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Robotic-Based prevention and health Promotion in Care Facilities – Interactive Design for Group Sessions

Elisabeth Raß
Institute for Digital and Sustainable Cooperation, DnZ gGmbH
elisabeth.rass@socio-informatics.de

David Unbehaun
University of Siegen
David.unbehaun@uni-siegen.de

Abstract. Robotic-based technologies may support older adults, people in need of care and relief professional actors in the health system. In this demonstration paper, the authors present a robotic-based system designed for individual and joint activities in care-facilities. Empirical insights and results from a 14-month participatory design study focusing on ideation, participation and evaluation of Socially-Assistive Robots for both, older adults in need of care and professional caregivers in different care and medical settings were considered. This work aims to be an inspiration and orientation for future research, development, and design of gamified robotic-based exercises in care.

Introduction

As the need for professional and institutional care grows and the number of qualified caregivers declines, governments and society are seeking innovative solutions to support professional care activities and the independence of those in need of care (Aal et al., 2016; Komendziński, et al., 2016; Ten Haken et al., 2018). The use of information and communication technologies (ICT) whether in the documentation of information, assistance systems, videogame-based interventions or socially-assistive robotics (SAR) has the potential to deliver such support as digitalization in the healthcare sector continues to progress rapidly (Carros et al., 2020; Fasola & Mataric, 2012; Feil-Seifer & Mataric, 2005; Müller et al., 2015; Unbehaun et al., 2018, 2019, 2020). Robotic-based interventions may support people in need of care and help them to maintain or improve their physical abilities and their activities of daily living. As shown by Kachouie et al. (Kachouie et al., 2014) or Abdi et al. (Abdi et al., 2018) the use of **socially assistive robotics (SAR) in elderly care** had some limited positive effects in affective therapy, cognitive training, social facilitation, companionship and physiological therapy (Abdi et al., 2018; Kachouie et al., 2014) could **improve the overall well-being of people in need of care and enhance the quality of care** (Carros et al., 2022; Raß et al., 2023).

Our work presents a Robotic-based system to foster physical activity, facilitate social interaction as well as create an innovative interface to promote active participation across all ages and abilities. In this paper, we present a Robotic-based System aiming to provide physical training activities and combine them with socio-creative elements such as music-based group activities or quiz-games to create cooperative and interactive scenarios. The developed robotic-based applications aim to promote health prevention and enable social interaction between people in need of care and SAR by creating a playful atmosphere that motivates them and to support professional care givers in their daily work routines. The study setting and framework is part of the German research project "ROBUST" that is founded by the Association of Substitute Health Funds (in German: Verband der Ersatzkassen e.V. (vdek). This Association represents the interests of overall six substitute health funds in Germany and also acts as their service provider. As the successful introduction new technologies depends on early involvement of the users personal and interpersonal needs and expectations, we followed a participatory and user-centered research and design approach to support the appropriation process of people in need of care and their caregivers (Schuler & Namioka, 2017).

Project and System Overview

The system was conceptualized and developed in the project *ROBUST* with overall four care facilities, integrating the voices and perspectives from residents, caregivers, managers and additional stakeholders. The System and its components games described in the paper are the outcome of a co-design process conducted by using in a LivingLab environment (Ahmadi et al., 2018). The purpose of the underlying concept was to provide a suite of digital activities that could give residents of care-facilities support gamified health prevention across their activities of daily living (ADLs). We conducted different long-term studies in that we focused on the relevant aspects and sustainable effects of the digital intervention on individual performance and social interaction and re-integrated the findings and observations into the design and development process. The robotic-based activities took place in various group settings from 3 to more than 20 participants. The robotic-based applications are designed in a participatory and user-centered approach including practical experiences and feedback from people in need of care, professionals, and their social networks.

TECHNICAL INFRASTRUCTURE AND APPLICATIONS

As a technical infrastructure, "Pepper" is used as robotic system. The robot is mainly used in group sessions for physical exercises, cognitive training, and socio-emotional support to encourage residents to engage in physical activity and improve their overall quality of life. The final system contains several technical components that are displayed in Figure 1. The components were organized around the humanoid robot pepper, which is designed to interact socially with humans and have an expressive appearance. Pepper is equipped with several sensors that ensure its safety and the safety of people and those that enable autonomous navigation.

Figure 1 The Humanoid Robot Pepper

With the help of these sensors, it is also possible for the robot to recognize people, movements as well as emotional states. However, to use such robotic systems in more complex scenarios, programming of these systems is required. This programming of different applications was done using standard development environments such as Choregraphe and Android Studio. Choregraphe is a Softbank-developed graphical software that can be used to create applications on the Pepper robot. An application can consist of "boxes" that let the robot make movements and say things, turn on its LEDs, etc. Android Studio is a free integrated development environment (IDE) from Google and official development environment for Android software development. The menu interface was designed to be simple and easy to use for professionals and residents in care facilities (Figure 2; Figure 3). Additionally, the robot was programmed to demonstrate physical

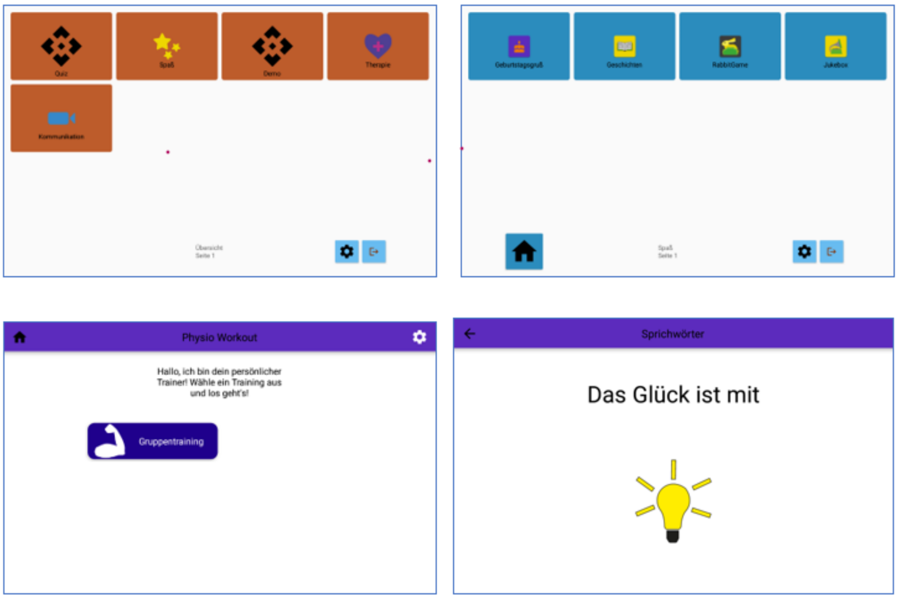

Figure 2 Interface Design

activity and movement exercises such as raising arms, making fists or bending forward the upper body. The exercises were designed in cooperation with physiotherapists and practitioners in the care facilities. As Pepper can only move his arms, movements performed or demonstrated by "Pepper" focus on upper limb muscles that are important during functional movements, walking, and recovering balance. Due to technical limitations, Pepper cannot demonstrate exercises for the lower limb. To compensate this issue, "Pepper" explain these exercises and participants were asked to repeat these exercises.

The applications developed for cognitive activation include playful exercises for memory training, quizzes, or interactive puzzles. A jukebox app was developed to play music before, between or after cognitive or physical exercises (ex. Figure 4) to improve psychological well-being and promote engagement during robotic-based group sessions.

Figure 3 Robotic-Based Activities for Residents - Exercises for Physical Activation

The following table lists a selection of exemplary applications and their short descriptions, as a short description of the cognitive, physical, and socio-emotional activities.

Table 1 List of exemplary applications

Physio app:	The robot demonstrates various upper body exercises (including arms and hands) that the user should imitate. The app includes individual exercises and pre-made workouts for different levels of physical mobility and activities.
Jukebox:	The application includes different songs organized into categories for playing and singing along. The robot can also perform dance moves and spin. This App is often used to start and end a group session.
Chess:	The user can play chess against the robot on the tablet following official rules. Pieces are moved by tapping, and the robot provides motivation and encouragement.
Rabbit Game:	The user must catch rabbits that appear on the screen. By tapping on the rabbits on the screen, they disappear, but appear faster and faster over time. If too many rabbits are not tapped, the game ends.
Meditation/dream journey:	The app offers a selection of meditations and dream journeys. Contents can be played under each category.
ABC app:	With the push of a button, the application generates a random letter and reads it aloud twice, optionally with or without an alphabet chart. The user can then draw a new letter or have the letter read aloud again.
Proverb quiz:	The robot states the first part of a proverb, and the participants must complete it. On command, the robot reveals the solution, which is the complete proverb. The quiz is divided into different categories of proverbs

Conclusion and Outlook

While the robot Pepper has proven to be a useful tool for engaging with elderly individuals in care facilities, it is not without its limitations. For example, its speech capabilities can be too quiet or too fast for individuals with hearing impairments. Additionally, the robot focuses on physical exercises primarily for the upper extremities, which may not provide a well-rounded approach to physical therapy for all individuals. Furthermore, the execution of these exercises may not be analogous to human movements, as residents may rely on eye contact to confirm they are performing the exercises correctly. These limitations of the robot "Pepper" underline the importance of human support during the group sessions. The applications in the project are therefore designed to be used in a human-robotic collaboration and to promote social interactions between people in need of care and caregivers.

In the following course of the project, the existing apps will be improved in close cooperation with the users – people in need of care, relatives and professional caregivers who also support and participate in the development and design process of new applications based on their needs and ideas. In perspective, we thus create a pool of applications for cognitive, physical and socio-emotional training for people in need care from which professionals can compile robotic-based group sessions.

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