Appendix B – References of the Scoping Review

Paper: A Scoping Review on Human-Centered Design Approaches and Considerations in the Design of Technologies for Loneliness and Social Isolation in Older Adults

Appendix B presents a summary of the included 98 papers and the corresponding technologies developed. Technologies involve Accessible Interfaces (n=5), Applications using Augmented/ Mixed/ Virtual Reality (n=9), Communication and Social Networks (n=22), Companion Technology (8); Training, Educational Applications (3), Games (2), Robotics (n=26), Social TVs (6), Loneliness/ Isolation Monitoring (n=13); Ambient Assisted Living Systems (3), and care Network (1)

Supplement 1 Table of the Included Literature

Paper	Application
(Goumopoulos, Papa and Stavrianos, 2017)	*Accessible Interface* – Senior App suite combines different needed applications of social networking, activity, and medicine reminders, fall detection, information needs and other services in one app for easier usage and enabling greater social interaction
(Mueller *et al.*, 2021)	*Accessible Interface* – SmartCards-Tablet-System
(Restyandito *et al.*, 2020)	*Accessible Interface* – a social media application interface designed for elderly
(Horie, Chen and Nakamura, 2022)	*Accessible Interface* – video playback service to make recommendations based on people's interests
(Hsieh, 2015)	*Accessible Interface* – Virtual pet as assistant to older people in using mobile application to help keep contact with family and friends.
(Cook and Winkler, 2016)	*Augmented, Mixed, Virtual Reality* – Second Life (includes "friending" and messaging)
(Antunes *et al.*, 2017)	*Augmented, Mixed, Virtual Reality* – practicing games in VR environment
(Arlati *et al.*, 2019)	*Augmented, Mixed, Virtual Reality* – SocialBike, a virtual reality-based exergame to train physical and cognitive abilities at home
(Graf, Liszio and Masuch, 2020)	*Augmented, Mixed, Virtual Reality* – cognitive task games in a natural environment with a dog as companion
(Lim, Lee and Anggoro, 2019)	*Augmented, Mixed, Virtual Reality* – An Augmented Reality 3D cubes Puzzle Bingo game
(Broneder *et al.*, 2022)	*Augmented, Mixed, Virtual Reality* – mixed-reality board games playable with a remote partner and, physical exercises done together with a virtual avatar
(Cunha *et al.*, 2021)	*Augmented, Mixed, Virtual Reality* – Virtual Cycling experience
(Lundström, Ghebremikael and Fernaeus, 2021)	*Augmented, Mixed, Virtual Reality* – watching a 360-degree VR film together
(Dijkstra-Soudarissanane, Gunkel and Reinders, 2022)	*Augmented, Mixed, Virtual Reality* – Augmented Reality communication system
(Baecker *et al.*, 2014)	*Communication and Social Networks* – Ringo: tablet that shows a picture frame and picture, messages and media could be uploaded
(Boudin *et al.*, 2014)	*Communication and Social Networks* - HOST Comm: a collaborative website where users create content based on shared interests

(Gao *et al.*, 2012)	*Communication and Social Networks* – mobile social application for the organization of leisure-time activities between older people with similar interests living in adjacent areas.
(Muñoz *et al.*, 2015)	*Communication and Social Networks* –SocialConnector: application to exchange messages among community members, fixed and installed on a wall
(Ruschin, 2015)	*Communication and Social Networks* – tablet app to connect with friends and relatives and formal carers (doctors and nurses). It enables messaging but also the display of information (calendar and schedule, activities such as detect sitting, walking, and talking, mood) from sensors and facial recognition
(ter Voort *et al.*, 2015)	*Communication and Social Networks* - 'APPointment' to plan social activities within a closed community
(Frohlich, Lim and Ahmed, 2016)	*Communication and Social Networks* – Photo Phone (facilitating showing photos online), TV Talk (watching television while talking to others across distance), Twitter Well concept for broadcast text messaging.
(Marcelino, Laza and Pereira, 2016)	*Communication and Social Networks* – a social network adapted to older people
(dos Santos *et al.*, 2016)	*Communication and Social Networks* – ANNI, that combines social network platforms and health care features for simplified access of all information
(Wirth *et al.*, 2016)	*Communication and Social Networks* – Public interactive surface for planning shared activities in a community of older residents
(Zhao *et al.*, 2016)	*Communication and Social Networks* – Blossom, vases with flowers and a family photo as interface for message and photo exchange across distance
(Ha and Hoang, 2017)	*Communication and Social Networks* - social network where seniors connect with and offer services to the community
(Nevay, Lim and Gowans, 2017)	*Communication and Social Networks* – e-textiles
(Li *et al.*, 2018)	*Communication and Social Networks* - public interactive installation placed outside
(Peng, 2018)	*Communication and Social Networks* - Wearable Memory: beacon wearable device to store a photo album, and photos. Can be displayed through different TV displays in a variety of public or private locations, carers and family members can add pictures.
(Neves *et al.*, 2018)	*Communication and Social Networks* – tablet-based communication system
(Mushiba, 2018)	*Communication and Social Networks* – SoundPlay, installation in a room where music changes through movement and encourages interaction between strangers in a room
(Isaacson, Cohen and Shpigelman, 2019)	*Communication and Social Networks* – Social and connective television system for video calls and online classes
(Meinert *et al.*, 2020)	*Communication and Social Networks* – app for social interaction with family and friends, with simple interface, font size adjustment, a chatbot, a voice control assistant, and voice messaging with family members
(Zamir *et al.*, 2021)	*Communication and Social Networks* – 'Skype on Wheels': video call application on wheels
(Yang and Chen, 2022)	*Communication and Social Networks* - MoreTime Smart Blanket: device with pressure and temperature feedback, video communication takes place through the TV, family members can send a touch or massage to the blanket

(Johansson-Pajala *et al.*, 2023)	*Communication and Social Networks* – A room that allows to join conversations in form of video, voice, or chat in online groups
(Huang *et al.*, 2014)	*Companions* - Companion with depth sensors that records out-of-home activity
(Machesney *et al.*, 2014)	*Companions* – Gerijoy virtual pet avatar
(Takeda, Huang and Kawagoe, 2014)	*Companions* – Virtual companion agent who can listen to and build a relationship with the user to maintain a long-term relationship, and that is more personalised and records daily activities
(Bott *et al.*, 2019)	*Companions* – Embodied conversational agents, animal avatar on a tablet device, monitored and controlled by care staff
(Bravo *et al.*, 2020)	*Companions* – Cate: Conversational agent in a mobile application. Besides conversation, it also provides the option to make a call, remind of appointments, and play games to alleviate loneliness.
(Garcia-Mendez *et al.*, 2021)	*Companions* – EBER: an intelligent radio that adapts to the user's mood.
(Valtolina and Hu, 2021)	*Companions* – conversational agent that supports companionship, reminders, and promoting self-compassion
(Kramer *et al.*, 2022)	*Companions* - PACO, a web-based service in which 2 Embodied conversational agents engage in dialogue with an older adult to provide motivation for improving eating behavior and decreasing loneliness.
(Mahmud *et al.*, 2022)	*Training, Educational Applications* – ElderConnect: an application that provides information how to develop new social connections and maintain existing connections
(Nikitina *et al.*, 2018)	*Training, Educational Applications* – social trainee app, online group exercising application on a tablet and in some cases activity monitoring sensor are linked
(Loiseau et al., 2015)	*Training, Educational Applications* – digital tablet-based application that supports informing about events in the residential home, upcoming trips games, and drugs administration
(Ku, 2018)	*Games* - Fortune8: an augmented reality game console combining a traditional game of poker to augmented reality and an app, where family members can invite older adults to play across distance. The app collects and can share information about the older people's gaming activities to their family members.
(Baez *et al.*, 2019)	*Games* – Gymcentral, a group exercising tablet-based application for trainees/ the coach.
(Marin Mejia, 2014)	*Robotics* – social network and it's access through assistant robots
(Yamazaki *et al.*, 2014)	*Robotics* – Telenoid, teleoperated androids for telecommunication
(Correia *et al.*, 2016)	*Robotics* – social robot to play a card game with humans, playing the role of a partner and opponent.
(Koceski and Koceska, 2016)	*Robotics* -Telepresence robot – can navigate, help start a video call, electrocardiograph measurement, fetch and carry water, medication reminders
(Sansen and Torres, 2016)	*Robotics* – robot that supports indoors/ outdoors, companion for dialogues and help in the detection of health issues, humanoid robot that sits on an electric wheelchair
(Wang and Lan, 2016)	*Robotics* –companion robot with sensors to detect body movement and the environment (pressure sensor, light sensor, photoelectric sensor, thermal sensor, microphone, and camera, gas detection sensor)

(Aaltonen, Niemelä and Tammela, 2017)	*Robotics* – The telepresence robot (two-wheel rolling base and iPad), family members use laptop and internet browser to connect. With a "Please call me" button to send a message to the family member's mobile phone.
(Hirata *et al.*, 2017)	*Robotics* – chat robot
(Onofrio *et al.*, 2019)	*Robotics* – social robots
(Buono *et al.*, 2020)	*Robotics* – care robots
(Casey *et al.*, 2020)	*Robotics* – *Robotics* – MARIO: companion robot for people with dementia, supports listening to favourite songs, helps users recalling memories, provides daily news, further provides games, a calendar, communication with family and friends, and Comprehensive Geriatric Assessment
(K. Chen *et al.*, 2020)	*Robotics* – Kabochan: humanoid robot doll representing a three-year-old, with sensors on its surface, it can talk, sink and nod its head and comes with 400 phrases
(Huang *et al.*, 2020)	*Robotics* – pet robots
(Poulsen, Fosch-Villaronga and Burmeister, 2020)	*Robotics* – care robots
(Woo *et al.*, 2020)	*Robotics* – teddy bear like robot system with touch and non-verbal interaction and one with verbal interaction
(Coghlan *et al.*, 2021)	*Robotics* - distinctive companion robots: a talking assistant; a roving toylike vehicle; and a robotic dog.
(S.-C. Chen *et al.*, 2020)	*Robotics* - PARO Therapeutic Robo
(Khosla *et al.*, 2021)	*Robotics* – Betty: social robot for people with dementia, particularly designed to increase social engagement with humans and displays emotions.
(Demaeght *et al.*, 2022)	*Robotics* - social robot Misa with different facial expressions with emotion recognition
(Ghosh *et al.*, 2022)	*Robotics* – puppy robot Aibo, humanoid robot Nao
(Yamazaki, Hirata and Isshiki, 2017)	*Robotics* – NAO: companion robot that appears more intimate, due to recorded and evaluated information
(Johnston, 2022)	*Robotics* - robotic care assistants can provide care and companionship
(Koceska and Koceski, 2022)	*Robotics* - robot system that can assist elderly and professional caregivers in everyday activities.
(Mackey, Bremner and Giuliani, 2022)	*Robotics* - users can view and control a robot in a remote environment via a video feed streaming into the head mounted display of a virtual reality system, they can communicate with others through attached microphones and a display
(Wilson, Keane and Jones, 2022)	*Robotics* – GenieConnect: a companion robot with large face and animated eyes, positioned on the table. The robot finds out how a person is doing on a daily basis, and it provides medication reminders
(Villaverde Naveira *et al.*, 2022)	*Robotics* - Guardian project, social robot to support frail seniors and to give health data to carers, they can send meal or/and medication reminders, wellbeing or/and sleep quality requests, suggest personalized activities.
(Alaoui and Lewkowicz, 2015)	*Social TV* – Television as alternative device for connecting with family

(Limdumrongnukoon, Mongkolnam and Visutarrom, 2015)	*Social TV* – communicative TV
(Pereira *et al.*, 2015)	*Social TV* – smart remote control +Social and a Smart box to access to the television programs and phone contacts
(Syeda and Kwon, 2017)	*Social TV* - "Photo Alive!" social network and smartphone app for taking photos that are displayed via television. to TV based "Photo Alive!"
(Doppler *et al.*, 2018)	*Social TV* – BRELOMATE, a TV and tablet-based communication and entertainment platform
(Noguchi, Sato and Saito, 2022)	*Social TV* – receipt of photos/videos across distance over the TV
(Petersen *et al.*, 2014)	*Monitoring* - time spent out-of-home was detected through motion and contact sensors in all rooms
(Eldib *et al.*, 2015)	*Monitoring* - Visitor detection through low resolution visual sensors
(Sanchez *et al.*, 2015)	*Monitoring* –smartphone records ingoing and outgoing calls to friends or family, time spent outside home, average times spent in different rooms
(Petersen *et al.*, 2016)	*Monitoring* – installed a phone monitoring device to detect incoming and outgoing calls
(Goonawardene, Toh and Tan, 2017)	*Monitoring* – going out behaviour, daytime napping, time spent in the living room, time spent outside home level, motion-sensors and a door contact sensor
(Gaete *et al.*, 2017)	*Monitoring* – Visitrack, detection of visitors with help of a camera, microphone, and facial recognition
(Huynh, Tan and Lee, 2017)	*Monitoring* – sensors at home to detect the in-home physical activities, use of passive infra-red sensors to detect motion, reed switches to detect the main door opening and closing, to inform carers
(Martinez *et al.*, 2017)	*Monitoring* – mobile application combined with sensors placed at home, it detects incoming and outgoing calls/ messages, the time spent in certain areas of the home through presence sensors
(Ejupi and Menon, 2018)	*Monitoring* - wearable textile-based stretch sensors to detect talking (chest contraction)
(GOH, TAN and TAN, 2019)	*Monitoring* – monitoring system over smartphone and Bluetooth beacons installed in the home to detect activity levels
(Sunghoon, Parasuraman and Jaunbuccus, 2019)	*Monitoring* – loneliness manually recorded, that links to a chat to get in touch with family members, a gallery to keep memories and recordings, live steaming of tv and radio, and an emotional service to report their emotional state to carers
(Rebollar *et al.*, 2020)	*Monitoring* – smartphone application for monitoring isolation and for sending notifications to the carers, it monitors incoming and outgoing calls, as well as the average time spent in different areas of the home to detect mobility
(Valero *et al.*, 2022)	*Monitoring* – detects vital data with microwave sensors, facial expressions with cameras, speech tone with a microphone, temperature, and brightness to detect different activities
(Brandenburgh *et al.*, 2014)	*Ambient Assisted Living* - virtual coach and activity sensor (tracking activity and duration), tablet usage data is evaluated, to make appointments, to help monitor older people and their social environment, to Skype with friends. Caregivers and relatives can login into a web portal and view activity-related information: general tablet activity, calendar activity, Skype activity, and physical activity, provides recommendations to the caregiver

(Davis *et al.*, 2017)	*Ambient Assisted Living* - and context-aware systems (accelerometer, gyroscope data in a waist-mounted smartphone around the waist for activity detection) and how they affect a sense of connectedness to caregivers and the feeling of a social presence
(Morgavi, 2015)	*Ambient Assisted Living* – Virtual Village Network: vision of a connected group of older neighbours, overall system focuses on monitoring safety, health, provide comfort in the home environment, and connection
(Fiori, 2014)	*Care Networks – the* eCare Network is an online network connecting general practitioners and hospitals within a region. It includes a website to retrieve individual health data, a call center for support, and social workers. Daily phone calls serve companionship and to monitor frailty. In cases where necessary nurses spend more time on monitoring and socialization.

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