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Remote Assistance for Home Care Workers: Concept and Technical Implementation at a Glance

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Abstract. *Background*: Long-term care faces severe challenges on the supply (shortages of formal and informal carers) as well as on the demand side (increasing number of care-dependent people). To cope with these challenges, new forms of support for the professional care network are needed. *Objectives*: This paper describes the concept and implementation of a Remote Care Assist (RCA) service, consisting of a web-application for the Care Expert Center (CXC) and Remote Support (RS) applications for the HoloLens 2 as well as for Android and iOS smartphones. *Methods*: Using the evidence-based and user-centred innovation process (EUIP), a Remote Care Assist service was conceptualized and implemented for home care service settings in three European countries. *Results*: After five iterations within two phases of the EUIP, the final feature set of the RCA-service was determined and implemented. *Conclusion*: By working closely with the target group, it was possible to identify potential hurdles and additional requirements such as a well-thought-out interaction concept for the HoloLens or a good organizational embedding of the service.

Keywords. Ambient Assisted Living, Computer-Assisted Instruction, Augmented Reality, Mixed Reality, Remote Support, Home Care Services.

1. Introduction

In the coming years, demographic change will put a strain on health and long-term care systems in Europe [1]. Many countries are responding to the older people's preference to live at home as long as possible [2] by expanding home care and giving it political priority over residential care [3]. In the EU, the number of years a person is expected to live in good health at age 65 is about 9.8 [4]. With a life expectancy of about 80.1 years [5], care needs may occur for the remaining years. As people's health deteriorates with age, home care becomes more demanding and requires more and specialized professional support.

However, it is difficult to expand home care because the number of care workers is decreasing rather than increasing due to demographic change. Home care is therefore already reaching its limits and requires new solutions to address the problem of labor shortages and enable caregivers to adequately meet the needs of their ageing clients [6].

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To make matters worse, in home care, care workers are usually on their own (with little exchange with colleagues), whereas in residential care, care teams with different backgrounds work together and share/exchange information [7]. This is challenging and exhausting, especially, when caring for people with multiple conditions. Moreover, specialists (e.g. wound managers, therapists) cannot always be onsite when they are needed, even though the demand for such expertise is increasing, especially in remote areas. In addition, the training of home care workers in many countries is considered insufficient with respect to geriatric care [6]. This leads to a further burden on informal carers due to additional tasks that have to be taken on and to a higher turnover of staff in care organizations [8]. Finally, the COVID-19 pandemic has worsened the situation of home care workers, including lack of or inadequate training and assistance in coping with the situation [9], [10].

For these reasons, it is important to rethink home care as we know it today. Technology can play a significant role here. It can be used to scale up support and advice for the ever-increasing number of older people. In addition, measures can be taken to retain experienced care workers and to attract young people to care work or to ensure the quality of care. It is therefore necessary to succeed in using information and communication technology (ICT) to create efficient and attractive workflows that enable effective information exchange as well as remote assessments, peer mentoring and virtual assistance between home care workers.

Currently, home care worker support is arranged in such a way that care workers who encounter problems on-site at the client's location contact their colleagues or team leaders by phone. Telephone calls may turn out difficult to describe a situation with words alone. In these cases, employing new technologies like augmented or mixed reality (AR, MR) could help. An AR/video call app for smartphones could be sufficient to exchange information in image and sound. If this is not sufficient, particularly for care workers who need both hands free to do their work or follow instructions from a remote expert, AR/MR glasses would be more beneficial [11], [12]. While in the medical field [13] and in acute inpatient care [14] this technology has already been adopted, it is rarely used in home care. Since COVID-19, however, AR/MR glasses are gradually gaining interest here as well [15]–[17].

This paper deals with the concept and implementation of a Remote Care Assist (RCA) service developed in the European AAL-project *Care about Care*. The development of the RCA-service builds on the iterative 'evidence-based and user-centred innovation process for AAL projects – EUIP'[18] which builds on [19]. We provide insights into the application of EUIP's first two phases, idea development and co-creation/-design, which were used for the concept development and implementation of the RCA service[2]. The results of the third EUIP-phase (testing and evaluating of the entire system in a large field trial) is not the subject of this paper.

2. Concept and feature set

The **idea development phase** (first phase of EUIP) for the Remote Care Assist (RCA) service to be used for home care settings comprised several *coordination meetings* with

[2] The user involvement at different stages (including the informed consents) was reviewed and approved by the independent ethics board of the University of Applied Sciences Wiener Neustadt (02/09/2021; chairperson: Nimmerichter Alfred).

potential end-user partners. The meetings intended to identify main problem areas in home care and to discuss possible technical solutions. The main tenor was that having enough time is a severe issue in home care and existing resources must be used even better in the future. In other words, new tools will be necessary to scale up support and also help to ensure/improve quality of care. For this reason, the immediate support of care workers who face difficult situations in the households of their clients turned out as an important issue. Solutions have to bring people together who need support and who are experienced enough to provide support. Care workers and managers also stressed that solutions should support care situations in which care workers need to have both hands free. Moreover, it became apparent that there must be designated contact persons who have the necessary time and the relevant experience to provide support in appropriate quality.

Based on this starting point, the first step was to outline the potential Remote Care Assist Service (RCA) consisting of: (i) *CARE EXPERT CENTER – CXC* to remotely support care provision and (ii) *REMOTE SUPPORT – RS* to obtain the support on-site, which can be scaled-up (as there is no need to travel) while still ensuring and even improving quality of care. In order to make the idea as understandable as possible for everyone involved in the process, two *example scenarios* – one for CXC and one for RS – were used. They were designed jointly in several iterations (technicians, social scientists and end-user partners):

(i) *CARE EXPERT CENTER*: Anna is a 60-year-old care worker, who, like other colleagues of her age, lives with a musculoskeletal pain condition. Using innovative technologies, the Remote Care Assist service allows Anna to share her expertise with younger colleagues as she is now part of her organization's CXC. There, she works as senior care advisor together with other specialists, such as occupational therapists and wound managers.

(ii) *REMOTE SUPPORT*: At 8am, Max (a home-helper who just completed his training) has noticed that his client faces difficulties moving around and is unsure what to do. Max calls Anna via the RS app. While Max speaks to Anna, he is wearing his mixed reality (MR) glasses, so that Anna sees what he sees. For a quick fix, she directs Max how to correctly adjust the client's walker and adds measures to the care planning to improve the client's mobility.

The **co-creation/co-design phase** (second phase of EUIP) comprised eight co-creation workshops, six interviews and three co-design workshops (in total 67 participants) as well as two pilot tests (at least 40 care workers and 65 home care service users visited) for collecting input and feedback. The starting point were *co-creation workshops* based on the previously described scenarios followed by *co-design workshops* based on first mockups with different professions (home helpers, nursing assistants, registered nurses, wound managers and therapists), home care service users and informal carers in three countries (Austria, Belgium, Luxembourg). From these workshops we have learned that it is important to "show" situations on-site and to be able to point out ("mark") different items/areas. A feature that was actively requested by the workshop participants was the ability to save a consultation to the care documentation. After a *first pilot test* with the HoloLens 2 (mixed reality glasses) and the CXC – features see Table 1 – it became apparent that a smartphone app would also be useful, which had already been planned but was now also actively requested by the testers. Furthermore, additional functions for starting a call from the CXC or for measuring objects or wounds were requested. During this phase, the need for a well-thought-out interaction concept for the HoloLens app also became clear – especially for new users. After a *second pilot test* –

features see Table 1 – using both the HoloLens 2 and a first version of the RS Smartphone app for Android, organizational hurdles were as present as technical ones. For example, there were problems with the presence state or the LTE router. It also turned out that organizational embedding requires more attention, i.e., experts need more time. The RS Smartphone app proved to be quite useful. However, since many experts are also visiting clients, the desire was expressed for a mobile CXC option to support their colleagues. The feature set for the first and second pilot as well as for the final expansion stage of RCA is shown in Table 1. The iterative nature of the EUIP allowed user feedback to be considered after an interaction.

Table 1. RCA's feature set for all stages of development

Care Expert Center (web-application)	**Pilot 1**	**Pilot 2**	**Final expansion stage**
Login	x	x	x
Accept incoming video call	x	x	x
Take screenshot and draw something or place markers	x	x	x
Transfer edited screenshot to call partner	x	x	x
Presence status display	x	x	x
Start outgoing video call		x	x
Multi domain support		x	x
Care documentation			x
Remote Support HoloLens 2	**Pilot 1**	**Pilot 2**	**Final expansion stage**
Login via QR-code	x	x	x
Start outgoing video call	x	x	x
Hand menu to switch hand rays on/off	x	x	x
Move/fetch windows in the room	x	x	x
View images provided via Care Expert Center	x	x	x
Accept incoming video call		x	x
Multi domain support		x	x
Digital rulers		x	x
3D marking		x	x
Integration/transfer of mixed reality capture to call partner			x
Send photo to call partner			x
Remote Support Smartphone	**Pilot 1**	**Pilot 2**	**Final expansion stage**
Login		x	x
Start video call		x	x
Start outgoing video call		x	x
Accept incoming video call		x	x
View images provided via Care Expert Center		x	x
Multi domain support		x	x
Send photo to call partner			x
iOS support			x
Android support			x

3. Implementation and architecture overview

Details of the RCA system architecture can be found in Figure 1.

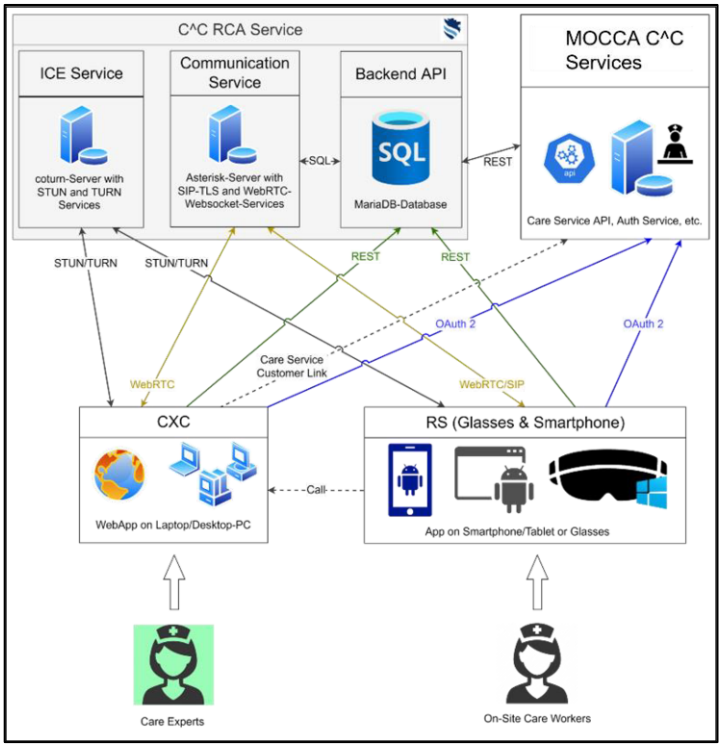

Figure 1. The RCA system architecture for home care settings.

3.1. RCA Backend

For the backend of RCA following services/components/interfaces are used: (i) Asterisk server – open-source solution providing VoIP with SIP/TLS and WebRTC, (ii) OAuth 2.0 – industry-standard protocol used for authentication and authorization, (iii) MariaDB – open-source relational database, (iv) Interactive Connectivity Establishment (ICE) service – for solving IPv4 NAT issues and (v) interfaces – data exchange via HTTPS/REST and WebRTC.

3.2. RCA Frontend

The *RCA framework* in the frontend communicates with the Asterisk and ICE service for call handling and the backend API for managed data exchange. It also contains custom program logic for content handling in the context of remote support. The framework was implemented for the three different user interfaces:

Care Expert Center: The CXC (Figure 2) was implemented as single-page web application using Angular (development framework built on TypeScript), CSS and HTML5.

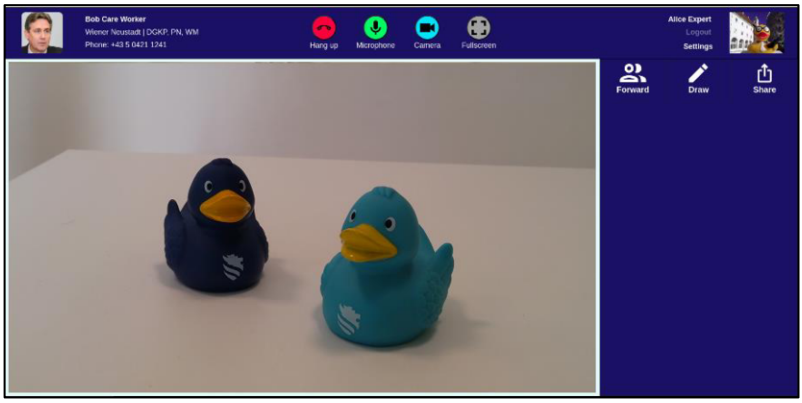

Figure 2. CXC video call – view of the calling care worker can be seen in the care expert center.

RS-HoloLens 2: The HoloLens application was implemented as a Unity app with C# as the primary programming language and ran as full-screen 3D app on the HoloLens 2. The user interface design was based on the Microsoft Mixed Reality Toolkit (MRTK) and worked completely virtually. Virtual windows were projected into the user's view (Figure 3), they were fixedly positioned in the room. The only input devices were the user's hands, which makes further hardware unnecessary.

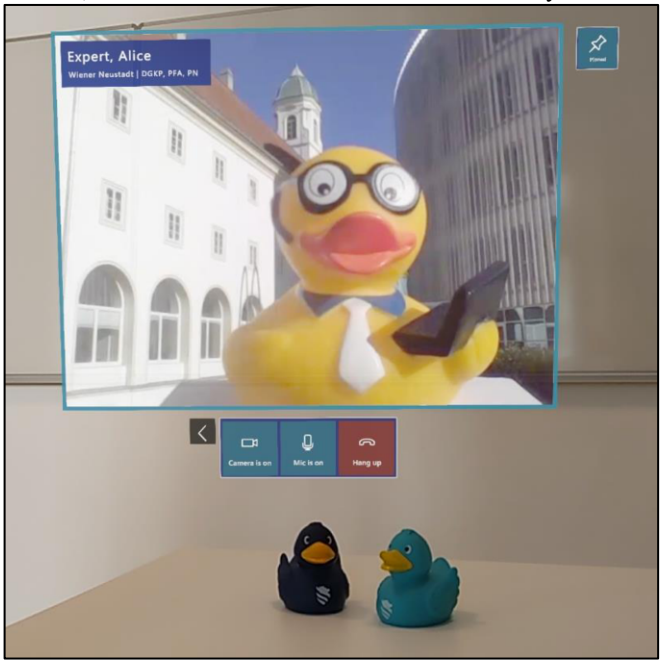

Figure 3. RS-HoloLens video call – expert can be seen in "floating" virtual window.

Figure 4. RS-Smartphone video call – expert top left, own camera image large in the center.

RS-Smartphone: To serve Android and iOS, the open-source framework Flutter was used in combination with the programming language Dart. Flutter enables multi-platform development from a single codebase. Figure 4 shows the user interface for Android.

4. Discussion and Outlook

The concept and the derived feature set as well as the related implementation and architecture of the Remote Care Assist service were developed according to the iterative EUIP approach [18]. The final feature set of the RCA service was determined in several iterations within the two phases *idea generation* (coordination meetings, development of example scenarios) and *co-creation/co-design* (co-creation/co-design workshops, pilot test 1 and pilot test 2).

Since the target group of the RCA-service (employees of end-user organizations) was already involved in the idea generation phase of the project, the development goal was clear from the beginning of the project and work on the technical solution could start immediately. For the first co-creation workshops, it was an advantage that the exemplary scenarios were already very close to reality and could be built upon. Furthermore, the technical possibilities were mapped out beforehand and an exemplary feature set was presented to the workshop participants, which proved helpful especially for envisioning the possibilities with AR and MR technology. In the two pilots, possibilities for improvements were identified for all three applications (RS-Smartphone, RS-HoloLens 2 and Care Expert Center). Working closely with the target group during the co-creation/design workshops and pilots allowed for further discussion of ideas and use cases, which were then incorporated into the development of new features and improvement of usability. Similar to [18], the approach allowed many potential hurdles or additional requirements to be identified early on and taken into account in the development. As also described in [20], these included the unfamiliarity of care workers and clients with virtual care delivery or a good organizational embedding of the service - keyword changed working conditions. It also turned out that for the trial a well-designed interaction concept for the HoloLens is required.

One of the key findings regarding the development process was that Flutter turned out to be useful for both the RS Smartphone app as well as the web app for the Care Expert Center. Thus, we plan to switch the web app from Angular to Flutter in a next step. Having a single code basis for the RCA framework logic and only developing the user interfaces separately should improve/ease the maintenance/reuse of components in the frontend. As conceptualized by EUIP's third phase, the final iteration of the RCA system will be tested in a field test in three European countries with 300 home care workers and nurses in Austria, 70 in Belgium and 190 in Luxembourg planned to measure effects, acceptance, usability and user experience.

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