressing the image card presents the user with the image itself, resized to a maximum of 2560x2560 pixels when it was uploaded.

Category management

In order to create reminiscence therapy sessions caregivers must know what images are present on the system to be used. To help with this we added a new table to the back-end server that stores information of the categories that exist on the system, as well as the number of images for each category. Every time an image is uploaded to the application, their corresponding categories are incremented by one in the table. When caregivers go to the creation of new sessions they know how many images exist in each category.

3.6 Summary

In this chapter we discussed the requirements that were gathered during previous studies that allowed us to determine what new mechanisms needed to be added to the KeepsakeBox application as part of this work, mainly concerning personalized and automatic image retrieval in order to reduce the burden and stress on the caregivers.

The solution design had the reducing of caregiver's burden as the main focus, since preparing media for sessions can be a lot of work. Taking into account the functional requirements that were gathered, a few solutions were designed such as mechanisms for allowing caregivers to search for images online, and request images from patient's friends and family, in order to more easily get access to more personalized images that are relevant to each patient. We also added a mechanism that allows caregivers to validate the new images added using either of the previous two functionalities.

The technologies used in the application were: Angular framework for the front-end components, PostgreSQL for the object-relational database and a REST service using Spring Boot developed in Java.

The new functionalities developed were: Request generation for outside users to upload images, automatic online image search based on image categories and validation of retrieved images.

In order to generate a request for outside user uploads the caregiver needs to access their or any of their patients profiles, on the images tab, select "Add images" and choose the "Ask other people" option which allows caregivers to generate a link that will expire after the duration selected by the caregiver. The link can then be sent to friends and family of the patient that will present them with an interface where they can upload images, categorize them and after entering their name, the images will be sent to the caregiver for validation.

To initiate an automatic image search the caregiver must select the "Search online" option. Selecting this option will allow caregivers to choose the categories upon which

the automatic search will be based on, as well as the number of images that they wish to find. Unlike the previous mechanism, the caregiver is tasked with categorizing every image found.

To validate images submitted by outside users, caregivers can access the ”Validation” tab on their profiles where every submission that was not validated yet will be presented, with the submitter’s name, number of images and submission date. The caregiver can choose to start the validation process or discard the images without validating. Start the validation process will redirect the caregiver to another screen where the images are presented and grouped in two tabs, one containing the images that will be included and one containing the images that will be discarded. The images are automatically grouped by using the information provided by the Clarifai system. However the final decision falls on the caregiver in regards to deciding which images will be uploaded to the system and made available for use. After an online search the caregiver is immediately presented with this screen.

Chapter 4

Evaluation

The KeepsakeBox application was developed with caregivers in mind and the mechanisms that were developed in this work were also directed towards them (image validation, automatic image search and request generation for outside user uploads). This means that the evaluation of these features was performed with this type of users when possible. However, the user interface for allowing outside users to upload images using a request generated by a caregiver was tested with users that are not the primary users of the rest of the application, since any person can upload images.

In the initial stages of development we developed low and medium fidelity prototypes. These were used in the first and second round of testing respectively. Results from these testing rounds were used to improve the application that would eventually reach the version presented in Chapter 3. For the third and final round we tested that version of the application, where all the new mechanisms were fully functional.

To act in conformity with the faculty's Ethics Committee users were required to provide consent before the testing takes place, with respect for the privacy and anonymity of the participants being a primary concern.

4.1 Prototype Testing

In this section we describe the initial testing phase that consisted of testing low fidelity paper prototypes, as well as the second phase of testing where users tested a medium fidelity prototype, with the application running on a computer with some limited functionalities.

These prototype tests were very important to help us determine if the mechanisms that were developed were actually corresponding to the users needs. The feedback from these tests helped make the changes we felt necessary after analyzing the results in order to improve not only the platform but subsequent testing as well.

No caregivers were able to test these prototypes due to the difficulty in recruiting them for testing, with a lot of them having very limited availability and Covid-19 restrictions at

the time.

4.1.1 Low Fidelity Prototype Testing

In this section we detail the first round of testing that took place using low fidelity prototypes consisting of several paper mock ups each containing a screen that was part of the interface.

Structure

This testing phase consisted of observing the users perform a series of tasks. They were conducted remotely using the screen sharing apps Zoom and Discord according to each users preference.

Figures 4.1, 4.2 and 4.3 display the initial design ideas for the overall functionality of the new mechanisms. Using these initial ideas as a base point, we developed several low fidelity prototypes that were tested by users.

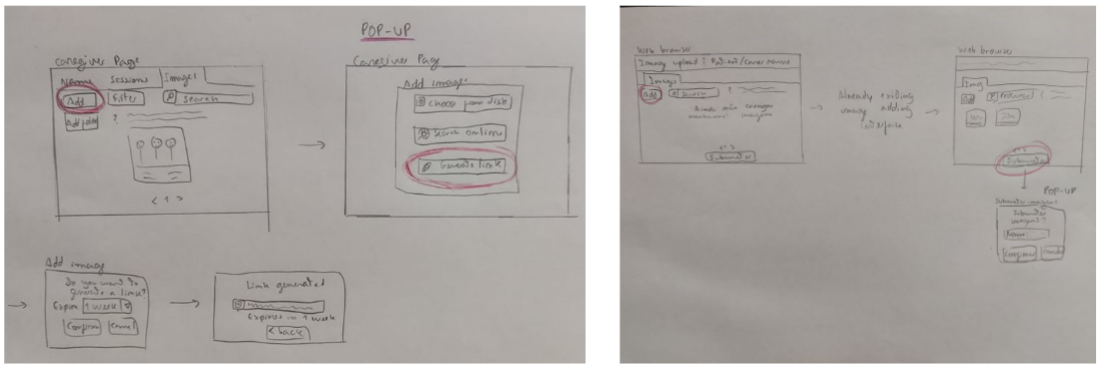

Figure 4.1: Initial interface ideas for the request for outside user uploads

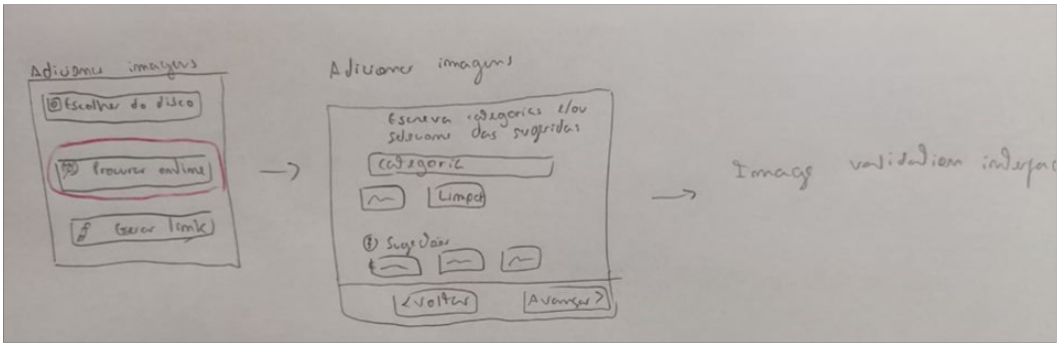

Figure 4.2: Initial interface ideas for the online search mechanism

The prototypes were made in paper (see Figure 4.4) so the limitation of having to do the tests remotely due to Covid-19 restrictions at the time made it hard to simulate the

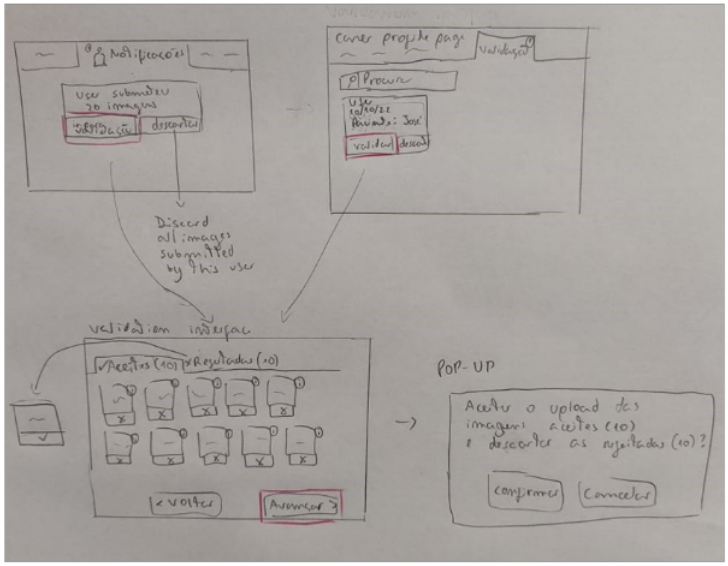

Figure 4.3: Initial ideas for the interface for the validation of new images

interaction with the system. To conduct the tests we shared our screen in order to show a picture of the interface the user was currently using, asking the user what buttons they wanted to click in order to complete the task provided. The picture would then be changed to one of the interface that the user would be redirected to.

The users were asked to think out loud while performing the tasks, describing their reasoning behind clicking certain buttons or where they were looking for certain information on the screen. After a brief introduction explaining the context of the project and our main objectives, we proceeded with the tasks.

The tasks provided were divided in groups, each corresponding to one of the mechanisms developed as part of this work. There were in total 6 tasks divided into 3 groups, each with 2 tasks. The first group had a task consisting of creating a new request for outside users to upload images for the caregiver profile, and another one for using the generated request to upload images. For the second group the user had to initiate an online search and then validate the images retrieved. For the third group they had to access the validation interface to validate the images submitted by other users.

After each group of tasks the user was asked to answer the 2 first questions of the ASQ (After-Scenario Questionnaire). The ASQ is a 3 question questionnaire used to evaluate perceived difficulty by users in performing tasks in a scenario. The questions are answered using a Likert scale from 1 to 7, with 1 meaning that the user strongly disagrees with the statement and 7 meaning the user strongly agrees. The first 2 questions, which are the ones included in the tests performed, are “Overall, I am satisfied with the ease of completing the tasks in this scenario” and “Overall, I am satisfied with the amount of time it took to complete the tasks in this scenario”. The third question is “Overall, I am satisfied with the support information (online help, messages, documentation) when

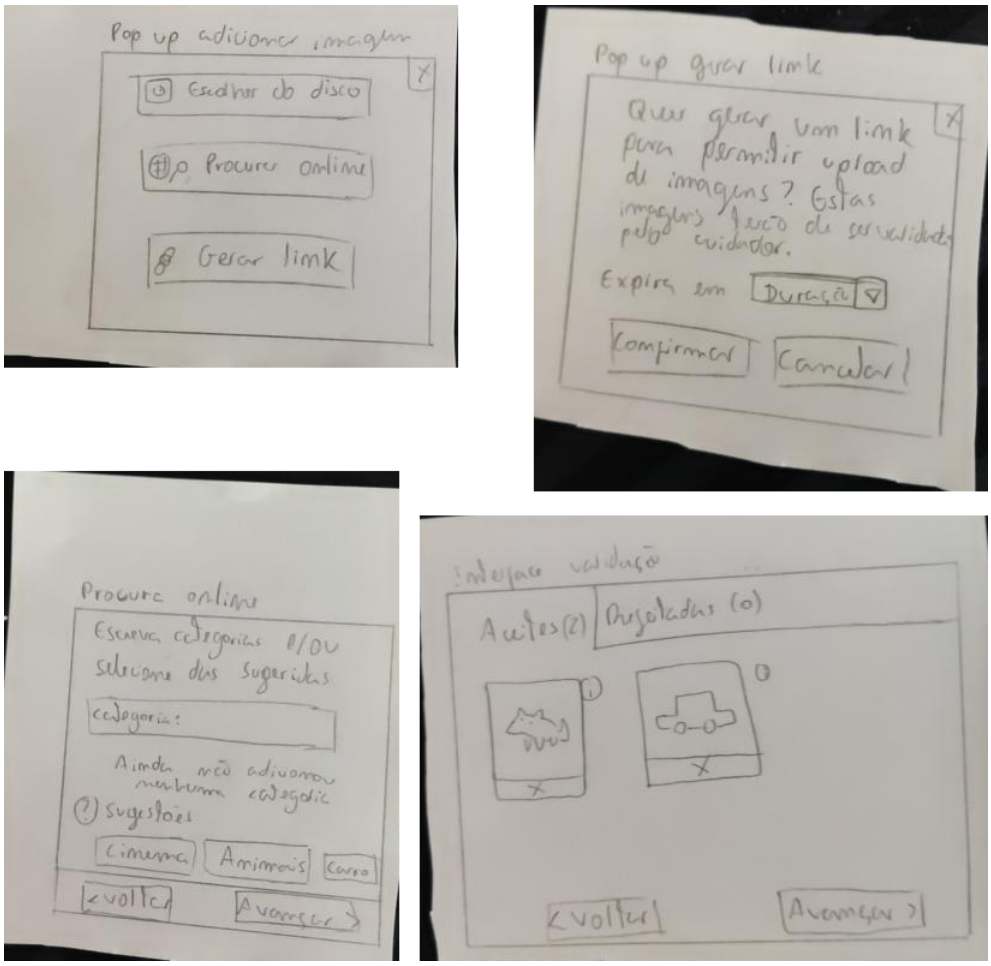

Figure 4.4: Some of the low fidelity prototypes used in the initial phase of user testing

completing the tasks". It was not included because there was no documentation of any similar sort of help available for performing the tasks.

Data Analysis

In total there were 5 test subjects, aged between 22 and 72.

We took note of the most relevant talking points by each user as well as certain mistakes or decisions they made while performing the tasks, such as the paths they took to find certain functionalities. Despite the limited functionality of this prototype and the non ideal test conditions, the feedback provided by the users proved very useful.

The scores from the ASQ were also analyzed in order to assess perceived ease of use and perceived satisfaction with the time taken to complete each group of tasks.

Results and Design Improvements

According to the ASQ scores, there was an average perceived ease of use (in accordance with the first question of the ASQ) of 5.8 (SD = 1.3) out of 7, with the lowest being

4 and highest being 7, we can conclude that the users found the system easy to use in general, and with a perceived satisfaction of the time taken to perform the tasks of 5.0 (SD = 0.7) out of 7 with 4 being the lowest and 6 the highest, we can also conclude that the users were, in general, satisfied with the time they took to complete the tasks.

There were also some common relevant occurrences and thoughts brought up during testing. One of them being the fact that navigating the initial page trying to find where to generate the link proved to be somewhat challenging, with 3 out of the 5 users navigating to the wrong tab at least once. However this isn't necessarily a problem with the interface but more of a natural learning process that occurs when using a new application, so no changes were made in this front.

Several users also found having a separate button just for adding a folder of images a bit confusing, so this button was removed and now the users would be able to add multiple images from their device by using the "Choose from disk" option after pressing the "Add images" button, by simply selecting multiple images. The name was also removed from the confirmation popup in the interface for outside user uploads and was moved to above the section displaying the images that were added for submission and would only be able to submit after filling in their name, and having added at least one image.

Another suggestion was to allow users to remove selected categories for online search individually, since there was no icon or symbol such as a cross to represent that that was possible, this was promptly added. Two users also said that the image upload interface would make sense on a mobile device, since that is where they kept most of their pictures and where they could most easily access, hence the focus on making sure this interface worked on these type of devices.

Finally, 2 out of the 5 users accessed the image validation interface for the outside user upload using the notifications tab instead of going through the caregiver profile. Having multiple paths of achieving the same outcome is also important when designing an interface, since it makes using it more intuitive for different users.

4.1.2 Medium Fidelity Prototype Testing

This section describes the second round of testing that was conducted using a medium fidelity prototype of the application running on a computer and with the mechanisms mostly functional.

Structure

The medium fidelity prototypes were prototypes that resembled the final application in terms of looks (see Figures4.5 and 4.6) , but had very limited functionality, just enough for users to test some of the basic features relating to the new mechanisms.

Similarly to the previous testing phase, after an introduction explaining what the study was for and the main goals of the project, collecting some basic demographic data (gender,

Figure 4.5: Medium fidelity prototype of the request for outside user uploads

Figure 4.6: Medium fidelity prototype of the online image search using categories

age, occupation, experience with technology and visual limitations) and asking the users to think out loud while performing the tasks, they proceeded with performing the tasks.

Once again the tests were done remotely, with remote control being provided via Zoom in order to let users interact with the application themselves directly. There was also a need to use the Notepad application in order to allow users to paste the links they generated when creating requests for outside user uploads, so this application was opened

before testing started and we explained to the users what the use for it would be.

The tasks were altered in order to provide a more natural flow of application usage to reduce confusion and backtracking, as well as for testing new functionalities that were implemented. There were still 3 groups, the first one had 3 tasks, one where the user had to create a request for outside user uploads for caregiver profile and copy and store the generated link (this was done in order to simulate the copying and sending of the link to family and friends. For testing purposes we simply asked them to store the link in the Notepad app that was opened before). The other tasks were the same but for the profile of a person with dementia, in order to show users that they could request images that would only be made available for certain profiles. The last task of this group was to use the request generated for the patient with dementia to submit three images.

Group 2 only had one task and that was to validate the images submitted in the request for outside user uploads by accepting only the first image and discarding the last two.

The last group had two tasks, one consisting of conducting an online search and another consisting of validating the retrieved images based on the suggestions provided by the Clarifai Image Classification Model.

Once again the users were asked to answer the first two questions of the ASQ questionnaire after each group of tasks.

Data Analysis

There were in total 5 test subjects aged between 22 and 72.

Like the previous testing phase we wrote down the most relevant information provided by the users, as well as analyzing the ASQ scores.

Results and Design Improvements

The ASQ scores once again proved very positive with an average perceived ease of use of 5.4 (SD = 1.14) with the lowest being 4 and highest 7. Perceived satisfaction with the time taken to perform the tasks was also positive with an average of also 5.2 (SD = 1.09) with the lowest being 4 and highest 7.

Some of the most relevant information brought up during testing included the fact that it was not immediately apparent that some of the images retrieved were already grouped in the rejected tab during validation and the Clarifai information about how many images were tagged as unsafe was also not readily apparent. This can also be a result of the natural learning process of the application, but we still moved the Clarifai information to the top of the validation page and increased the font size, while also highlighting the number of images that were next to each tabs name, that represented how many images were grouped in that tab.

No major changes were made since most of the testing went well. Other minor improvements included adding a button next to the category manual input bar that would

submit the input instead of having to press ENTER, since a few users searched for that button for a little bit. We also changed some of the language to be more clear such as changing ”Choose from disk” to ”Select from device” and improving the descriptions above each image selection method. We also made it so that these new mechanisms no longer appeared in the form of popups, namely the request generation for outside user uploads and the online image search, because they made the screen too cluttered. Making the application switch screens made it so the interaction was more seamless and intuitive.

4.2 KeepsakeBox Platform Tests

In this section we describe the final round of testing where actual caregivers that worked in institutions that help people with dementia got to test the application. They tested not only the mechanisms developed as part of this work, that implemented new ways to insert and validate images, but also the mechanisms developed by colleagues Pedro Neves, that allowed caregivers to use said images to create sessions and conduct them, and Bruna Vieites that provided a way for caregivers to review sessions and view several statistics of the sessions they conducted.

4.2.1 Structure

Like the previous two testing phases, the users were asked to perform a set of tasks. The number of tasks was shortened due to the fact that the caregivers would be testing more mechanisms than in the previous phases, since the works from the other colleagues were also included.

The sessions were conducted via Zoom where remote control was given to the caregivers. The caregivers were also briefed on the goals of the project and were asked to think out loud just like in the previous testing phases.

Concerning this work there was one set with 3 tasks for the caregivers to perform: 1) Create a new request for outside user uploads and send the generated link in the Zoom chat (to simulate sending it to friends and family of the people with dementia); 2) Validate images received through the generated request using the validation interface (we quickly submitted images in the generated request); 3) Conduct an online search using certain categories and validate the images retrieved based on information provided by the Clarifai system.

The caregivers were then asked to answer an UMUX-Lite questionnaire after finishing these 3 tasks. The questionnaire consisted of 2 questions, regarding perceived ease of use and whether the mechanisms satisfy their necessities (see Figure 4.7). The questions were: 1) The insertion and validation of images satisfies my necessities; 2) The insertion and validation of images is easy to use. After completing all the tasks from the test script they then answered the SUS (System Usability Scale) questionnaire to measure system

usability and the TAM (Technology Acceptance Model) questionnaire to measure system utility (check Appendix A).

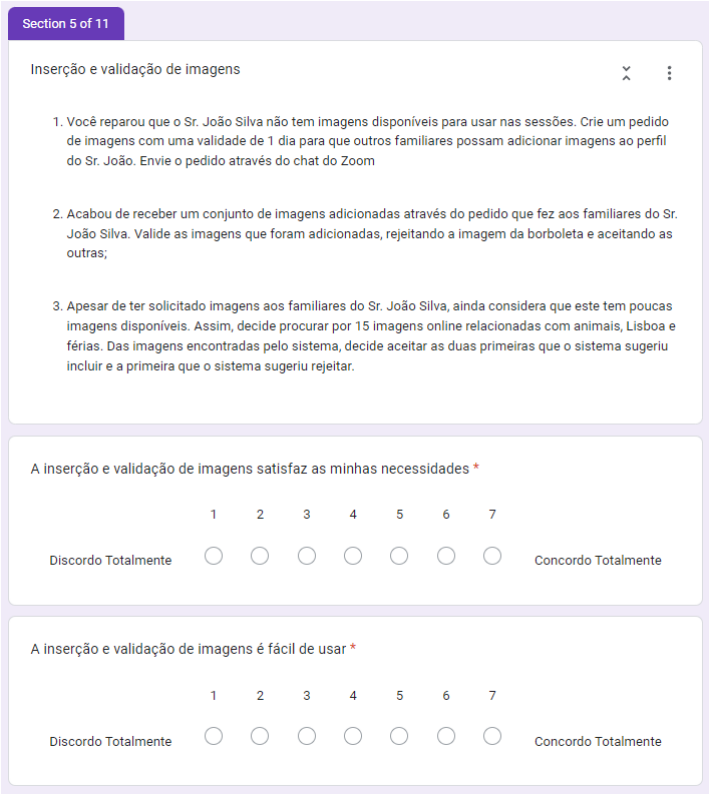

Figure 4.7: Tasks performed by the users as well as the questions answered

The SUS questionnaire is designed to measure the general usability of a system. It consists of 10 questions that use a 5 point Likert scale with 1 being the lowest level of agreement and 5 being the highest. The questions are:

1. I think that I would like to use this product frequently.
2. I thought the product was more complex than necessary.
3. I found the product easy to use.
4. I think I would need support from a technical person to use this product.
5. I found the various functionalities of this product were well integrated.
6. I thought this product had a lot of inconsistencies.
7. I would imagine most people would learn to use this product quickly.
8. I found the product very cumbersome to use.
9. I felt confident using this product.

10. I had to learn a lot before using this product.

On the other hand, the TAM questionnaire is designed to measure the adoption of a new technology or product. The questions are answered using a 7 point Likert scale with 1 being the lowest level of agreement and 7 being the highest. There are 12 questions in the TAM questionnaire but for our purposes we used 6, since there was no need for some of the other questions because they were similar to some of the ones found on the SUS questionnaire. The questions used were:

1. Using this product in conducting reminiscence therapy sessions would allow me to accomplish my tasks more quickly.
2. Using this product would improve my performance when performing reminiscence therapy sessions.
3. The use of this product when performing reminiscence therapy sessions would improve my productivity.
4. Using this product would enhance my effectiveness in performing reminiscence therapy sessions.
5. The use of this product would make my job of conducting reminiscence therapy sessions easier.
6. I think this product would be useful when performing reminiscence therapy sessions.

For users using the outside user upload interface, only one task was required, that was to submit three images and their name in a request provided by the tester.

They were then asked to answer the first two questions of the ASQ.

4.2.2 Data Analysis

The test sessions were recorded with the consent of the users and reviewed in order to draw conclusions from them.

For these tests we were able to recruit 4 formal caregivers, however, due to technical difficulties and time constraints only 2 of them were able to test the mechanisms concerning this work.

We analyzed the UMUX questionnaires answered to measure perceived ease of use and satisfaction when using the application. We also measure the SUS and TAM scores to assess overall system usability and acceptance.

To test the outside user image upload interface, 4 users were recruited to perform the tests, none of which were caregivers. The results from the ASQ were also analyzed.

4.2.3 Results

The test sessions with the caregivers were very positive with them stating that the mechanisms implemented as part of this work can be very useful in helping caregivers prepare sessions.

For the application tests with caregivers the SUS score averaged out at 81.25 (SD = 3.75) out of 100, meaning that users perceived the overall usability of the system very positively. The TAM questionnaires also provided very positive answers, with no answers below 4 and an average of 5.9 (SD = 0.95) agreement on the answers overall. This shows that the users found the system actually useful.

The most relevant change that would need to be made is to allow caregivers to view submissions from outside users for each patient individually, instead of having to go to the caregiver profile and viewing them all at once.

Some comments from caregivers included: "It is a very useful application, relatively easy to use and should be of great use for caregivers as well as people with dementia"; "Both the request for images and the online search make sense [...] having descriptions and categories for the images is important to assess which ones are actually relevant to the patient [...] why use only the images we have and not broaden the scope and make use of the many images that are available online that might still be of interest to the person"; "The image search makes sense, after learning how to use it makes a lot of sense, perhaps there was some initial difficulty in executing the task but that is probably due to the fact that this is my first time doing it. However, after doing it, it seems easy".

Another user commented that maybe the validation should be performed by actively selecting the images to include, instead of having to reject the ones that are not wanted. This was a very valid point, since the way the system currently works results in a negative cognitive action. What this means is that the images will be included by default (except the ones rejected using the Clarifai information) and it is up to the user to actively reject the images they don't want. Doing it the other way around, by having de images not included by default and having the user actively select the ones they want could be more intuitive. However, we believe the current approach to be more appropriate due to the fact that the system classifies the images as dangerous prior to the user validating them. Having unsafe images automatically grouped into the rejection tab and including the safe ones by default, whilst allowing the user to remove the ones they don't want, despite them being deemed safe, seems more appropriate in this context. The user can still look at the rejection tab and check if any images deemed unsafe were perhaps miss-classified and are adequate for reminiscence therapy sessions. After explaining our perspective the user commented: "Okay, I understand the reasoning, for the effect you are going for which is to automatically reject unsafe images it makes more sense".

For the outside image upload interface the testing was also positive, with an average ASQ score of 6 (SD = 0.82) out of 7 for perceived ease of use and 5.75 (SD = 1.26) for

perceived satisfaction with time taken to complete each group of tasks. This shows that users that tested this interface perceived it as ease to use and intuitive.

The users in general performed the task quickly and with little to no issues. One user commented about the fact that each image had to be categorized, and how that could somewhat bothersome if a lot of images were uploaded. However, as we explained previously, this information about the images is very important for caregivers to select images when creating new sessions as well as analyzing previous sessions. Having these users categorize the images also lessens the workload on the caregivers, and allows for the image descriptions to be more accurate, since the people uploading the image will have a better idea of what the image is actually about and why it is relevant to the person with dementia.

4.3 Summary

The testing for all the phases consisted of observing users perform a set of tasks, while thinking out loud so we could take note of what was happening and what they were thinking while they interacted with the application.

After the first round of testing, with the low fidelity prototypes, we were able to identify several design elements that needed to be changed in the application, such as removing the button for adding an image folder, removing the popup from the outside image upload interface and focusing on the mobile aspect of that interface. Despite several changes having to be made, the foundation for the mechanisms and interface proved to be very solid.

The second round of testing, with the medium fidelity prototypes, allowed us to test some of the changes identified previously and add other improvements that were identified, such as highlighting the Clarifai Information and which images were in what tab in the validation interface and changing some language and descriptions of features to be more clear.

Using the ASQ score from both of these testing phase we can say that the mechanisms developed proved easy to use.

In the final testing phase, despite some limitations, the feedback was still positive, with caregivers recognizing the mechanisms as useful for helping prepare sessions.

Chapter 5

Conclusions and Future Work

In this work we developed several new mechanisms that would allow caregivers to more easily find images relevant to their patients and allowing them to validate said images. After the requirements gathered in previous works, we identified these functionalities to be helpful in reducing caregiver's burden and stress.

The feedback from the final user testing was overall very positive, with these new mechanisms that were developed being seen as useful by actual caregivers. However, some improvements could still be made to the application.

The next sections provide a summary of the content that is part of this work, while also explaining our contributions and acknowledging the limitations that were present. We also provide an overview of what future work could be developed.

5.1 Summary

Chapter 1 serves as the introduction to this work, identifying the main motivation behind these new developments, that being providing a way for caregivers to more easily find relevant images to use in sessions in order to reduce their burden when preparing them. We also provide an overview of the solution developed. In this work our solution was built upon the existing KeepsakeBox platform that allows formal and informal caregivers to register patients and store their information as well as information about themselves, including images that can be used in sessions. The focus of our solution was on the acquisition and validation of images.

Chapter 2 provided background about dementia and reminiscence therapy. Dementia being an incurable disease means that reminiscence therapy is very important since it is one of the most effective therapy treatments for patients with this condition. We also presented several works that made use of technology in assisting reminiscence therapy sessions. We were able to conclude that technological solutions could prove very useful in assisting caregiver in preparing and conducting sessions.

Chapter 3 presented some of the requirements gathering that was performed in previ-

ous works and that served as the main justification for the goal this work was trying to accomplish. We also provided the solution design and technology and architecture behind the developed solution. Afterwards we presented the functionalities that were developed, which could be divided into three main groups: 1) Generating requests for outside users to upload images (to allows caregivers to ask for images from the friends and family of patients); 2) Conducting automatic online image searches based on image categories (to allow caregivers an easier way to search for images quickly that, although not as personal as they could be, can still be very personalized to each patient and useful in sessions); 3) Validating retrieved images (in order to ensure that the images that actually enter the platform are safe to use). We describe also some optimizations and improvements that were made to the application.

Chapter 4 described the evaluation that was done of the developed solutions. Essentially consisting of three phases of testing, one using a low fidelity prototype using paper mock ups, the second one using a medium fidelity prototype with an app running on a computer, and a final one where the application was tested by caregivers. Feedback was very positive overall, and the mechanisms proved useful and easy to use, despite some improvements still being in order. The tests were done remotely and users had to perform a series of tasks and afterwards answer some questions.

5.2 Contributions and Limitations

This work's main contribution is a solution that provides caregivers a way of more easily preparing sessions and reducing their burden and stress. Using different types of technology and APIs we were able to develop several mechanisms that proved very useful in finding new images to use in reminiscence therapy sessions.

This work was not without its limitations. Finding users to test the application proved very difficult, especially actual caregivers, that were always under heavy time constraints and found it hard to find time to engage in the testing sessions. Because of this the sample was fairly small, thus the conclusions drawn, despite being very positive overall, would need to be further backed by more testing.

5.3 Future Work

In the future the improvements identified in the final round of testing should be implemented, as well as any improvements that were identified in mechanisms devised in the works that were developed parallel to this one. One of these improvements is the ability for caregivers to access image submissions for validation in the context of individual patient's profiles, instead of having them all grouped in the caregiver profile. Another improvement could be allowing all the caregivers that share the care of a person with

dementia to validate the images submitted by outside users for that person, instead of allowing just the caregiver who created the link to validate them.

Future testing with more caregivers, both formal and informal, is essential to identify further important improvements and increasing the usability and ease of use of the application.

The caregivers that were part of our tests, as well as those that were part of previous works showed interest in accompanying the development of this application and as such it would be a good idea to involve some caregivers in that process. This would also help keep user centered design as a focus, since it is so important for this type of application.

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Appendix A: Experimental Evaluation Form of the KeepsakeBox Application

Avaliação Experimental da Aplicação KeepsakeBox

Durante esta sessão de testes irá realizar tarefas, divididas em três secções cada uma correspondente a um conjunto de funcionalidades. Após isso, ser-lhe-á pedido para responder a um questionário sobre a usabilidade e utilidade da aplicação KeepsakeBox. Todos os dados recolhidos serão apenas usados para este estudo, não sendo partilhados com terceiros.

*Required

Formulário Consentimento Informado

Desde já agradecemos o seu interesse e colaboração neste estudo. Ao continuar a execução dos testes confirmo que:
- Fui informada(o) do estudo em questão e foi-me disponibilizado o folheto informativo.
- Foi-me dada a oportunidade de esclarecer qualquer dúvida em relação a este estudo, e que estas foram respondidas de forma satisfatória.
- A minha participação é voluntária, logo sou livre de desistir do estudo em qualquer altura, sem ter de dar quaisquer explicações e sem quaisquer consequências.
- Autorizo que os dados recolhidos durante o estudo sejam partilhados com os restantes membros responsáveis pelo estudo. Se a investigação for publicada, todos os dados serão mantidos anónimos e nenhuma informação será identificável como sendo minha.
- Declaro que não comuniquei nenhuma razão potencial de qualquer natureza que constitua um
eventual factor de risco para a minha saúde ou integridade física.
- Declaro que participo neste estudo sem qualquer remuneração ou contrapartida.
- Declaro que aceito que as entrevistas sejam gravadas em áudio e vídeo ou captura de ecrã, excluindo a cara.
- Declaro que tomei a minha decisão de forma inteiramente livre.
- Concordo em participar neste estudo.

1. Insira o seu email caso queira que lhe seja enviado o relatório final do estudo.

_____

2. Insira o seu email caso queira ser contactada(o) acerca de sessões ou estudos adicionais relacionados com este estudo.

_____

Caracterização do Cuidador

Dados relativos ao cuidador.

3. Género: *

Mark only one oval.

- ◯ Feminino
- ◯ Masculino
- ◯ Outro

4. Idade: *

Mark only one oval.

- ◯ Menos 21
- ◯ 21 - 30
- ◯ 31 - 40
- ◯ 41 - 50
- ◯ 51 - 60
- ◯ 61 - 70
- ◯ Mais de 70

5. Tipo de Cuidador: *

Mark only one oval.

- ◯ Cuidador Informal
- ◯ Cuidador Formal

6. Se respondeu na questão anterior "Cuidador Informal" indique o grau de parentesco em relação à pessoa de quem cuida. *
Se respondeu na questão anterior "Cuidador Formal", indique a sua especialidade.

_____

7. Indique o número de dias por semana em que utiliza cada um dos seguintes equipamentos. *

Mark only one oval per row.

	0 (Não uso)	1 - 2	3 - 4	5 - 6	7 (Todos os dias)
Computador	◯	◯	◯	◯	◯
Telemóvel	◯	◯	◯	◯	◯
Tablet / iPad	◯	◯	◯	◯	◯

8. Quantas pessoas com demência tem a seu cuidado? (Indicar o número, sff.) *

_____

9. Em média, quantas Sessões de Atividades de Reminiscência realiza por semana (contabilizando todas as pessoas com demência de quem cuida)? *

Mark only one oval.

- ◯ Nenhuma
- ◯ 1 - 3
- ◯ 4 - 6
- ◯ 7 - 9
- ◯ 10 - 12
- ◯ Mais de 12

10. Tem alguma dificuldade visual? *

Tick all that apply.

- [ ] Não
- [ ] Astigmatismo (visão distorcida ou desfocada a todas as distâncias)
- [ ] Daltonismo (dificuldade em distinguir as cores)
- [ ] Fotofobia (sensibilidade à luz nos olhos)
- [ ] Hipermetropia ou presbiopia (dificuldade de ver de perto)
- [ ] Miopia (dificuldade de ver ao longe)

Explicação da Plataforma

Explicação sumária da plataforma e das suas funcionalidades.

Inserção e validação de imagens

1. Você reparou que o Sr. João Silva não tem imagens disponíveis para usar nas sessões. Crie um pedido de imagens com uma validade de 1 dia para que outros familiares possam adicionar imagens ao perfil do Sr. João. Envie o pedido através do chat do Zoom

2. Acabou de receber um conjunto de imagens adicionadas através do pedido que fez aos familiares do Sr. João Silva. Valide as imagens que foram adicionadas, rejeitando a imagem da borboleta e aceitando as outras;

3. Apesar de ter solicitado imagens aos familiares do Sr. João Silva, ainda considera que este tem poucas imagens disponíveis. Assim, decide procurar por 15 imagens online relacionadas com animais, Lisboa e férias. Das imagens encontradas pelo sistema, decide aceitar as duas primeiras que o sistema sugeriu incluir e a primeira que o sistema sugeriu rejeitar.

11. A inserção e validação de imagens satisfaz as minhas necessidades *

Mark only one oval.

	Discordo Totalmente						Concordo Totalmente
	1	2	3	4	5	6	7

12. A inserção e validação de imagens é fácil de usar *

Mark only one oval.

	Discordo Totalmente
1	
2	
3	
4	
5	
6	
7	
	Concordo Totalmente

Criação e Realização de Sessões

1. Ultimamente não tem tido muito tempo para criar sessões específicas para cada uma das pessoas de quem cuida. Como tal, decide criar uma sessão, que possa ser usada com várias pessoas. A sessão deve conter 4 imagens sobre comida, 3 sobre animais e 3 sobre natureza. Ao olhar para o resultado, verifica que a terceira fotografia da sessão pode entristecer as pessoas. Troque essa fotografia por outra mais alegre;

2. Como o seu colega António Costa anda um pouco sem tempo para criar sessões, decide partilhar esta sessão com ele, para que ele a possa utilizar com as pessoas de quem cuida;

3. Associe esta sessão ao Sr. João Silva (beneficiário/familiar) para que no futuro, você ou outro cuidador do Sr. João, possam realizar esta sessão com ele;

4. Como esta semana já dispõe de algum tempo, decide criar uma sessão específica para o Sr. João Silva, com 5 imagens relacionadas com férias, 6 com passatempos,

e 3 com pessoas. Ordene as 14 imagens para a sequência ficar do seu agrado;

5. Hoje é o dia de realizar uma sessão de terapia com o Sr. João Silva. Como ele se encontra bem-disposto, decide usar a sessão que criou anteriormente com as 14 fotografias. Inicie a sessão e registe as reações do Sr. João para cada imagem caso ache necessário. Após visualizar cinco imagens, tem de terminar a sessão pois o Sr. João fica triste e agitado. Registe a reação global à sessão.

13. A criação e realização de sessões satisfaz as minhas necessidades? *

Mark only one oval.

	Discordo Totalmente						Concordo Totalmente
	1	2	3	4	5	6	7

14. A criação e realização de sessões é fácil de usar? *

Mark only one oval.

	Discordo Totalmente
1	◯
2	◯
3	◯
4	◯
5	◯
6	◯
7	◯
	Concordo Totalmente

Visualização de Histórico Sessões

1. Vai realizar uma nova sessão com o Sr. João. No entanto antes disso, pretende ver quais foram as imagens usadas numa das sessões em que ele não teve sintomas, para perceber o tipo de imagens que menos o afetam;

2. Como hoje vai ter algum tempo para a realização da sessão, gostaria de ter alguns temas para abordar que fossem do agrado do Sr. João. Verifique quais os temas que este mês produziram resultados mais positivos;

3. Você esteve de férias no último mês (Novembro) e já não se lembra quantas sessões realizou no mês anterior (Outubro). Verifique quantas sessões negativas teve nesse mês e com quem;

4. Verifique quais foram os temas abordados na sessão em que o Sr. João teve os sintomas mais negativos, assim como as imagens mostradas.

15. A visualização do histórico de sessões satisfaz as minhas necessidades? *

Mark only one oval.

	Discordo Totalmente
1	
2	
3	
4	
5	
6	
7	
	Concordo Totalmente

16. A visualização do histórico de sessões é fácil de usar? *

Mark only one oval.

	Discordo Totalmente
1	
2	
3	
4	
5	
6	
7	
	Concordo Totalmente

Formulário sobre a aplicação KeepsakeBox

Após ter experimentado a aplicação KeepsakeBox, pedimos-lhe agora mais 5 minutos no máximo para preencher o seguinte formulário. Daqui para a frente iremos referir-nos à aplicação como o produto desenvolvido. O objetivo deste formulário é perceber se este produto é fácil de utilizar e útil para dar suporte à realização da terapia de reminiscência. Desta forma iremos perceber a opinião das pessoas que experimentaram o produto e assim poderemos tirar conclusões e fazer as melhorias necessárias.

Questionário de Usabilidade

Nesta secção pretendemos avaliar se o produto desenvolvido é acessível e de fácil utilização. Para isso, responda às seguintes perguntas mediante a escala apresentada.

17. Acho que gostaria de utilizar este produto com frequência. *

Mark only one oval.

Discordo Totalmente

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Concordo Totalmente

18. Considerei o produto mais complexo do que necessário. *

Mark only one oval.

Discordo Totalmente

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Concordo Totalmente

19. Achei o produto fácil de usar. *

Mark only one oval.

	Discordo Totalmente					Concordo Totalmente
	1	2	3	4	5	

20. Acho que necessitaria de ajuda de um técnico para conseguir utilizar este produto. *

Mark only one oval.

	Discordo Totalmente					Concordo Totalmente
	1	2	3	4	5	

21. Considerei que as várias funcionalidades deste produto estavam bem integradas. *

Mark only one oval.

Discordo Totalmente

1
2
3
4
5

Concordo Totalmente

22. Achei que este produto tinha muitas inconsistências. *

Mark only one oval.

	Discordo Totalmente
1	
2	
3	
4	
5	
	Concordo Totalmente

23. Suponho que a maioria das pessoas aprenderia a utilizar rapidamente este produto. *

Mark only one oval.

Discordo Totalmente

1
2
3
4
5

Concordo Totalmente

24. Considerei o produto muito complicado de utilizar. *

Mark only one oval.

Discordo Totalmente

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Concordo Totalmente

25. Senti-me muito confiante a utilizar este produto. *

Mark only one oval.

Discordo Totalmente

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Concordo Totalmente

26. Tive que aprender muito antes de conseguir lidar com este produto. *

Mark only one oval.

	Discordo Totalmente
1	
2	
3	
4	
5	
	Concordo Totalmente

Questionário de Utilidade

Nesta secção pretendemos avaliar se o produto desenvolvido é útil para dar suporte à terapia de reminiscência. Para isso, responda às seguintes perguntas mediante a escala apresentada.

27. A utilização deste produto na realização da terapia de reminiscência permitir-me-ia realizar tarefas mais rapidamente. *

Mark only one oval.

Discordo Totalmente

1
2
3
4
5
6
7

Concordo Totalmente

28. A utilização deste produto melhoraria o meu desempenho na realização da terapia de reminiscência. *

Mark only one oval.

Discordo Totalmente

1
2
3
4
5
6
7

Concordo Totalmente

29. A utilização deste produto na realização da terapia de reminiscência iria aumentar a minha produtividade. *

Mark only one oval.

Discordo Totalmente

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

6 ◯

7 ◯

Concordo Totalmente

30. A utilização deste produto iria aumentar a minha eficácia ao realizar a terapia de reminiscência. *

Mark only one oval.

	Discordo Totalmente
1	◯
2	◯
3	◯
4	◯
5	◯
6	◯
7	◯
	Concordo Totalmente

31. A utilização deste produto facilitaria o meu trabalho na realização de terapia de reminiscência. *

Mark only one oval.

	Discordo Totalmente
1	◯
2	◯
3	◯
4	◯
5	◯
6	◯
7	◯
	Concordo Totalmente

32. Eu acharia este produto útil para a realização da terapia de reminiscência. *

Mark only one oval.

	Discordo Totalmente
1	
2	
3	
4	
5	
6	
7	
	Concordo Totalmente

Sugestões

33. Se tiver alguma ideia de funcionalidades importantes para o desempenho e gestão da terapia de reminiscência e/ou gestão dos seus pacientes, e alterações que deveriam ser feitas, agradecemos a sua sugestão. Se não tiver sugestões, pode terminar e submeter o questionário.

Obrigada pela sua participação!