Recenzovaný zborník z medzinárodnej interdisciplinárnej doktorandskej konferencie
DOKOR 2024 konanej dňa 30. apríla 2024 v Ružomberku
Proceedings of International Interdisciplinary Doctoral Conference
April 30, 2024, Ružomberok, Slovak Republic
ISBN 978-80-561-1102-4

OPEN ACCESS Article

DOI: https://doi.org/10.54937/2024.9788056111024.79-96

TECHNICAL-DESIGN-SOCIAL ASPECTS OF SMART HOME TECHNOLOGY IN ELDERLY CARE SECTOR AS MULTIDISCIPLINARY APPROACH

Georg **ROCKEL** [1] - Oldrich **TRENZ** [2] - Jan **ILKO** [3] - Intigam **AGHAMURADOV** [4]

[1]*Faculty of Business and Economics, Mendel University in Brno, Czech Republic / FLEXIM, GmbH, Berlin, Germany*
ORCID iD: 0000-0003-0379-0653 https://orcid.org/0000-0003-0379-0653

[2]*Faculty of Business and Economics, Mendel University in Brno, Czech Republic*
ORCID iD: 0 0000-0002-1260-590X https://orcid.org/0000-0002-1260-590X

[3]*MEDON, GmbH, Olbendorf, Austria*
ORCID iD: 0009-0000-4696-7194 https://orcid.org/0009-0000-4696-7194

[4]*University of Sheffield, Sheffield, UK / FLEXIM, GmbH, Berlin, Germany*

ABSTRACT

In this study the implementation of modern technologies in the field of computing and artificial intelligence in the field of smart homes in the sector of care for people of retirement age is discusses, in general point of view. The goal is to map the current development of integration of these technologies and artificial intelligence from the perspective of engineering, health and social care area. The study presents the possibilities of cooperation of experts from the technical, social, health, ergonomic fields, as well as the field of design and engineering practice, especially focusing to academic field. The frame of interest are the grade of modern IT technologies integration in the elderly care area, their implementation, health care in direction detection-reaction, communication technical possibilities among seniors` relatives and social and medical staff and at the end the

ISBN 978-80-561-1102-4

application of high-tech systems to simulate the natural environment to ensure the best living place for seniors adequate to their age and needs.

Key words: *Smart home, AI, computer technology, social approaches*

Introduction

In the senior age, a person needs increased care from other people, health care, and especially understanding and empathy of those around him. Not everyone has a person or people close to them who can provide these people with everything they need, and here there is space for modern technologies that, thanks to advanced programming, communication and design levels, can provide equal service as a social staff, friends, family, or even significantly help in social and health care for seniors. Modern technologies are rapidly penetrating almost every area of human life. By using technological possibilities and artificial intelligence, which is increasingly used today, it is possible to perform human activity with higher efficiency, reliability, speed and precision of requested tasks. Thanks to today's technologies and computer technology, we can even give the digital system not only a task to perform a certain operation, but also a request to choose the most effective solution to a specific problem. On the basis of statistics and synergetic as a science, by implementing their knowledge and tools, we can predict the development of a certain situation and, with the help of intelligent systems, choose a plan and procedure for the most effective handling of anticipated events or problems. In the field of care for people of retirement age, these approaches have great potential.

Elderly people social aspect

Old age is a period of life which, on the one hand, is associated with life fulfillment and, on the other hand, is associated with various difficulties and changes, especially biological, psychological and social.[1]An important factor is fulfilling the needs associated with a given age. In this area, technology and artificial intelligence can create a virtual environment that a person can perceive as reality and affect the emotional perception of the environment and improve the quality of life. This theme were dealing *Williams, J., Lyons, B., & Rowland, D. (1997)* in their study *Unmet Long-Term Care Needs of Elderly People in the Community*, where they processed information on the given topic from professional literature and their claims are: ”*The extent of unmet need, or the extent to which needed assistance is unavailable or insufficient, is an important issue in public policy and financing of health and support services. This article reviews the research literature to assess how unmet need is measured, and the extent of unmet needs among elderly people in the community. Measurement difficulties include variable definitions and measures of need across studies, the relative dearth of studies which undertake to measure unmet needs, and varying methodologies used to estimate need and unmet need. In addition, some measures of status and need, such as cognitive impairment and care giver burden are excluded from many estimates. Estimates of unmet need range from around two percent to about 35 percent of community dwelling elders, depending on what is included or excluded from the definition. Unmet need is associated with higher disability levels and living alone. The literature suggests that estimates of future unmet need will be mitigated by declining disability levels and increased use of assistive devices among the elder population*[2]. “

Interdisciplinary approach

In the care of the elderly, an interdisciplinary approach can also be understood as a sum of professional medical, nursing, social, religious, psychological and rehabilitation activities provided to people dependent on the help of others, with the aim of minimizing and alleviating all the difficulties resulting from old age and the complications of life brought by oneself life. The interdisciplinary team takes into account the bio-psycho-spiritual-social needs of the old person and his family. We know from both theoretical and practical standpoints that caring for seniors requires an extensive and complex set of activities, which tells us about the necessity of interdisciplinary cooperation. A functioning mutual cooperation between the health and social spheres, as well

ISBN 978-80-561-1102-4

as cooperation with the client and his family, shows a number of positives, which are reflected in the following areas:

- there is an improvement in communication between participants, as well as results,
- access to and quality of care for the elderly improves,
- enables better maintenance and development of health and social services,
- working human resources, their professional and practical experience in working with seniors are used more effectively and efficiently,
- the satisfaction of clients and social service providers is at a higher level and social services are provided in a more targeted and purposeful manner,
- the time, financial and economic demands of providing social services and care for the elderly are reduced,
- interdisciplinary cooperation represents an "open container" of knowledge, insights, skills and abilities, which are enriched by the interaction of subjects who participate together in solving problems [3].

Socio-technical aspect

Old age is a stage of a person's life, an irreversible biological process that each person endures differently. Some live a healthy life to the end and others struggle with various health problems. We often meet seniors with dementia and Alzheimer's disease. Exacerbation, i.e. the progression of the disease, worsens over time in seniors, it can be observed mainly in communication and self-care skills. Seniors become dependent on care, first from family members and later from caregivers. Dementia is a very serious disease that disrupts a person's functionality in everyday life and therefore requires an empathetic attitude of family, loved ones and friends and their motivation to provide help and care in a family environment. An important role in illness is accompanying a loved one with the above-mentioned diagnoses and being able to understand him. The more a senior feels empathy and understanding, the more he will trust his loved ones and the environment.[4]According to a survey by Majumder, S. And al. (2017) in the study *Smart Homes for Elderly Healthcare-Recent Advances and Research Challenges*, the primary objective of the smart homes is to allow the elderly to receive continuous, non-invasive and seamless healthcare service while staying in their convenient home environment. It allows the elderly to minimize their frequency of visits to, or length of stay in expensive healthcare centers such as clinics, hospital and long term care centers, thereby allowing them to lead independent and active lives. Smart homes can also monitor and control the home environment by assessing the behavioral and daily living patterns of the users. The significant advancement in the technology that enables the development of low-power, small and low-cost sensors, and actuators coupled with modern communication technologies paved the way towards realizing continuous monitoring services in a smart home platform from a distant facility [5].

Increasing of independence

One of the primary goals of smart homes in elderly care is to promote independence and autonomy among seniors. Smart devices and assistive technologies, such as smart sensors, wearable devices, and voice-activated assistants, enable seniors to perform daily tasks more easily and safely. From automated lighting and temperature control to voice-controlled appliances and medication reminders, smart homes empower seniors to maintain their independence and quality of life.

This theme was researched by Qin Ni, Ana Belén García Hernando and Iván Pau De la Cruz (2015) in their interesting study with the proposal of practical solutions under the title *The Elderly's Independent Living in Smart Homes: A Characterization of Activities and Sensing Infrastructure Survey to Facilitate Services Development*. In the conclusion of the study the authors say: "*We have presented a review of the main concepts, devices, techniques and models used for the provision of services tailored to enhance independent living for the elderly in smart homes. This review is aimed at making it easier for developers and service providers to construct and deploy complete solutions. To achieve this, we have presented the review in a top-down approach, beginning with the services provider vision. This way we have started with the services perspective, gone through high-level*

ISBN 978-80-561-1102-4

concepts such as the activities, and finished with the description of sensors and the processing of their data. In each of the sections we have paid special attention to the issues more related to the provision of real services[6].“

Remote Monitoring and Health Management

Smart home technologies offer unprecedented capabilities for remote monitoring and health management, enabling caregivers and family members to monitor the well-being of elderly individuals from afar. Health monitoring devices, such as smart-watches and wearable sensors, track vital signs, activity levels, and sleep patterns, providing valuable insights into seniors' health status. Remote monitoring systems can alert caregivers to potential health issues or emergencies, enabling timely intervention and support.

Remote health caring of patients at home is increasing with the popularity of various nature of mobile devices that has developed to enable remotely caring. The cloud as well as IoT (Internet of Things) and the mobile technologies make it easier to monitor the patient health conditions by sharing the health information to health care teams such as doctors, nurses and specialists.[7]

PGHD Patient-generated health data

Healthcare providers can use PGHD to gain a better understanding of the patient’s health over time and cut back on office visits and hospital readmissions, resulting in better outcomes and less burden for the patient.[8]PGHD are defined as health-related data-including health history, symptoms, biometric data, treatment history, lifestyle choices, and other information-created, recorded, gathered, or inferred by or from patients or their designees (i.e., care partners or those who assist them) to help address a health concern. PGHD are distinct from data generated in clinical settings and through encounters with providers in two important ways. First, patients, not providers, are primarily responsible for capturing or recording these data. Second, patients direct the sharing or distributing of these data to health care providers and other stakeholders. In these ways, PGHD complement provider-directed capture and flow of health-related data across the health care system. PGHD are not new phenomena; many patients record and share information on their health and wellness with care providers. However, the proliferation of Smart phones, remote monitoring devices, application development platforms (e.g., iPhone and iPad apps) and ubiquitous networks are enabling massive growth of PGHD. Increasingly, PGHD will be created, recorded, and shared electronically.[9]Robab Abdolkhani, Kathleen Gray, Ann Borda and Ruth DeSouza (2019) in their study *Patient-generated health data management and quality challenges in remote patient monitoring* are dealing with Patient-Generated Health Data (PGHD) in remote monitoring programs. They did interviews with twenty experts with experience in the use of PGHD in remote patient monitoring, including healthcare providers, health information professionals within clinical settings, and commercial providers of remote monitoring solutions. As a result, they wrote: “*The remote monitoring programs in the study did not follow clear PGHD management or quality assurance approach. Participants were not fully aware of all the considerations of PGHD quality. Digital health literacy, wearable accuracy, difficulty in data interpretation, and lack of PGHD integration with electronic medical record systems were among the key challenges identified that impact PGHD quality. Co-development of PGHD quality guidelines with relevant stakeholders, including patients, is needed to ensure that quality remote monitoring data from wearables is available for use in more precise and personalized patient care.*[10]”

Advantages of PGHD are:

- Empower the patient to track, change and improve health by enabling better self-management,
- support healthcare professionals monitor and assist their patients, allowing real-time adjustments to treatment in response to patients' symptoms and physiology,
- improve relationships and communication between patients and healthcare teams and support shared decision-making,
- augment patient-driven quality of care assessment,
- provide additional information to inform pharmacoepidemiologic research on:

ISBN 978-80-561-1102-4

- Adverse events, especially non-serious events, their severity or their impact on patients' lives,
- previously unassessed factors including patient-reported outcomes such as functionality, quality of life, pain or depression scales, as well as more accurate and precise information on timing and severity,
- additional covariates (potential confounders and effect modifiers) which may not be present in EHRs, such as weight, smoking, alcohol consumption, as well as physical activity, sleep, mobility, location, diet and biochemistry (e.g., home-based blood glucose measurements) [11].

Safety and Fall Prevention

Falls are a leading cause of injury and loss of independence among seniors, making safety a top priority in elderly care. Smart homes integrate a range of safety features and fall prevention measures to mitigate risks and enhance home safety for elderly individuals. Motion sensors, smart lighting, and automated alert systems can detect falls or accidents and notify caregivers or emergency services promptly. Smart home modifications, such as grab bars, ramps, and non-slip flooring, further reduce fall risks and improve accessibility for seniors.

Audio-based methods for the detection of elderly falls involve utilizing sound or audio signals to identify fall events. These methods rely on analyzing audio patterns associated with falls, such as impact sounds or changes in ambient noise. Integration of Radio-Frequency Identification (RFID) technology, IoT, and Artificial Intelligence (AI) has opened new horizons in the realm of detecting elderly falls. This innovative approach leverages RFID-enabled sensors to discreetly monitor movements and enable real-time fall detection, addressing privacy concerns and advancing the accuracy of detection. RFID technology, known for its ability to wirelessly identify and track objects using radio waves, is applied to fall detection by embedding RFID tags in wearable devices or strategic locations within living spaces. These tags communicate with RFID readers, detecting abrupt changes in position or movements that could signal a fall event. The integration of IoT facilitates seamless data transmission from these RFID sensors to centralized systems, enabling caregivers or medical professionals to receive instant alerts and respond swiftly to fall incidents. One of the primary advantages of RFID and IoT integration lies in their unobtrusive nature. Unlike camera-based solutions, RFID-enabled sensors operate without invading personal privacy, making them particularly suitable for sensitive environments such as homes or care facilities. Furthermore, this technology operates in real-time, reducing the response time to fall incidents and minimizing the potential consequences of delayed assistance.[12]

Social Connectivity and Engagement

Loneliness and social isolation are significant concerns among elderly individuals, impacting their mental health and well-being. Smart homes facilitate social connectivity and engagement through various communication and entertainment technologies. Video calling platforms, social media apps, and virtual reality experiences enable and educational content from the comfort of their homes.

ISBN 978-80-561-1102-4

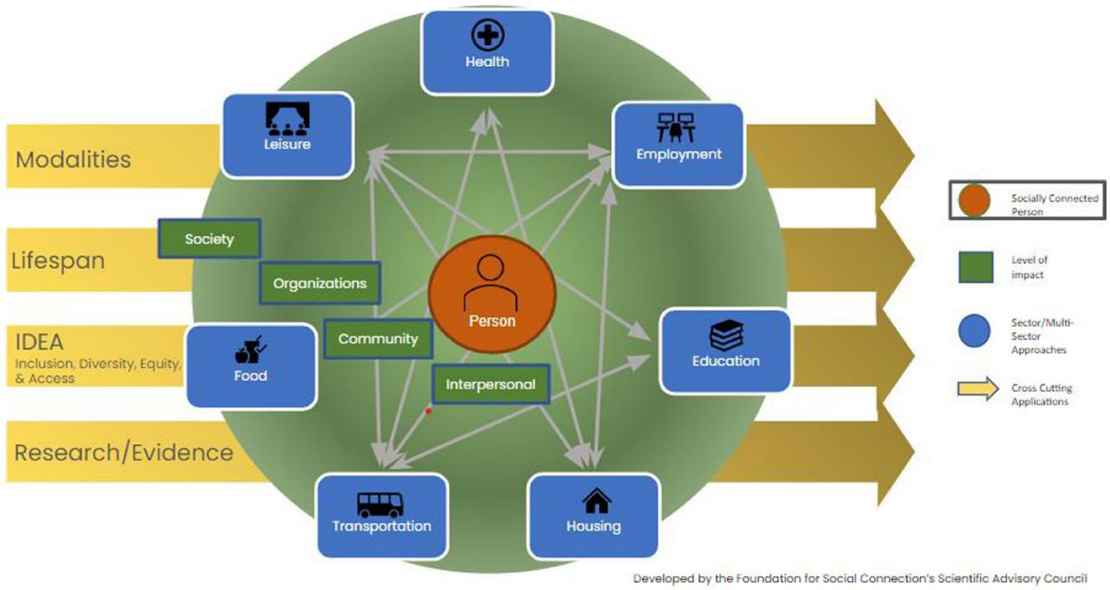

Figure 1. SOCIAL Connection Framework.[13]

Collective planning across organizations and sectors is often contingent on utilizing a common framework. Such frameworks can help organizations better understand the roles and offerings of other organizations within a community, identify leverage points for collaboration, duplicative services, and service gaps which require additional resources or partnership. An example of an inclusive framework is the Systems approach Of Cross-sector Integration and Action across the Lifespan (SOCIAL) Framework (see Figure 1), which was developed by the Foundation for Social Connection's Scientific Advisory Council (SAC) "to facilitate and accelerate multi-stakeholder actions to reduce social isolation and loneliness, increase social connectedness, and identify opportunities for impact and gaps for additional research and solutions"[14]

Care Coordination and Support

Smart homes serve as a central hub for care coordination and support, bringing together caregivers, healthcare professionals, and family members to collaborate in providing comprehensive care for elderly individuals. Digital care management platforms, electronic health records, and telehealth services streamline communication, facilitate information sharing, and enable remote consultations and care coordination. Smart home automation and voice- individuals.

There is a platform designed for a care coordination among such type of care community. The model is shown in the Figure 2.

ISBN 978-80-561-1102-4

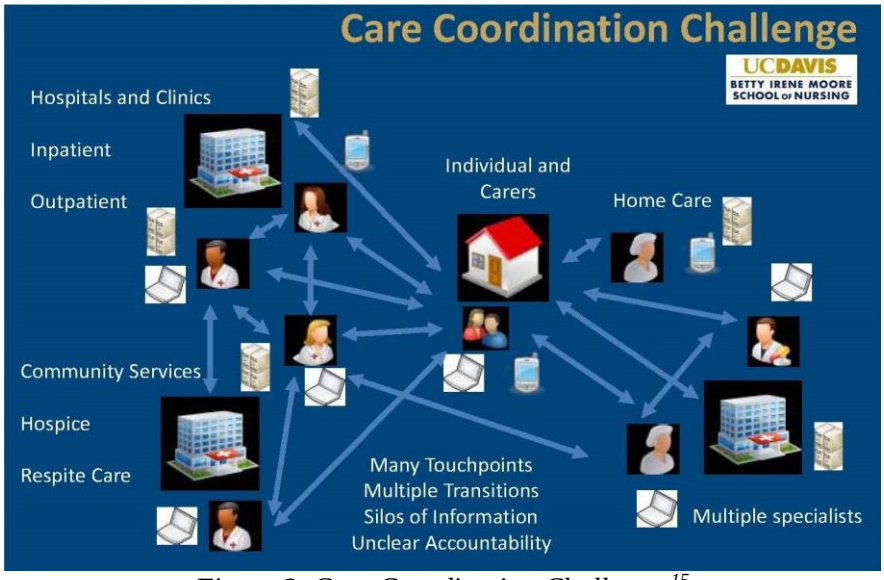

Figure 2. Care Coordination Challenge.[15]

Community-wide care coordination (CWCC) is a process that integrates care teams, patients, family members, caregivers, and community resources, wherever they might be, in order to provide the best possible patient care and experience. CWCC aims to improve healthcare by improving the experience of care, improving the health of populations, and reducing per capita costs of health care. CWCC recognizes how social, community and environmental determinants of health impact how individuals, neighbourhoods and communities thrive and share accountability for care coordination. Technology platforms to support CWCC are critical given the complexity of the task. CWCC must consider diverse user`s needs and digital literacy, a large number of health information sources, a wide variety of health information exchange and data sharing strategies, and conflicting cultural and political influences. People participating in CWCC need a technology platform that allows them to share information and data easily and securely, enables interoperability between diverse electronic medical records systems and monitoring devices, facilitates time-efficient and accurate use by the care team members (who are often spread across several facilities), and offers affordable access to patients, carers and families, even those for whom Internet is not readily available [16].

Privacy and Ethical Considerations

While smart homes offer numerous benefits for elderly care, privacy and ethical considerations must be carefully addressed. Respect for seniors' privacy rights, informed consent, data security measures, and transparent data practices are essential to ensure ethical deployment and use of smart home technologies in elderly care. Safeguarding sensitive health information and empowering seniors to control their data and privacy settings are paramount to building trust and fostering acceptance of smart home solutions.

Professionals underline that a multidisciplinary approach is needed, in which lawyers communicate with technologists to translate GDPR principles into the design of smart technologies. IoT companies are often not aware of their obligations in relation to vulnerable people and collaboration of technologists with lawyers is required to ensure GDPR compliant by design approaches. Within smaller organizations, data protection officer roles (necessitating extensive GDPR knowledge) are often exercised by chief technology officers, further proof how in practice technology and law are intertwined within the data protection field.[17] A brief schematic of GDPR compliance is shown in the Figure 3.

ISBN 978-80-561-1102-4

Figure 3. GDPR Compliance design.[18]

Senior & Family Lifestyle – System

There is a system architecture for the communication among seniors, family members, medical services etc. called Senior & Family Lifestyle System. The schematic model is shown in the Figure 4.

Figure 4. Senior & Family Lifestyle System.[19]

For decades, consumers have had access to remote controls and home control panels to run an "automated" home. Unfortunately, simply connecting an appliance or device to the web so it can be controlled by a smartphone, tablet or laptop is not creating a smart device. That internet connection is essentially just a long-range remote control. A smart device needs to be smart. That means it needs to be intelligent - it needs to be able to learn and/or take independent action. So what is a smart home system? In some ways, it is like a smart butler. When a family hires a butler, they don't need to teach him the basics of how a household works. It is the same for a smart home solution that includes integrated intelligence that can analyze data, learn from it and make decisions. First, a modern day smart home ecosystem is built around a system of sentrollers (sensors, actuators and controllers),

ISBN 978-80-561-1102-4

a hub or gateway that transmits the data to and from the internet, as well as cloud-based intelligence to analyze and assess the data. The smart home system can also hook into various social media platforms such as Twitter and Facebook. Finally, as someone needs to handle the responsibilities of installation, maintenance and billing, there needs to be service provider component that enables a customer service interface and a billing system. Smart home systems like ours consist of sensors connected to the cloud via a ZigBee home gateway which is then monitored and managed via smartphones, social media, service providers and cloud analytics and intelligence. Using a network more small sensors in the home, this system is able to securely monitor what is going on in the house - who is moving around, when and where. It then learns what normal behavior is. The data gathered from the sensors and transmitted to the cloud application via a home gateway is then analyzed and compared to the established baseline. When compared to a standard range of deviation, the system then judges if the resident's activities fall within the range of normal. If not, the system alerts a caregiver or family member to take action. The beauty of this system is that it does not require cameras or microphones, so it is not an infringement on privacy. The system is also smart enough to recognize gradual changes over a longer period in time that indicate a possible medical problem is developing. Another advantage of this type of system is that the home gateway can be expanded into new applications such as security, lighting, home climate control, and power and energy management. A clever manufacturer can design products and devices that can link into this existing platform without having to spend excessive cycles on developing connectivity solutions, user interfaces, billing, etc. A smart home system is more than just a single connected device and its app. Manufacturers need to look at the big picture and see where they fit in within the ecosystem. There are many advantages to this system-level product design approach - developers do not need to be experts at all aspects of the solution. By understanding the smart home platform, they can develop solutions that fit into an already-in-place, successful solution. This enables those developers to do what they do best - develop devices and appliances that consumers actually want and need. All IoT Agenda network contributors are responsible for the content and accuracy of their posts. Opinions are of the writers and do not necessarily convey the thoughts of IoT Agenda.[20]

Research

Overall, a smart home is a complete system that is expected to bring healthcare, safety and well-being services to the user's doorstep with the aid of modern technologies such as environmental and medical sensors, actuators, high performance computing processors, and wireless commination platforms. The system exploits the concept of Internet-of-Things and connects all sensors and systems of the home to facilitate remote surveillance of the occupants' health as well as the environment, safety and security of the home. Although several standalone systems such as vital sign monitoring, emergency call and reminding systems are available, a fully-fledged smart home is still far from the reality. Therefore, more research and development is required in this sector to develop a fully-functional smart home while ensuring system reliability, privacy and data security, robustness of processing and prediction algorithms, seamless connectivity with minimal transmission delay, energy-efficiency and low setup and maintenance cost.[21]

As the senior population continues to grow, so does the cost of caring for them. The current shortage of caregivers, coupled with the increasing number of seniors choosing to age in their own homes, has put a strain on healthcare resources. As a result, many providers are turning to technological solutions like artificial intelligence.[22]

ISBN 978-80-561-1102-4

Figure 5. AI robot accompanying senior.[23]

Since the explosive launch of ChatGPT from Microsoft-backed OpenAI in November 2022, the number of applications to which generative AI has been put has expanded exponentially, with critics arguing that the adoption and use-cases have gone too far, too fast, given the lack of an objective source of truth and in most cases, no public scrutiny of the training data for leading large language model versions of generative AI.[24]

Grade of AI integration into the elderly care in frame of smart homes

Smart home technology provides benefits for the elderly in six primary categories: safety, health and nutrition, physical activity, personal hygiene and care, social engagement, and leisure. Safety is about detecting and mitigating, if not removing, hazards from the user's environment.[25]

Implementation of modern IT technologies in the senior care and therapies

Digital healthcare platforms (DHPs) represent a relatively new phenomenon that could provide a valuable complement to physical primary care – for example, by reducing costs, improving access to healthcare, and allowing patient monitoring. However, such platforms are mainly used today by the younger generations, which creates a "digital divide" between the younger and the elderly.[26] First-generation systems include personal alarm systems and emergency response telephones. These systems generate alarms with the intervention of the patient who can press a wireless pendant alarm worn around the neck or wrist and connect with a control centre.[27]

AAL

As one of several alternatives home healthcare is using the Internet of Things – referred as **ambient assisted living (AAL)** – is drawing much attention. Although the individual technologies of healthcare and smart home have undergone rapid development, there has been little integration between the two.[28]AAL uses artificial intelligence to process the information gathered from several types of communication (e.g., wireless sensor networks, wireless ad hoc networks, wireless mesh networks) over any type of communication technologies (e.g., device-to-device, machine-to-machine, sensor-actuator), know what is happening in the network, and detect if elderly people need assistance.[29]An AAL platform consisting of a Personal Health System with Sensors that provides Information to Services over the Internet as shown in the Figure G

ISBN 978-80-561-1102-4

Figure 6. AAL platform schematics.[30]

Honor is a platform that provides high-quality home care for seniors, and it has partnered with Philips to offer smart home devices that monitor and improve the safety and well-being of seniors [31].

There are two types of comprehensive smart home systems on the market.

Closed system - Such solutions, also known as proprietary, often offer a particularly high level of security. In addition, their components are perfectly coordinated with each other, so there are little or no connection problems. However, buyers of such a system are always limited to their manufacturer and cannot integrate smart home devices that their own manufacturer does not offer.

Open system- As the name suggests, open smart home systems can be put together from devices from completely different brands. For example, the Innogy Smart Home system can be used together with lamps from Signify (Philips Hue) or Netatmo room thermostats, among others. Amazon's voice software Alexa currently offers the most flexibility. The Alexa app not only allows to use Amazon's own tablets, speakers or streaming services (e.g. Amazon Prime), but also hundreds of products from other manufacturers. The selection ranges from Alexa coffee machines to vacuum robots like we show in our vacuum robot test, irrigation systems for the garden, lamps, thermostats and televisions to Alexa adapters for the car.[32]
For a better overview, we have summarized all the important features of the three popular voice assistants in the following table.

Table 1. Comparing of smart home systems functions.[33]

	Alexa	**Google Assistant**	**Siri (via HomeKit)**
Standard functions (alarm clock, knowledge query, etc.)	Direct use	Direct use	Direct use
Central unit required for smart home control	Yes, e.g.Echo Show 10 with integrated ZigBee hub	yes, e.g.a Google Nest Hub 2	Yes, e.g.a HomePod or Apple TV
IFTTT connection	Yes	Yes	Yes, via Homebridge
Radio standard	WiFi, ZigBee	WLAN, Bluetooth, Thread	WLAN, Bluetooth, Thread

ISBN 978-80-561-1102-4

Areas of application	Household appliance automation, garden irrigation, lighting and heating control, entertainment and much more.	Heating/room climate, entertainment, gadgets	Home automation, entertainment, gadgets
Biggest advantage	Very large selection of Amazon's own Echo speakers with Alexa integration and compatible third-party products	Offers a very wide range of knowledge	Particularly secure thanks to strict certification guidelines for compatible devices
Biggest disadvantage	Sometimes fails when it comes to knowledge questions	In some device categories there is (still) not enough selection of comp. products	The least selection of networkable products to date and cannot be controlled with Android devices

Early detection of health problems and fast and efficient reaction of medical staff

The development of new and innovate technologies in modern day life and their ability to enhance our daily activities has lead researches to focus on their use within clinical domains. The improvement of healthcare systems is gaining significant focus from both researchers and industry alike, by providing more convenient and automated healthcare products.[34]

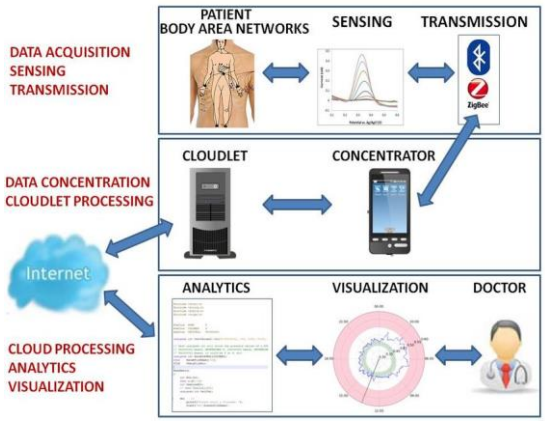

Figure 7. Components of a remote patient monitoring system that is based on an IoT-Cloud architecture [35].

Internet of Things (IoT) is the association of substantial objects where information and communication tools connect various embedded devices to the internet for gathering and switching over data. The combinations of embedded devices with cloud servers recommend extensive pertinence of IoT to several areas of human life. In combination with the implementation of various inbuilt capabilities, internet-enabled heterogeneous wearable sensors can be used for the collection of biomedical data to transmit patient data directly to cloud severe systems to monitor health remotely [36].

Communication with relatives, family, medical and social care staff

Communication technologies have the potential to increase older adults' self-efficacy and their social contact with friends and family.[37] The possibilities for using technology to meet the communication needs of an aging society are as broad as the communication needs of individual older adults. The ability to communicate is essential if older adults are to solicit assistance with daily living activities; fulfill lifelong learning goals; gain access to health and legal information from print, broadcast,

ISBN 978-80-561-1102-4

or electronic media; or enjoy intergenerational contacts with family members. Older adults need to communicate with their families, friends, neighbors, and with their lawyers and physicians through face-to-face interaction and over the Internet.[38]

Figure 8. Enhancing patient care with mobile clinical communication technology .[39].

Application of IT technologies to simulate natural environment

Paintings and wallpapers, sculptures or collages can make the environment more pleasant. In old age, when a human is not as active as in mature age, it is better if the surroundings abound with a certain dynamism. The most common means of a dynamic environment is a television. Instead of a regular TV program, nature can be played on the screen to make the atmosphere more pleasant, for example a stream with the sound of a flowing stream, birds singing, etc. However, the television itself as an electronic device is distracting for more sensitive people, who the seniors are. Another option are the video projectors, which are increasingly used nowadays, and are commonly available on the market. However, their disadvantage is the relatively high noise level of the fan in a quiet environment. In any case, in connection with artificial intelligence, which is able, on the basis of learned and entered data, to effectively choose the environment and backdrop to ensure a calm or even therapeutic atmosphere for a person or even a group of people in a room.

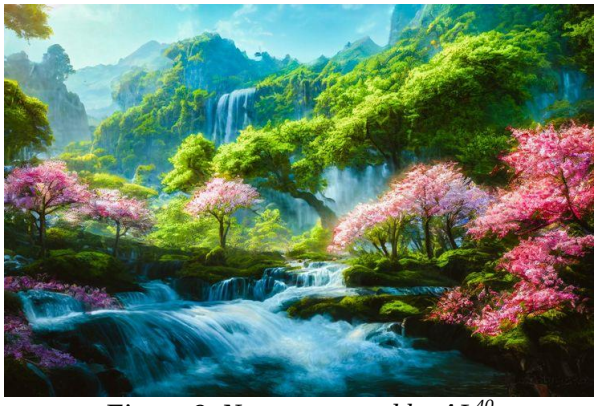

Figure 9. Nature created by AI.[40]

According AV Alliance, with immersive technology you can deliver a unique experience that creates the illusion of blending our physical world with virtual reality without using green screen. Many associate immersive strictly with virtual environments, VR gadgets, AR, and technologies that are expanding the limits of what we as humans are able to perceive through our senses. However, not all immersive experiences quite simple to describe. They have the ability to evoke feelings, transport you to a different time and space, to absorb your environment on a much more engaged level, and lose yourself in the moment. With immersive technologies, what you see, hear, and experience is exactly what you get, and more. Whether it is 360° projection mapping, highly advanced LED technology,

ISBN 978-80-561-1102-4

mixed reality content fed through media servers onto massive surfaces, a lighting extravaganza, or surround sound that tricks the mind and leaves goosebumps in its wake – immersive is an art form that has its rightful place from the biggest event venues, exhibition halls, and galleries to churches, parks, and even the streets, or even the middle of the desert.[41]

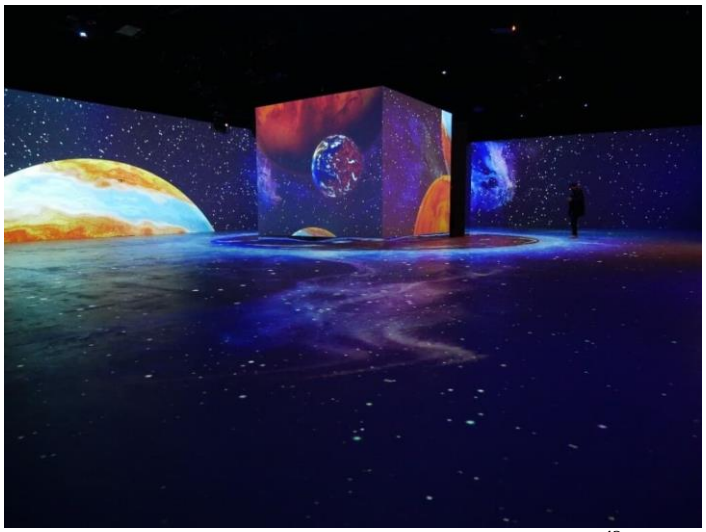

Figure 10. Immersive experience in a room.[42]

Such technology should have a high advantage and possibilities in the frame of elderly care or therapies using the proper software and designing by specialists from medicine, IT and social care areas.

Social view

Dr. Machalová, M. in her study *Inappropriate ways of social communication with the elderly* writes: **„***The development of the personality of seniors is supported by conditions that are favourable for their social relations and communication. It means that they are allowed to spontaneously express their personality in the circle of considerate relatives and other people. Optimum freedom and optimal opportunities for self-expression of seniors help them not to lose sensitivity to themselves and others. At the same time, this will support the physical, mental and social motility (mobility, liveliness) of seniors, which is noticeable in their physical mobility, lively non-verbal communication and verbal communication*.[43]”

Horvátová I., who is a social worker in a day care center, has many years of experience in caring for seniors with dementia, and has focused on the impact of various therapies on seniors with various types of disabilities. Her conclusions documented in her diploma thesis, are: "*During the work, the great importance of comprehensively processed case studies and goal setting became apparent. The day care center is a suitable space for the use of elements of therapies that help with the stability and development of the recipient's condition. The most appropriate way of demonstrating the need and importance of social work is the visible progress of the client's psychological, physical and mental state. We suggest that snoezelen therapy, which has proven itself in other facilities as an effective therapy for clients with Alzheimer's disease, is also introduced in the given day care facility. Within the potential capacity and personnel options, we recommend introducing animotherapy and dramatotherapy into the therapeutic program of the inpatient facility and ensuring the technical means for their implementation*." As a social worker, she perceives great importance in the introduction of technical means, not only in the area of smart homes, but also in the use of modern technologies to improve the therapies themselves. In her work, she deals with therapies such as cognitive therapy, art therapy, bibliotherapy, music therapy, play therapy, reminiscence therapy and validation. All these types of therapies can be improved and enriched by properly chosen technology

ISBN 978-80-561-1102-4

based on AI or similar platforms and the desired results of improving the quality of life of these seniors will be at a very high level, ultimately.

Discussion

The exploration of smart home technology in elderly care sheds light on various dimensions of this rapidly evolving field. One prominent theme is the potential of smart homes to enhance safety and fall prevention for seniors. By integrating motion sensors, smart lighting, and automated alert systems, smart homes can detect falls or accidents and promptly notify caregivers or emergency services. This proactive approach to safety not only mitigates risks but also fosters independence and peace of mind for seniors and their families. Moreover, the discussion extends to the role of modern IT technologies in senior care and therapies. Digital healthcare platforms and remote patient monitoring systems offer valuable tools for improving access to healthcare, reducing costs, and enabling proactive health management. However, there exists a digital divide between younger and elderly populations, highlighting the importance of bridging this gap through user-friendly interfaces and tailored interventions.

The integration of artificial intelligence (AI) emerges as a key enabler of smart home technology in elderly care. AI-powered systems can analyze data from various sensors to detect anomalies, predict health issues, and personalize care plans for seniors. From early detection of health problems to efficient communication with caregivers and medical staff, AI holds the promise of revolutionizing elderly care by enabling proactive interventions and personalized support. Additionally, the texts underscore the significance of social connectivity and engagement in promoting the well-being of seniors. Smart homes facilitate communication with family members, friends, and healthcare providers through video calling platforms and social media apps. Moreover, immersive technologies such as virtual reality offer opportunities for seniors to engage in therapeutic experiences and maintain cognitive function.

However, alongside the potential benefits, ethical considerations and privacy concerns associated with smart home technology must be carefully addressed. Respect for seniors' privacy rights, informed consent, and transparent data practices are essential to build trust and acceptance of these technologies. Furthermore, interdisciplinary collaboration between healthcare professionals, technologists, and social workers is crucial to ensure that smart home solutions are inclusive, culturally sensitive, and aligned with the diverse needs of aging populations.

In conclusion, the discussion highlights the transformative potential of smart home technology in elderly care, offering opportunities to enhance safety, health monitoring, social connectivity, and quality of life for seniors. By navigating ethical challenges, bridging the digital divide, and fostering interdisciplinary collaboration, we can harness the full potential of technology to create a more supportive and empowering environment for aging populations.

Conclusion

For the effective implementation of computer technologies and the use of their intelligence, mutual communication with experts in the field of computer technology, ergonomics, social work, healthcare, etc. is necessary. There is a lot of space for the cooperation of scientific teams from different directions, especially for technical, natural and social ones. The result of such cooperation provides solutions that are requested by society and implemented in social life for the high efficiency of solving one or a whole range of problems, and thanks to the integration of issues from ergonomics and design, they have a great impact on emotional acceptance by humans and comfortable mutual human-machine communication.

From a technician's point of view, the development of technology over the past decades increased. In the 80`s, devices were more or less composed of individual parts into a functional block. In the 1990s, with coming of first sofisticated computers, the way of thinking and the view of technology was changed by the fact that using of software first compact architectures, it was possible to equipa device with thinking for the performance of certain algorithms or actions. After then, devices began to be mounted by functional blocks, where, in addition to individual components, there was easy access to ready-made modules, and thus the construction of devices became easier and faster. Nowadays, we

ISBN 978-80-561-1102-4

have already reached the stage where technology based on AI is able to understand the problem itself and suggest the proper technics and procedures. It can integrate other devices and multiply itself, as well as its thinking and perception of its surroundings. Such a level of maturity already allows us to change the current procedures in the daily activities in the home of seniors and their care in an exceptional way, both with properly designed technology implemented in the home building, but also in social care and, in the case of seniors with the necessary therapeutic care, in the therapies themselves.

The aim of the study is also to point out the need for interdisciplinary cooperation in the academic sphere, as a thematic structure of student theses, seminars, diploma and dissertation theses etc.. Such way would be the students lead to cooperation with other fields, which gives their work higher social and scientific value with better application in practice.

References

[1] CINTULOVÁ, Lucia. Starostlivosť o seniorov-potreba interdisciplinárnej a medzisektorovej spolupráce. *Interdisciplinárna kooperácia v ošetrovateľstve, pôrodnej asistencii a sociálnej práci*, 2010, 16.

[2]WILLIAMS, Judith; LYONS, Barbara; ROWLAND, Diane. Unmet long-term care needs of elderly people in the community; A review of the literature. *Home health care services quarterly*, 1997, 16.1-2: 93-119. ISSN: 1545-0856. https://doi.org/10.1300/J027v16n01_07

[3]HENCELOVÁ, Veronika; CINTULOVÁ, Lucia. STAROSTLIVOSŤ O SENIOROV A INTERDISCIPLINÁRNY PRÍSTUP. *Interdisciplinárna kooperácia v ošetrovateľstve, pôrodnej asistencii a sociálnej práci*, 2010, 55.

[4]HORVÁTHOVÁ, Iveta. 2020. *Vplyv terapeutických činností na život seniorov s demenciou a Alzheimerovou chorobou navštevujúcich denný stacionár.* [diploma thesis]. Bratislava: Vysoká škola zdravotníctva a sociálnej práce sv. Alžbety Bratislava, 2020. 88 ps.

[5]MAJUMDER, Sumit, et al. Smart homes for elderly healthcare—Recent advances and research challenges. *Sensors*, 2017, 17.11: 2496. https://doi.org/10.3390/s17112496

[6]NI, Qin; GARCIA HERNANDO, Ana Belen; DE LA CRUZ, Iván Pau. The elderly's independent living in smart homes: A characterization of activities and sensing infrastructure survey to facilitate services development. *Sensors*, 2015, 15.5: 11312-11362. https://doi.org/10.3390/s150511312

[7]GHOSH, Ananda Mohon; HALDER, Debashish; HOSSAIN, SK Alamgir. Remote health monitoring system through IoT. In: *2016 5th International Conference on Informatics, Electronics and Vision (ICIEV)*. IEEE, 2016. p. 921-926. https://doi.org/10.1109/ICIEV.2016.7760135

[8]EPAM. Ranghanathan, D. et al. 2020. Your Patients, Their Data: Why Patient-Generated Health Data Is Critical for the Future of Healthcare. Available online: https://www.epam.com/insights/blogs/patient-generated-heath-data-is-critical-for-the-future-of-healthcare

[9]SHAPIRO, Michael, et al. Patient-generated health data. *RTI International, April*, 2012, 813: 814. ISSN 2378-7996

[10]ABDOLKHANI, Robab, et al. Patient-generated health data management and quality challenges in remote patient monitoring. *JAMIA open*, 2019, 2.4: 471-478. ISSN 2574-2531. https://doi.org/10.1093/jamiaopen/ooz036

[11]EUPATI. Data sources for pharmacoepidemiological research. Available online: https://learning.eupati.eu/mod/book/view.php?id=670&chapterid=567

[12]ALHARBI, Hatem A.; ALHARBI, Khulud K.; HASSAN, Ch Anwar Ul. Enhancing Elderly Fall Detection through IoT-Enabled Smart Flooring and AI for Independent Living Sustainability. *Sustainability*, 2023, 15.22: 15695. ISSN: 2071-1050. https://doi.org/10.3390/su152215695

ISBN 978-80-561-1102-4

[13]FRONTIERSIN.SOCIAL Connection Framework. Available online: https://www.frontiersin.org/files/Articles/1176895/fpubh-11-1176895-HTML/image_m/fpubh-11-1176895-g001.jpg
[14]FRONTIERSIN. Societal- and community-level strategies to improve social connectedness among older adults. Available online: https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2023.1176895/full
[15]HCLDR. Care Coordination Challenge. Available online: https://hcldr.files.wordpress.com/2014/10/care-coordination-challenge.jpg
[16]HCLDR. Platforms for Community-Wide Care Coordination. Available online: https://hcldr.wordpress.com/2014/10/25/community-wide-care-coordination/
[17]PIASECKI, Stanislaw. Expert perspectives on GDPR compliance in the context of smart homes and vulnerable persons. *Information & Communications Technology Law*, 2023, 32.3: 385-417. https://doi.org/10.1080/13600834.2023.2231326
[18]PAULVANDERLAKEN. GDPR Compliance design. Available online: https://paulvanderlaken.com/2018/11/12/privacy-compliance-ethical-issues-predictive-people-analytics/
[19]Senior & Family Lifestyle System. Available online: https://cdn.ttgtmedia.com/ITKE/uploads/blogs.dir/284/files/2016/10/Senior-and-Family-Lifestyle-System-Qorvo.jpg
[20]TECHNTARGET. Making a smart home system smart: Why connectivity is not enough. Available online: https://www.techtarget.com/iotagenda/blog/IoT-Agenda/Making-a-smart-home-system-smart-Why-connectivity-is-not-enough
[21]MAJUMDER, Sumit, et al. Smart homes for elderly healthcare—Recent advances and research challenges. *Sensors*, 2017, 17.11: 2496. https://doi.org/10.3390/s17112496
[22]SafeGuard. Available online: https://www.vigilife.com/enhancing-senior-care-with-artificial-intelligence
[23]AdaStock. Available online: https://stock.adobe.com/cz/images/elderly-care-robot-in-the-intelligent-hospital-concept-artificial-intelligence-consultancy-services-and-health-care-with-future-robots-generative-ai/574898504
[24]T_HQ. Available online: https://techhq.com/2023/05/generative-ai-in-social-care/
[25]KON, Bethany; LAM, Alex; CHAN, Jonathan. Evolution of smart homes for the elderly. In: *Proceedings of the 26th International Conference on World Wide Web Companion*. 2017. p. 1095-1101. https://doi.org/10.1145/3041021.3054928
[26]FRISHAMMAR, Johan, et al. Digital health platforms for the elderly? Key adoption and usage barriers and ways to address them. *Technological Forecasting and Social Change*, 2023, 189: 122319. https://doi.org/10.1016/j.techfore.2023.122319
[27]D'ULIZIA, Arianna, et al. Smart homes to support elderly people: innovative technologies and social impacts. In: *Pervasive and Smart Technologies for Healthcare: Ubiquitous Methodologies and Tools*. IGI Global, 2010. p. 25-38.ISBN-13: 978-1615207657. https://doi.org/10.4018/978-1-61520-765-7.ch002
[28]CHOI, Donghyeog; CHOI, Hyunchul; SHON, Donghwa. Future changes to smart home based on AAL healthcare service. *Journal of Asian Architecture and Building Engineering*, 2019, 18.3: 190-199. ISSN 1347-2852. https://doi.org/10.1080/13467581.2019.1617718
[29]LLORET, Jaime, et al. A smart communication architecture for ambient assisted living. *IEEE Communications Magazine*, 2015, 53.1: 26-33. ISSN: 0163-6804. https://doi.org/10.1109/MCOM.2015.7010512
[30]ResearchGate. Available online:https://www.researchgate.net/figure/An-AAL-platform-consisting-of-a-Personal-Health-System-with-Sensors-that-provides_fig6_257835746
[31]Faster Capital. Available online: https://fastercapital.com/topics/how-elder-care-platform-is-revolutionizing-elder-care-and-what-to-expect-next.html
[32]HOMEANDSMART. Available online: https://www.homeandsmart.de/ambient-assisted-living-aal
[33]Home and Smart. Available online: https://www.homeandsmart.de/smart-home-systeme-vergleich

ISBN 978-80-561-1102-4

[34]AL-KHAFAJIY, Mohammed, et al. Remote health monitoring of elderly through wearable sensors. Multimedia Tools and Applications, 2019, 78.17: 24681-24706. https://doi.org/10.1007/s11042-018-7134-7

[35]RESEARCHGATE. Components of a remote patient monitoring system that is based on an IoT-Cloud architecture. Available online: https://www.researchgate.net/profile/Tolga-Soyata/publication/280924370/figure/fig1/AS:391610190843910@1470378553530/Components-of-a-remote-patient-monitoring-system-that-is-based-on-an-IoT-Cloud.png

[36]LAKSHMI, G. Jaya; GHONGE, Mangesh; OBAID, Ahmed J. Cloud based IoT smart healthcare system for remote patient monitoring. *EAI Endorsed Transactions on Pervasive Health and Technology*, 2021, 7. Jg., Nr. 28, S. e4-e4. Available online: https://publications.eai.eu/index.php/phat/article/view/1204. https://doi.org/10.4108/eai.15-7-2021.170296

[37]JUDGES, Rebecca A., et al. "InTouch" with seniors: Exploring adoption of a simplified interface for social communication and related socioemotional outcomes. *Computers in Human Behavior*, 2017, 75: 912-921. ISSN: 0747-5632. https://doi.org/10.1016/j.chb.2017.07.004

[38]KEMPER, Susan; LACAL, Jose C. Addressing the communication needs of an aging society. In: Technology for adaptive aging. National Academies Press (US), 2004. ISBN-10: 0-309-09116-0

[39]MEDCITYNEWS. Enhancing patient care with mobile clinical communication technologies. Available online: https://medcitynews.com/2022/03/enhancing-patient-care-with-mobile-clinical-communication-technologies/#

[40]Pinterest. Ai Created Most Beautifull Nature. Available online: https://sk.pinterest.com/pin/beautiful-nature--1100567227677290381/

[41]AVALLIANCE. Available online: https://avalliance.com/stunning-immersive-experiences-from-projection-mapping-to-audio-and-lighting/

[42]BLOOLOOP. Top 4 things to consider when creating an immersive experience. Available online: https://blooloop.com/technology/opinion/creating-an-immersive-experience/

[43]MACHALOVÁ, M. 2015. Nevhodné spôsoby sociálnej komunikácie so seniormi. Prohuman. ISSN 1338-1415