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SMILE: SMart Inclusive Living Environments supporting aging in place using eHealth solutions

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Abstract. SMILE is an EU project that uses conversational agents (CA) to enable older adults with different diseases to live independently at home. This paper presents the first phase of designing a CA supporting people with COPD. User needs were identified through a literature search and individual interviews with people with COPD. Nine relevant features were identified for the CA which were later reduced to the following four after workshops with the end-users: (1) Clinical Condition, (2) Physical Activity, (3) Social Health, and (4) Sleep Quality. These features were then implemented into the CA and will be evaluated through individual interviews with end-users. The final prototype will be implemented and tested in different European living labs.

Keywords: Conversational agent, older adults, COPD.

1 Introduction

SMILE is an EU project (2021 – 2023) that focuses on creating SMart Inclusive Living Environments using novel eHealth solutions - a conversational agent (CA). The goal is to enable independent living amongst older frail people (above 65 years old) with various kinds of diseases. At the current stage of the project, the main use case is the elderly with chronic obstructive pulmonary disease (COPD) – which is a group of lung conditions that cause airflow blockage and breathing difficulties [1,2]. However, the outcome of SMILE is not limited to the elderly with COPD.

For people with COPD, gaining insight into their medical conditions and factors influencing their symptoms is imperative. Today, health data is made available to citizens through various health portals. A concern is that older, frail people are not able to utilize this information due to, among other things, low eHealth literacy. SMILE's response to this challenge is to develop a CA that supports older frail people in living independent and active life.

The CA will rely on a Digital Care Facilitator (DCF) and AI-based integration system - a backend administration platform that stores critical health data (e.g. heart rate, oxygen saturation and lung capacity), sleep pattern as well as other personal data. This data, accessed through different sensors and wearables placed on or close to users, as well as through the dialogue between CA and users, will be analysed using machine learning to understand users' intentions and behaviours. These valuable insights along with relevant data again will be sent back to CA to enable personalized advice for the users.

To achieve this, SMILE brings together 14 different partners from the EU and Canada, including Innlandet Hospital Trust, SINTEF, Tellu IoT AS, Norway Health Tech, Hamilton Health Sciences, McMaster University, Cloud Diagnostics, Region Zealand, University of Copenhagen, Appinux A/S, Stichting Smart Homes, Stichting Tante-Louise, Tendertec Hellas and Stichting Health ClusterNET.

To develop a feasible CA, a series of co-creation workshops are planned to be conducted, individual testing sessions with older adults with COPD in Norway. The project relies on a user-centred design process, and the approach can be divided into three main phases (Figure 1). Users will be involved in all phases through observation, individual interviews, workshops, and testing of the final system. This paper will present considerations in the design process of the CA with a particular focus on COPD users and what we plan to do for the next step.

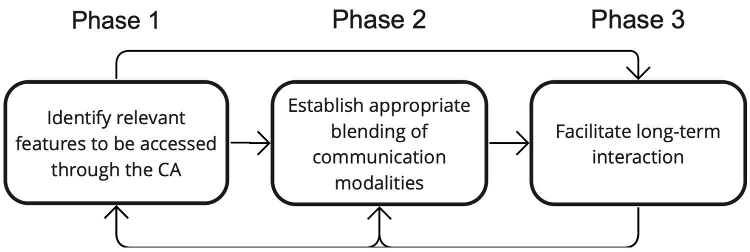

Figure 1 Phases in the CA design process

2 The development approach of the CA: the first iteration

2.1 User needs and requirements

User needs and requirements have been identified in various ways: The user´s readiness for health technology was measured through the READHY survey (3). The results from the survey were used to stratify users into 4 groups based on their severity of conditions, eHealth literacy, health literacy and experience with technology. These groups will be used to tailor the language in the CA. Initial user needs and requirements guiding the choice of features in the CA were identified through qualitative interviews, and then verified and complemented with a literature search. This yields nine potential features (see Table 1), which were later reduced to four based on the outcomes of workshops with users in Denmark and Norway: (1) clinical condition, (2) physical activity, (3) social health, and (4) sleep quality. The workshops also revealed technical considerations such as a need for wearable sensors to track the user's physical activity and sleep quality and to run the CA on a smartphone or tablet with big text.

Table 1. Nine user needs that CA needs to address.

Need/feature name	Description
Clinical Condition*	Educate them about COPD and how to manage their disease in an easy-to-understand fashion. Provide information about health status using sensors and wearables measuring oxygen saturation, lung capacity, heart rate and so on.
Physical Activity*	Provide suggestions on relevant physical activities, track and encourage physical activity
Social Health*	Motivate users to have regular contact with family and friends, and attend social activities. Inform about relevant upcoming social events.
Sleep Quality*	Analyze sleep patterns using sensors, identify possible reasons for poor sleep quality, and provide suggestions to mitigate them.
Hygiene	Motivate users to take care of personal hygiene, such as showering and washing hands.
Emotion Support	Listen and provide support when users feel anxious or sad. Encourage users to share their feelings with family members or close friends.
Nutrition and Hydration	Provide nutritional information, recommend recipes based on users' nutrition needs, and motivate users to eat healthily and drink enough water. Follow up on the diet plan by registering the weight changes and hydration status.
Air Quality	Inform users of indoor air quality and provide relevant suggestions.
Entertainment	Engage users with radio, podcast, music, video, or game.

*Have been included in the first mock-up

2.2 Conversational design considerations

Initial conversational design considerations revolved around (1) mode of communication, (2) tone of voice, (3) multichannel and multi-media usage, and (4) relational onboarding.

Communication modality: For the first mock-up, we used text-based CA with structured, button-based dialogues. This was seen as appropriate because we were most interested in understanding the relevance of the features. Predefined options are easy to use and remove the possibility of getting "stuck" in the dialogue. This also allowed us to see where other modalities are needed, such as voice or free-text commands. We included a few questions that required free-text answers to see how the participants responded to them. We used Botpress[1] to develop the conversations - an open-source chatbot engine. We chose this platform because it is possible to run Botpress on our own servers, which satisfied our need for privacy and data control.

[1] https://botpress.com

The tone of voice: We aimed for a friendly yet professional tone of voice. The objective was to communicate in a way the participants perceived to be inviting, engaging, and easy to understand. When CA was delivering facts, the tone was more formal and professional.

Multichannel and multi-media: We used different media such as images and video when displaying sensor data or providing instructions. This offers a more interactive and user-friendly experience – especially when presenting complex information. Figure 2 shows an example conversation.

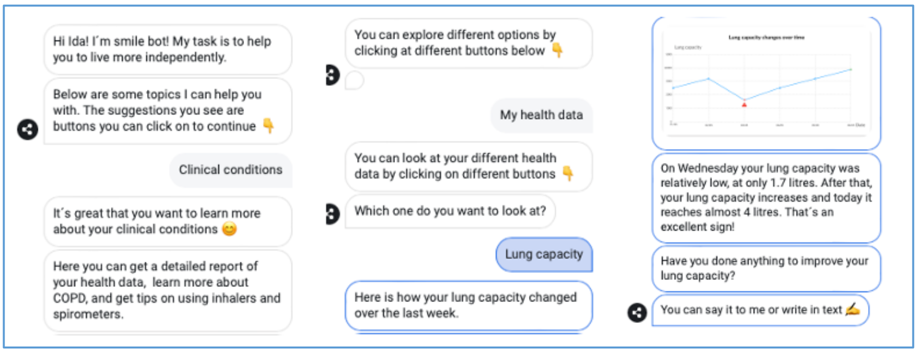

Figure 2 Conversation flow of Clinical Conditions

Relational onboarding: The onboarding was developed with three objectives in mind: (1) teaching the end-user how to interact with CA, (2) gathering personalized data that the CA can use to create personalized advice, and (3) facilitating relationship development by showing interest in the user (See Figure 3).

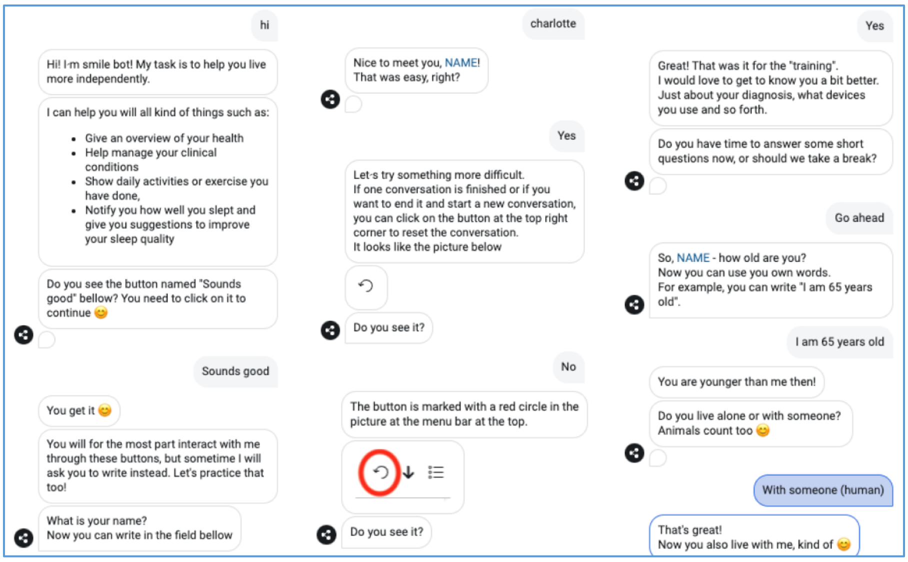

Figure 3 Onboarding conversation flow

3 What is next?

We are planning individual interviews with end-users to get feedback on the mock-up. We will then iterate and make the necessary changes. We are also starting to focus on phase two (communication modalities) and three (designing for long-term interactions). That is, we plan to test out different blending modalities to make it easier for the end-user to manoeuvre in the interaction by, for instance, adding an interface level on top of the CA and enabling commands (voice or text). We are also exploring which feature should be proactive by, for instance, having the CA initiate morning and evening check-ins, alert when the end-user has been inactive for too long, or if sensors pick up something concerning. Moreover, investigate how this can be done without the CA becoming intrusive.

Finally, we need to ensure long-term engagement. This will partly rely on the relevance of the CA, but we will also focus on relationship building between the CA and the end-user. The goal is for the CA to become an integrated part of the end user's life beyond a smart device.

We will continue with an iterative process with the end-users to gain needed insight. We will run a few more individual interview sessions with end-users in Norway before implementing the prototype and sensors in the Norwegian living lab. Here five end-users will have the opportunity to use CA and provide feedback continuously. If the user experience is satisfactory, we will implement the CA in the Danish and Dutch living labs. The CA will be evaluated through observations, interviews and surveys with end users. We will also analyse the dialogue to gain insight into how the CA have been used and the problems that have occurred.

After the project is finished, we expect that our solution will not only be beneficial for people with COPD, people with dementia, post-surgery patients (these are also our main use cases, but not mentioned in this paper) and their circle of care, but also for elderly with other diseases. We expect the following contributions from our project. Firstly, our solution will improve the user´s understanding of their health, to help them make better decisions for better life quality. Secondly, they feel less isolated from society and more included among their family, friends and community.

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