# Towards the deployment of a social robot at an elderly day care facility

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**Abstract.** Life expectancy is increasing with time, and with it, more support is needed to provide care for the elderly. Social robots may in this context support with therapy, monitoring or entertainment activities. This paper describes current work on deploying our social robot ARI at an elderly day care centre focused on promoting engagement in the routines carried out at the centre. By using a user-centred design approach, the paper presents the prototype development process of three activities and their initial validation in a 2-day pilot study. The preliminary results highlight an increasing responsive behaviour of the elderly towards the robot on day 2 compared to day 1 in one of the activities. In contrast, in a second activity, the robot was mostly ignored, suggesting that further work must be done in terms of attracting the attention of the user, and not giving for granted that the mere presence of a robot will suffice to trigger curiosity towards initiating interactions.

**Keywords:** elderly care · social robot · fostering engagement

## 1 Introduction

Life expectancy is increasing with time, and with it, more support is needed to live independently. In this context, social robots may offer cognitive support in healthcare sector by providing social interaction, by providing multi-modal behaviour to interact with clinical personnel and patients. Their use ranges from offering physical and cognitive stimulation, delivering reminders, monitoring temperature or falls, to providing entertainment [4, 18, 7]. The needs, desires, and concerns vary greatly from one person to another, and even more, from one care home to another. Thus, the solution needs to be flexible enough to adapt to the needs of each type of care center and end user.

In this paper, the PAL Robotics ARI robot [7, 6] is used to increase awareness of the daily routines at an elderly day care center. Through a joint collaboration, the AMIBA project aimed at adapting the activities the social robot ARI could perform to fit their needs. To this end, an iterative process of discussions with the caregivers and prototyping took place, where the robot was slowly introduced to evaluate its potential in the near future. The following goals were defined:

- To foster the involvement of the elderly in the day care routines

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- To provide support to the staff when carrying out activities with the elderly
- To increase the accessibility of advanced robotic interventions to elderly users in a day care environment.

## 2 Related work

In the past years, social robots have been gaining attention as supporting tools in human environments, with special interest the in the elderly care sector, through research projects, such as Hobbit [11], EnrichMe[10], GrowMeUp [1], SHAPES [6]). The role that such robots could play in elderly care has been reviewed in [2] identifying five key areas: affective therapy, cognitive training, social facilitator, companionship, and physiological therapy.

As a social facilitator, related studies showed that social robots can improve sociability and engagement among older adults [15, 5]. When it comes to cognitive training, robots have indeed been found to positively impact on engagement and motivation towards different activities, offering personalised care and proving therapy effectiveness [17]. This is further enhanced by use of expressive robots[8], which adapt their behaviour based on the culture, cognitive decline and language requirements of each end-user.

Most of the cases however, focused on one-to-one interactions, personalising robot behaviour to each user. Interactions targeted at multiple users or groups have been less common. In [15], for example, social robots are described as mediators in group activities to increase social interactions and engagement in everyday activities. In addition, one of the advantages of sharing a social robot by multiple individuals in care settings is to reduce costs and share the burden of care givers [6, 10, 1, 13]. Despite the advances made so far, there are still limitations when it comes to adopting such robots within healthcare [3], such as the fear of robots taking over caregivers jobs or the need of adaptation to different cultures and languages [8]. In this work, we aim at working hand-by-hand with the caregivers through an iterative co-design process to develop a prototype of an assistive robot that supports their everyday tasks in elderly group activities.

## 3 Understanding users' needs

Fundación AMIBA[1] is a non-profit organization in Barcelona (Spain) offering different services for elderly care, including a day care centre. It currently hosts 16 older adults, which cannot live fully independently.

One of the main barriers when talking to end-users is understanding what a social robot, such as ARI, is capable of. Thus, a first session was run (1) to better understand their daily routines (through interviews to the staff and observation of their activities), and (2) to show an interactive demo with ARI itself.

[1] `https://sid-inico.usal.es/centros_servicios/fundacion-privada-amiba/`

### 3.1 A day at the day care

The elderly arrive between 9:00 and 10:00 am. They are received by a caregiver at the entrance and are accompanied to the main room area. As they arrive, some have breakfast, and then start performing leisure activities (i.e, drawing, painting reading, playing puzzles, etc.). During this period, they individually perform short sessions of specific physiotherapy exercises tailored to their own needs, together with the psychotherapist. At 12:00 the whole group is gathered in the gym area for a 45 minute group session of physical gross-motor exercises. Next, lunch takes place at 13:00, followed by free afternoon time where they usually gather on the sofas around the TV until 16:00, for tea time. People leave the day care at different times throughout the afternoon. At 18:00, the final user leaves and the day care closes.

When it comes to the user profile, it is worth noting that older adults attend the centre because their families do not wish for them to stay alone during the day. In other words, they do not come on their own free will. Some have slight dementia, others have had an ictus. In general, they do not easily engage neither with the activities carried out at the centre, nor with other adults or staff. This poses a great challenge for a social robot, as it requires an extra effort to attract the older adults' attention.

### 3.2 Interactive demo

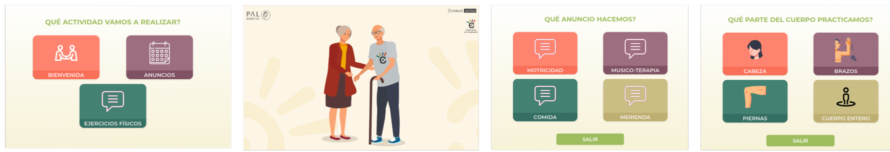
At the end of the observation session an interactive demo was presented to caregivers and older adults to showcase a set of activities carried by ARI in another similar project [6]: establishing video calls, monitoring body temperature, sending alerts to designated caregivers, providing the agenda of the day with events and reminders, filling in the weekly menu, and offering entertainment games (e.g., puzzles, memory games). A short presentation on how to use the robot followed the demo before allowing caregivers to play with it by themselves.

The existing activities were not considered to fit the needs of the caregivers and older adults. The games were too focused on entertainment, and they preferred more cognitive focused tasks. One-to-one personalised activities such as videocalls, daily menu, alerts or reminders, were not considered useful within the AMIBA context either. In contrast, more general tasks targeting the group as a whole, rather than individually, were preferred.

## 4 Iterative development of prototypes

Based on the feedback received from the caregivers and after the observation session at the centre, the following activities to be performed by the robot were identified:

- To greet the users upon arrival at the day care centre. The aim is to start the day with a welcoming message for the users, to empower them by feeling that they are central characters and the robot's attention is focused on them.




(a) (b) (c) (d)

**Fig. 1.** Example screens displayed on ARI's touch-screen for adapted demo: a) "Which activity do you want to do? Welcoming, Announcements, Physical Exercises". b) Welcoming activity. c) "Which announcement do you want to provide?" Motricity, Music therapy, Lunch time, Tea time" d) "Which body part do you want to exercise? Head, Arms, Legs, Whole body". ©PAL Robotics

- To give announcements of the events taken place throughout the day. The announcements to be made were intended towards group activities (physiotherapy and music-therapy) and meals (lunch and tea time).
- To provide encouragement during the group physical exercises activity to keep them motivated while performing the exercises [9].

These features were gradually developed and tested at the care centre throughout the following 8 weeks.

In order to trigger the activities, a QR detection process was proposed to show the main menu view listing the available activities (Fig. 1a). The purpose was to only allow the caregivers to activate the robot to start any of the tasks.

Regarding the greeting activity, once it was set, the robot would detect the presence of a person through face detection. Unfortunately, at the time where these tests took place, users had to always use masks. Thus, chances of accurately detecting someone were low. For this reason, the detection mechanism was switched to a "manual mode", where every time an older adult came to the centre in the morning, the carer had to touch the screen to trigger the robot's greetings (Fig. 1b).

With respect to the events announcements, the carer could choose from the main menu the event to announce whenever needed (Fig. 1c). Variations on the schedule could take place on a daily basis. Thus, setting a fixed time where the robot could automatically trigger the announcement was discarded. Once the staff indicated the announcement, the robot would show an image on the screen related to the announcement and verbally call everyone to perform the new activity. Examples of the sentences used were: "*It is lunch time!*", "*Let's go for lunch now!*", "*It is already lunch time, let's go to eat!*". Finally, regarding the physical exercises activity, a menu with the different main body parts was shown on the screen. The physiotherapist selects the main body part to work next (Fig. 1d) and the robot would then trigger encouraging messages regarding the body part to exercise. For example, "Let's move the head now", "*Come on everyone, moving the arms*", "*Those legs need to be moving!*". Variations on the robot's speech were always produced to avoid repetitive speech. No specific

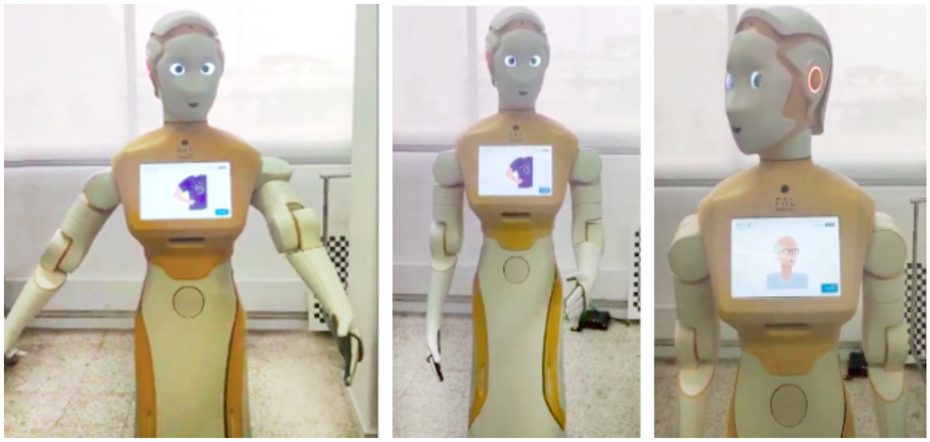


**Fig. 2.** Samples of the motions generated for the and arms to support the physical exercises activities. ©PAL Robotics

body motion description was provided since the carer indicated that she would decide on the exercises to be performed spontaneously, based on how the elderly were all performing, rather than methodologically planning each day exercises. Thus, a set of general physical motions were developed to accompany the verbal encouragements (Figure 2), including head, arm and body movements.

The robot behaviour was implement through state machines wrapped as Python ROS (Robotics Operating System) nodes to transition between the different behaviours and activities. A technical difficulty observed was the lack of WiFi connectivity at the centre, which prevented the use of Google's speech recogniser. Thus, the voice-bot had to be deactivated, greatly limiting potential automatic responses to user's speech. The first prototype was deployed at the day care so the caregivers could try it during the following days. We then interviewed the caregivers to gather feedback on the experience:

- QR code was not efficient to trigger welcoming messages, as most caregivers did not have a phone at hand and light conditions or brightness of phones affected scanning accuracy. It was then decided to trigger the main menu through the touchscreen instead. While this reduced the autonomous behaviour of the robot, caregivers preferred this approach.
- When providing announcements for events, care givers suggested to play music at the same time, to further attract the attention of older adults. Linking a melody to each type of event could increase awareness of the activities carried out, specially for those with cognitive decline.
- In terms of the robot's voice, the lack of expressivity in the voice was highlighted, being this one too plain. Thus, it was suggested to adjust the speed, pitch and volume according to the context.
- When providing greetings, carers requested the possibility to alternate between Catalan and Spanish languages, to adapt to the users' culture.

(a) (b) (c)

**Fig. 3.** Set-up for the robot of the three cases: (a) Greetings, (b) Announcements and (c) Physical exercises. ©PAL Robotics

- The use of verbal interaction is crucial for this target population, since it is the main channel of communication. Older adults attempted to talk to the robot about trivial conversations, and were disappointed when no response could be provided.
- Finally, staff members are really busy and it was difficult for them to spend time triggering the different activities. Thus, despite requiring a very simple process (pressing a sequence of two buttons maximum to set the activity), using the robot everyday was not a priority.

## 5 Use case study

Based on this new feedback, we evolved the prototype that was validated throughout two full morning sessions. During these sessions, the robot behaviours were triggered by a technical staff through the Wizard-of-Oz methodology. The aim was to reduce the caregivers workload (i.e. they did not have to spend time launching the different activities), while allowing the technical staff to also observe and take notes of the robot's interactive performance on-site. We next describe the observations made.

### 5.1 Greetings

The robot was placed at the entrance of the main room between 9 and 10 o'clock (Fig. 3a). Whenever older adults came in, the technical staff would trigger the robot to greet. Some adults came alone, others accompanied by caregivers. When evaluating the interaction, we annotated the number of adults that replied to the robot's greeting either on their own or when prompted by caregivers. Table 1 summarises the annotated interactions on day 1. Table 2 shows the results based on both days. A clear increase on the users' responses to the robot can be observed from day 1 to day 2 (increasing from %42.85 to %85.33). More people

**Table 1.** First day 'Greetings' interaction results: initiated by users ('Own'), 'Prompted by career' or ignored (-). U=user, C=carer and R=robot.

| User | Context | Interaction | Own | Prompted by carer |
|---|---|---|---|---|
| 1 | U walks on his own (with a stick) and fast | U: replies good morning to the R | x | |
| 2 | U walks very slowly, holds C's arm | U: doesn't look at R. C: "Look, it said hi". U: nods | | |
| 3 | U walks at normal speed holding C's arm. | U pays attention to the R. Stops. C: "Listen what the robot tells you. It's looking at you". R greets again. U seems pleased recalling that she had to greet everyday at her work as well | | x |
| 4 | U walks with a 'walker' on its own | U: doesn't even look at R. | - | - |
| 5 | U walks at normal speed, holding C | C: "Look!" U looks at R, raises his hand (copying R's hand movement) C: "It's greeting you" R: greets again. U: looks at R for a while. Then enters the room. C2: "Did R say hi?" U: "yes" | | x |
| 6 | U walks on its own (with a stick) and fast | U greeted tech staff. R greets. U doesn't even look at robot | - | - |
| 7 | U walks slow, with C's support | R greeted 4 times. Eventually U moved his head, noticing R | | x |
| 8 | U in wheelchair | R greeted 3 times. C insisted U to greet back | - | x |
| 9 | U enters walking fast on her own | U ignored R | - | - |
| 10 | U walking slowly with C's support | U doesn't reply back to R | - | - |
| 11 | U in wheelchair | R greets, no reply back from U | - | - |
| 12 | U enters walking fast | U looks at R but doesn't reply back to R | | |
| 13 | U in wheelchair with informal carer | they walked through without even noticing R (informal carer went straight into the next room, so no opportunity to slow down in front of R) | - | - |
| 14 | U wheelchair with C's support | C slowed down, U replied on its own | x | - |

initiated the interaction, raising from 2 to 6, reducing the number of users that entirely ignored the robot. The number of those replies prompted by caregivers remained the same. It should be noted that quite a number of users needed help to walk (be it a walker, wheelchair or caregiver support), interfering their attention towards the robot. In contrast, users 1, 3 and 5, who walked without much difficulties, were more prone to pay attention to the robot.

### 5.2 Announcements

At 11:45, on both days, the robot was moved to the main room (Fig. 3b) to carry out the "physical exercise activity" announcement. Low interest on the robot from the elderly was observed, hardly glancing at the it. Similarly, at lunch time, right after the physical activity took place, the robot announced the meal time. However, most of them were already on their way to the dinning area, so little attention was paid to the robot.

### 5.3 Physical exercises

Lastly, around 12 o'clock, older adults were moved to the physio room and sat in a circle (Fig. 3c). The robot was placed between them and, as the therapist indicated the body part to work on, the technician would trigger the encouraging support, which involved speech and motion.

**Table 2.** 'Greetings' interaction summary

| | Day 1 | Day 2 |
|---|---|---|
| Started interaction on their own | 2 | 6 |
| Started interaction when prompted by caregiver | 4 | 4 |
| Ignored the robot | 8 | 2 |
| Total number of participants | 14 | 12 |
| Percentage of responsive users | %42.85 | %83.33 |

At the beginning the robot was constantly cheering users to do the exercises, and the participants would indicate that the robot was "talking too much". The verbal encouragements were therefore reduced to avoid disturbing the group. There were positive comments about the robot, where the adults would look at the robot and question its gender, or noticing that the robot was doing the exercises in the wrong way –as often new exercises that the robot was not programmed to do were proposed by the therapist. Remotely controlling the movements to better simulate the exercises worked well –for example, in a game where they had to pass a ball between them, the robot was teleoperated to track the ball by moving its head, demonstrating integration in the group activity. Older adults kept looking at the therapist for guidance, rather than the robot, which was considered as one more participant in the group.

## 6 Discussion

The AMIBA project was regarded as a difficult scenario due to the overall low engagement older adults presented in their everyday [19] and the short timeline that was given to prepare a working solution. Nevertheless, through the observation study and the deployment of the use case, several lessons have been learned.

### 6.1 On the Activities

The welcoming scenario has had a rather positive outcome, notably increasing a responsive behaviour of the adults towards the robot on the second day compared to the first day. A potential reason could be that the elderly felt more familiar with the robot, and thus, knew what to expect from the robot. However, depending on the older adult's walking abilities, their attention to the robot differed: the higher the walking difficulties, the lower the attention they could pay to the robot or the environment. Thus, based on context and the user's capabilities, the robot should adapt its engaging strategies to properly attract their attention more efficiently. In the announcements activity, proactively approaching older adults, inviting them to join the events and adjusting the prosody of the messages spoken by the robot could potentially promote higher engagement.

Finally, regarding the physical exercises, remotely controlling the robot movements allowed us to quickly adapt to the last minute instructions of the therapist, which were not previously programmed in the robot. Thus, future efforts should be placed to allow the robot to replicate, at least to some extend, the proposed movements at execution time. Additionally, a seamless mechanism to switch between exercises should be designed for the therapist, such as detecting keywords from speech (e.g. "arm exercises up", "head sides"), instead of having to press buttons on the screen every time. In any case, we believe that assisting the group sessions is an interesting role that the robot could play to improve interactions in group activities [16].

### 6.2 On the Technical design

Several technical design decisions were identified and improved as follows:

- The use of QR codes to trigger the activities: though this approach made sense in terms of limiting the access to authorised personnel initially, it also involved an additional burden for the caregivers. Using NFC tags or adding lights from the robot side to point to QR area could increase robustness in the future.
- Adapting the solution to the spoken languages of the users may impact on the acceptability and willingness to engage with it[2];
- Providing music to both attract the attention of older adults and as an aid for event awareness, specially necessary for those with cognitive decline.

Moreover, the following technical difficulties have been detected throughout the development of the project, which should be addressed in future work:

- User privacy and internet reliability problems when using an online speech recognizer. As next steps an offline speech recognition system will be integrated on the robot, such as Vosk[3];
- Lack of expressivity in the robot's voice. Finding speech solutions that allow modifying the pitch, volume and overall rhythm of the voice in an easy an intuitive way is essential for further improvements.
- A faster and smoother robot body controller to generate motions (through use of Whole Body Control[4]), and gesture recognition systems to allow gesture imitation to adapt and recreate to the therapist's movements;
- To improve face detection while using face masks, combining approaches proposed in [14, 12].

Overall, the robot's awareness of the context should be included to both, increase the robot autonomy as well as its proactiveness when initiating interaction with older adults [15]. Nevertheless, the Wizard-of-Oz methodology to

[2] Citizens in Catalonia are used to switch between Catalan and Spanish. However, they usually have a preferred language which should be used in this case.

[3] `https://alphacephei.com/vosk/`

[4] `https://github.com/pal-robotics/pal_wbc_utils`

trigger robot behaviours proves to be a powerful approach at initial stages to allow end-users to gain a better understanding of the system's capabilities and to gather feedback on the design to improve acceptability and ease of use of the system.

## 7 Conclusions

The AMIBA project at a day care facility has been presented in this paper. It emphasises the need of a co-design process both with older adults and caregivers and to adapt the solutions to the needs of each site, but also highlights some common challenges and future works, such as improvement in the prosody of the robot speech, adaptability to languages and voice interactions, and in general, increase awareness in the surrounding environment. Future work will take these technical considerations into account and will carry out a longer pilot study with several cycles of co-design process in order to facilitate adoption of robots at such facilities.

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