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Zero UI to Help the Elderly

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PREFACE

I started thinking of my master's thesis in the fall of 2022 and wanted to do something using the latest trending technology. Then, I was introduced to my thesis advisor, Professor Aarne Klemetti, who allowed me to work on an ongoing project at Metropolia University of Applied Sciences, which concluded to be my master's thesis topic.

I learned that things can be simplified by making them into small multiple tasks that are doable and going step-by-step. There is a saying, 'You can't eat an elephant in one bite'; you need to have one bite at a time; the same applies to this task of a Master's thesis. I started writing in the summer vacation of 2023 once my practical part was ready, as there was no clear picture at the beginning. It took almost nine months for this thesis to be completed.

I would like to express my gratitude to my thesis advisor for his valuable time and mentorship. I am grateful to Kari Backman, CEO of Benete, for sharing his ideas, which led to the real-world practical part of the study. I am also grateful to Professor Ville Jääskeläinen for his support and guidance. I would like to say special thanks to my husband for his moral support so I can focus on my studies.

I am presenting my master's thesis, hoping it can be researched further and contribute to society.

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Abstract

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With aging, it is common for a person to prefer living an independent life. However, aging often comes with physical limitations and health issues. Activities of daily life (ADLs) become challenging for older adults. Sometimes, daily rituals are not performed due to a lack of motivation or memory issues, which can affect their health. They need to maintain a daily rhythm for their well-being. This study aims to find possible solutions to motivate and remind elderly persons living alone at home about their ADLs in possible and indirect ways. Due to the COVID pandemic, Zero UI technology is in trend, and this study aims to use this technology to solve the problem.

The study was conducted as a part of the HIPPA-Remote project carried out at Metropolia University of Applied Sciences. The HIPPA-Remote project provides services for product developers to support housing for the elderly and focuses on the development of digital services to improve the well-being and housing of the elderly.

The outcome of the study is some solutions and a proof-of-concept. This proof-of-concept has the potential to be developed further for business applications.

Keywords: Activities of daily life, motivate elderly, remind elderly, zero UI, Generative Pre-trained Transformer

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List of Abbreviations

ADL	Activities of Daily Life
SDR	Software Defined Radio
HRV	Heart rate variability
LSTM	Long Short-Term Memory

1 Introduction

Population aging is an irreversible trend. Due to advancements in the health sector and living standards, life expectancy has increased, resulting in an increasing number of aged people. The number of people aged 65 and older hit about 761 million as of 2021, and that figure is expected to more than double by 2050 to 1.6 billion, according to the UN's "World Social Report 2023" [1]. This substantial increase in the elderly population has significant implications for various aspects of society, including healthcare, social security systems, labor markets, and family structures. Governments and policymakers face the challenge of ensuring older adults' well-being and quality of life while promoting intergenerational equity and sustainable development.

Like any other developed country, Finland is also experiencing a rise in the aging population. The share of over-65-year-olds of the population will increase from the current 22 percent to 26 percent by 2030 and 29 percent by 2060 [2]. A rise in the age of first-time mothers, a decline in the birth rate, and an increase in life expectancy are factors that contribute to the rapidly aging Finnish population. The number of working-age people is reduced compared to aged people, which means there are insufficient employees for older care and services. Figure 1 shows the Finnish population according to age and year.

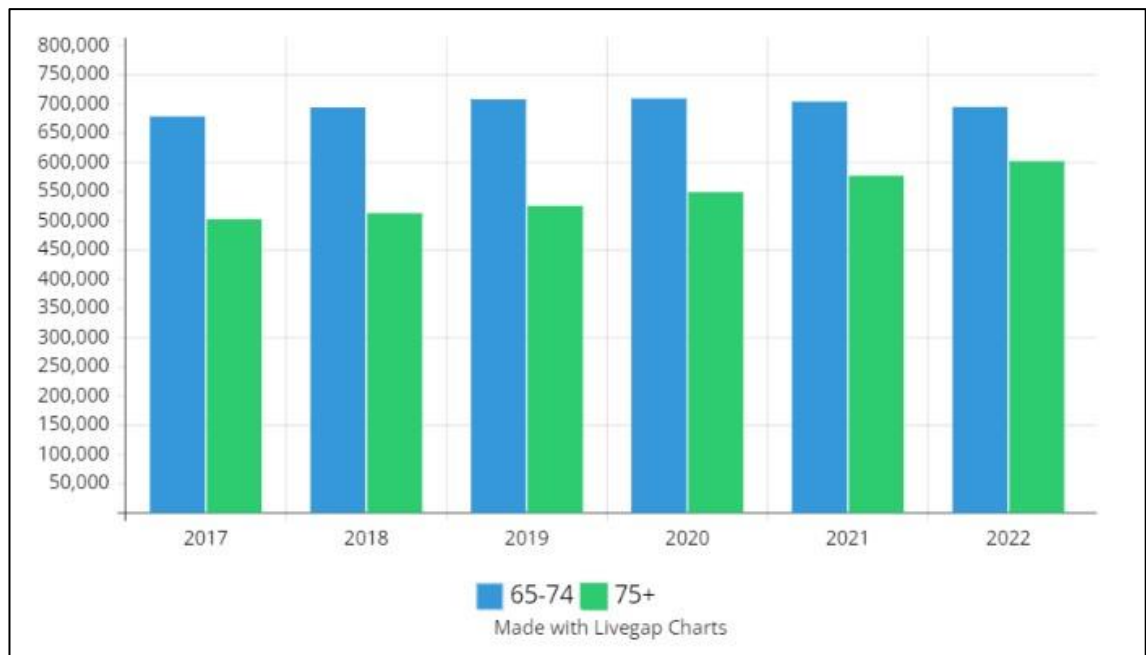


Figure 1 Finland population according to age and year [Statistics Finland's free-of-charge statistical databases]

The recent technology policy report by the Technology Advisory Board (2021) highlights the significant role of technology in addressing the challenge posed by the aging population [22]. Governmental strategies and programs have emphasized the urgent need to leverage new technologies, data, artificial intelligence (AI), and the digitalization of services to tackle this challenge effectively. These technologies offer promising solutions such as disease prevention, supporting aging at home for as long as possible, and enhancing the efficiency of early-phase care.

This study aims to support aging at home using one such recent technology.

1.1 Background

The biggest challenge of the aging population is to maintain their health. Aging often comes with problems related to physical and mental health, such as heart disease, muscle weakness, dementia, hearing loss, and many more. Each year, Finland sees over 14,500 new cases of diagnosed dementing disorders, significantly impacting individuals. Significant life changes such as retirement and

the loss of loved ones also have a massive impact on the health of elderly individuals. So, the top priority is to maintain the health of the elderly population. Figure 2 depicts some of the elderly health problems.



Figure 2 Aging problems [24]

ADLs (Activities of Daily Life) are the first step towards a healthy life. The primary activities of the day, like eating, bathing, dressing, toileting, preparing a meal, and mobility, are termed ADLs. These activities measure the functional status of an elderly person and have a positive impact on their quality of life. Changes in ADLs can be a sign of underlying medical conditions. Not detecting these changes at the right time can lead to significant health problems. Often, as people age, they lose motivation to engage in ADLs. “As we age, it’s harder to have a get-up-and-go attitude toward things,” says Ann Graybiel, an Institute Professor at MIT and member of the McGovern Institute for Brain Research [3]. An individual with dementia often needs help with ADLs as they lose the ability to perform it due to memory loss, confusion, and impaired thinking. Figure 3 is an illustration of Activities of Daily Life (ADLs).

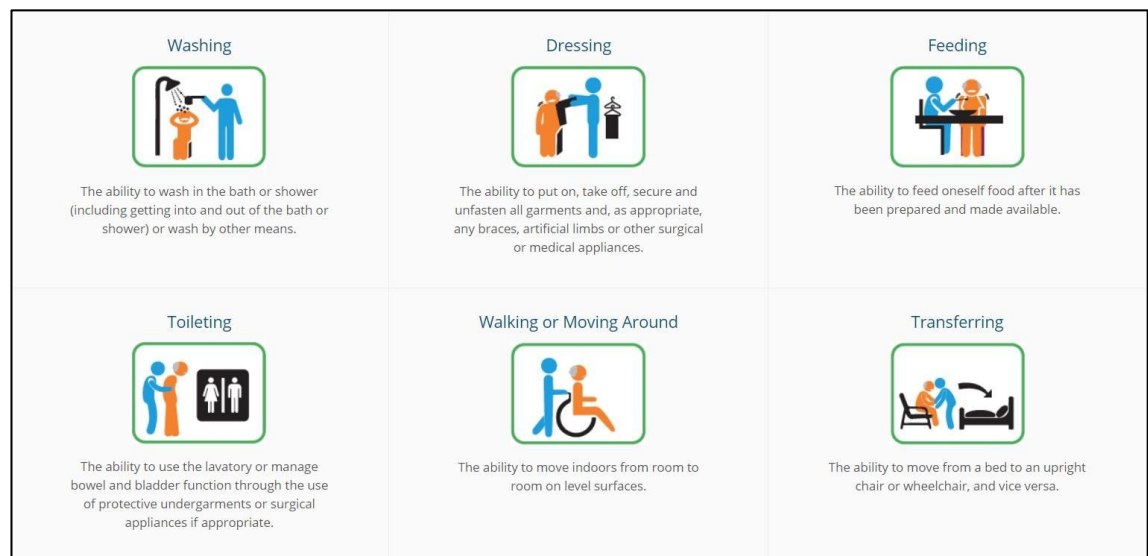


Figure 3 Activities of Daily Life (ADLs) (source: www.moh.gov.sg)

The elderly may face challenges regarding technology due to factors such as limited familiarity, physical limitations, and cognitive changes associated with aging. Issues such as small font sizes, complex navigation, and unfamiliar terminology can make technology use more difficult for them. Due to the pandemic in the last few years, the 'Zero UI' or interface-less technology can significantly benefit the elderly by eliminating the need for complex user interfaces and relying instead on intuitive gestures, voice commands, and automation. This approach simplifies the interaction with devices, making technology more accessible and user-friendly for seniors who may have difficulties navigating traditional interfaces, thus empowering them to effortlessly engage with the digital world and enjoy its numerous benefits. Amazon Alexa, Apple Siri, Google Home, and Nest thermostat are some examples of Zero UI that engage with users without needing a touchscreen. The idea is to get away from touching any screen and move towards artificial. People with physical disabilities can benefit from this technology.

This paper aims to help the elderly perform their ADLs by reminding and motivating them for ADLs. This paper uses Zero UI technology to remind and encourage ADLs.

1.2 Business Challenge and Research Questions

Currently, limited research is available on Zero-UI technology, as it is relatively new. Therefore, initially, it was challenging to envision potential solutions related to this study. As the target group of this study is elderly, and there can be many age-related impairments such as hearing or vision loss, memory issues, dementia, and so on, the business challenge of this thesis was to find ways to assist normal elderly or elderly with any type of age-related health issues in their ADLs using Zero UI technology. The other challenging part was identifying solutions that could enhance the capabilities and remind them about ADLs. Striking the right balance between gentle reminders and intrusive interventions is crucial.

At the start of the project, it was uncertain where this research would lead. There was scope for exploration and innovation. A commitment to addressing the needs of the elderly population navigated the direction of the project and potentially helped to discover new solutions that benefit the lives of individuals.

This study aims to answer the following research questions:

- How to support the elderly living alone at home?
- What kind of solutions can enhance the capabilities of the elderly?
- How can Zero UI technology challenge, motivate, or engage the elderly to perform their ADLs?

1.3 Thesis Structure

This thesis has been divided into six sections:

- The first section introduces the elderly population issues, elderly problems, research questions, and challenges.
- The second section explains the Zero UI technology concept and literature review of Zero UI technologies used in elderly care. This section also describes real-world scenarios and use cases for elderly care and discusses plans and thesis.
- The third section introduces the research approach, data collection methods, conducted experiments, tools, and environments used.
- The fourth section presents the outcomes of the study. It also lists recommendations for elderly care using Zero UI and proof-of-concept.
- The fifth section provides details about the implementation of proof-of-concept.
- The sixth section discusses future work, practical implications, and limitations of the study.

2 Theoretical Background

This study was carried out step by step, starting from understanding the Zero UI concept, a literature review around Zero UI technology, its solutions that can be helpful for elderly care and about elderly care and aging, and giving a thought on some real-world scenarios, meetings, and discussions. This section presents details regarding the theoretical study. This part of the thesis helped refine the broad research topic into specific research questions and produce meaningful outcomes.

2.1 Zero UI

The concept of interactive technology has evolved beyond touch screens to include touch-free interactions such as gestures, motion sensors, and hand interaction. This shift, accelerated by the COVID-19 pandemic, has given rise to Zero User Interface (UI) technology. Zero-UI technology is called touchless, contactless, interface-less, screenless, or invisible user interface. It enables users to interact with machines without traditional screen or button interfaces, offering convenience and hygiene benefits. Touchless solutions, including natural user interfaces (NUI), ambient computing, immersive computing, and non-physical interfaces, have gained recognition across various industries. Various back-to-work strategies emerged, leveraging IoT devices to adhere to new hygiene policies during the pandemic by minimizing touch interactions. Touchless interfaces have been widely adopted to mitigate contact with digital surfaces. At the very beginning of the pandemic, the touchless sensing market was projected to reach USD 15.3 billion in 2025, from USD 6.8 billion in 2020 at a CAGR (Compound annual growth rate) of 17.4%, while the gesture recognition market will grow from \$9.8 billion in 2020 to \$32.3 billion in 2025 [4]. Figure 4 shows examples of new contactless and touchless applications.



Figure 4 New Normal Contactless and Touchless Applications [25]

Andy Goodman introduced the zero UI concept. Formerly at Accenture Interactive's agency. In [20], Goodman says, "As we move away from screens, a lot of our interfaces will have to become more automatic, anticipatory, and predictive". Although Goodman is serious about the fact that screens are going to stop being the primary way we interact with the devices around us, he is the first to admit that the Zero UI name is not meant to be taken literally. "It's meant to be a provocation," Goodman admits. "There are always going to be user interfaces in some form or another, but this is about getting away from thinking about everything in terms of screens." [20]. In contrast to the traditional graphical user interface (GUI), which relies on on-screen interactions, Zero UI utilizes natural cues such as movement, ambient signals, gestures, and voice recognition to deliver information, minimizing screen and device engagement. For example, the Nest Thermostat collects data on a person's temperature preferences, schedule, and even details like how drafty the home is. So, if one typically leaves for work at the same time every day, it will automatically decrease the temperature in hopes of returning a lower utility bill [21].

Types of Zero UI enabling technologies and their range

Below is an overview of different types of technology or devices, their detection range, and the corresponding use cases:

- Infrared: With a detection range of up to 10 meters, it is commonly used indoors, in elevators, lavatories, and in health-related applications.
- NFC (Near Field Communication): This technology operates within a 10 cm range and is widely utilized for contactless payments.
- Personal Device: The detection range depends on the Wi-Fi range of the device. It is often employed for interacting with public screens and controlling smart home devices.
- Leap Motion: This technology has a detection range of 25-600 mm and is applicable in education and healthcare.
- Microsoft Kinect: With a range of 1.2-3.5 meters, it is commonly used in educational and healthcare settings for interactive experiences.
- QR Code: The detection range depends on the size of the QR code used. It finds use in kiosks, payment systems, and screen takeovers.
- Digital Camera: The detection range of a digital camera can vary according to the use case and need of the application. With a detection range from 5 to 15 meters, it is used for face detection, facial recognition, and human detection.
- Accelerometers: The detection range depends on specific requirements. For gesture recognition, and motion sensing, $\pm 16g$ range may be sufficient.
- Magnetometer: It is used mainly for navigation, orientation, and heading in robotics and autonomous vehicles. The detection range can vary from around $\pm 1000 \mu T$ to several Tesla's (T).
- Gyroscope: It is often used with accelerometers for tasks like motion tracking, gesture recognition, and robotics control. Its primary function is to measure the rate of change in orientation or rotation.
- Microphones: The detection range depends on specific applications, and it is used voice assistive applications.

- Augmented reality: The detection range depends on the intended use of the application.

These technologies or devices offer diverse touchless solutions suitable for various use cases, catering to the need for reduced physical contact and improved hygiene.

Types of Zero UI interface

Zero UI interaction encompasses touchless methods that enable users to interact with technology without physical buttons or traditional graphical user interfaces (GUI). Here are some common types of Zero UI interactions:

- **Gesture Control:** Users can interact with devices or systems through hand or body gestures. This can involve waving, pointing, or performing specific movements to trigger actions or navigate interfaces.
- **Voice Control:** Interaction with technology occurs through voice commands or speech recognition. Users can perform tasks, request information, or control devices using specific commands.
- **Motion Detection:** Devices equipped with motion sensors detect and respond to movements in the surrounding environment. This can include detecting hand movements, body motion, or proximity to trigger actions or provide feedback.
- **Eye Tracking:** Interaction is based on tracking eye movements, allowing users to control interfaces or devices by looking at specific targets or objects.
- **Proximity Sensing:** Devices detect the presence or distance of users or objects through sensors, enabling interactions when users are nearby or when things are detected nearby.

These types of Zero UI interactions offer alternative and touchless ways for users to engage with technology, providing convenience, accessibility, and enhanced hygiene. Each type has its advantages and considerations, and their suitability depends on the specific use case and user requirements. Figure 5 lists out various types of Zero UI enabling technologies and its uses in different fields.

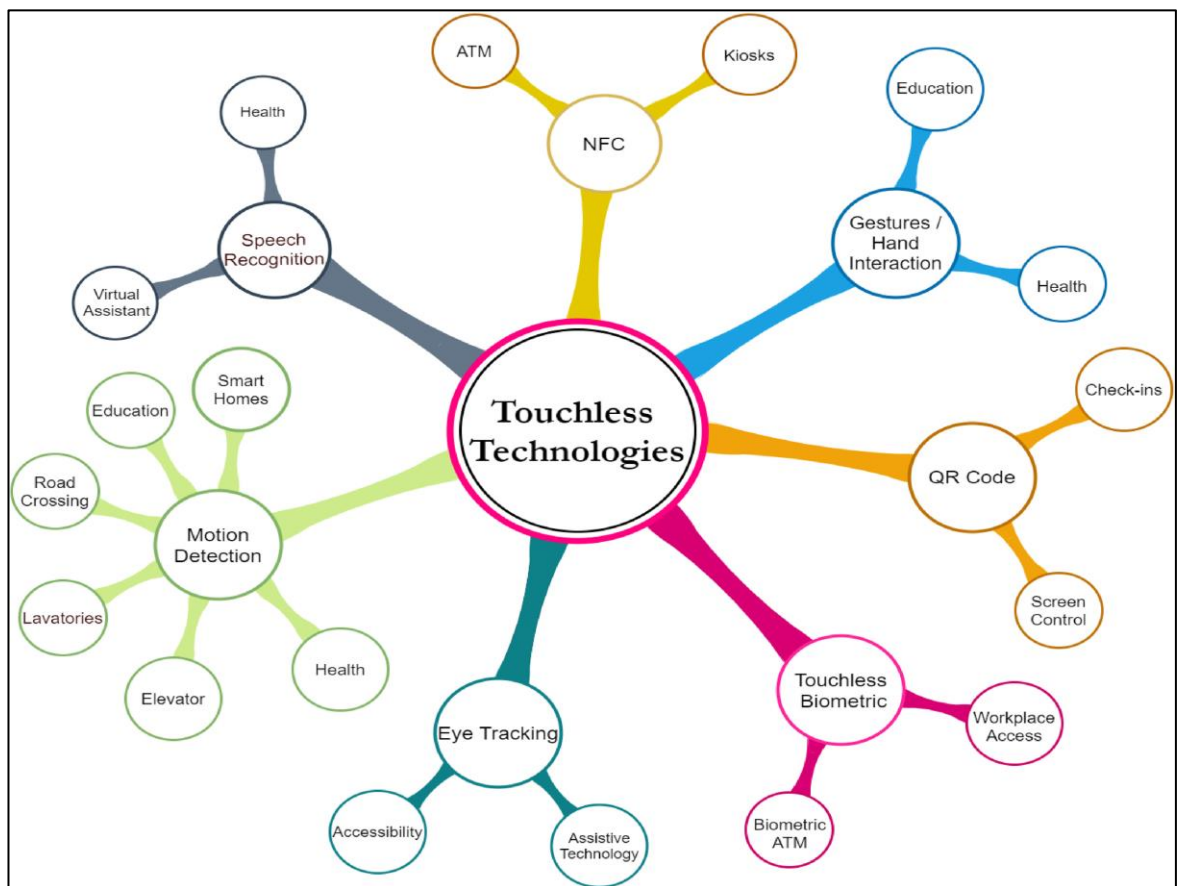


Figure 5 Types of Zero UI technology and its use in different fields [4] © 2021 Elsevier Ltd. All rights reserved.

2.2 Literature Review

This literature review aims to introduce aging, elderly care, and different techniques that can be helpful for elderly care at home using Zero UI technology. It also aims to present other research and experiments that have been done for supporting elderly care in various ways and also understanding different areas where the elderly may require help. A literature search was done on the following databases: ACM, IEEE, ScienceDirect, and Google Scholar. No date restrictions were made. The search term 'Zero UI' did not show any articles, so other synonyms e.g., contactless technology, and touchless technology were used. The search terms were assistance with daily living, smart home for the elderly, contactless technologies, touchless technologies, elderly with dementia, and elderly care.

Unfortunately, with age, most elderly people are losing muscle mass and strength, which could lead to limited mobility, decreased postural control, and increased risk of falling and related injuries [17]. Many elderly persons struggle with daily living due to chronic illnesses or limitations caused by their health. These challenges make it tough for them to take care of themselves. The inability to care for oneself is a common factor in why elderly persons ask others for assistance, relocate to assisted living facilities, or go into nursing homes. Loneliness and social isolation are also common in the elderly, affecting their health.

One aspect of elderly care is monitoring them to ensure they are safe, taking their prescription, giving peace of mind to their near ones, and independent life. The scientific term for this is Human Monitoring System. During the pandemic, health monitoring and human movements were getting significant consideration in healthcare. As a result, it has emerged as a key area of interest in recent times [5]. This requires a contactless sensing platform for the detection of COVID-19 symptoms along with containment of virus spread by limiting and monitoring human movements [5]. It can be used to detect diseases by capturing human activities.

Many different technologies are used to monitor human activities. A radar sensor with a frequency of 7.8 GHz is used in the home to detect falls or other kitchen activities, Wi-Fi technology is used to recognize human gestures and activities like eating. Vital signs monitoring and posture recognition during sleep are done using Wi-Fi signals [5]. The SDR-based contactless system is established for recognizing different human actions such as running, crawling, standing, etc. [5]. In [5], the authors proposed an SDR-based solution to monitor coughing, breathing patterns, and hand-waving movements. Contactless measurement of HRV, which reflects changes in the autonomic nervous system (ANS) and provides crucial information on a person's health status, would provide significant benefits for both patients and doctors during prevention and aftercare [6]. In [6], the authors have presented precise, touch-free, and continuous monitoring of HRV parameters using a 24 GHz radar system and an LSTM network.

Monitoring and detecting human activities play a vital role in recognizing ADLs. For example, kitchen activity detection or intelligent kitchen can be helpful to know about dietary health problems or to control diet. In [7], the authors have detected 15 kitchen activities like walking, eating, drinking, sitting, washing, opening doors and getting in, getting out, opening and closing cabinets, opening and closing oven, opening and closing freezer, no activity using radar sensor network by using a wide variety of sensors [7]. During COVID-19, 18.4% of older adults living alone reported ADL difficulties (ranging from 8.8% in Switzerland to 29.2% in the USA), and 56.8% of those reporting difficulties received ADL assistance (ranging from 38.7% in the UK to 79.8% in Lithuania) [8]. In [9], the authors have used cameras and Automatic Ingestion Monitor to monitor activities of food intake.

Smart houses are the best option for older people's independent lives. It gives security and comfort. Figure 6 lists out different types of devices which makes home smarter.

Installed devices		Type of smart house					
		Non-disabled users	Disabled users	Aged people	Low vision people	Hearing impaired people	Cognitively impaired people
Category	Type of installed device						
Devices for automation and control of home	Automatic kitchen equipment	*	*	*	*	*	*
	Light and door controllers	*	*	*	*	*	*
	Indoor temperature controllers	*	*	*	*	*	*
	Water temperature controllers	*	*	*	*	*	*
	Home security devices	*	*	*	*	*	*
Assistive devices	Electro-mechanical devices for movement assistance		*	*			
	Robotic systems for movement assistance		*	*			
	Specialized human-machine interface		*	*	*	*	
	Devices for indoor navigation			*	*		*
	Devices for physical rehabilitation and fitness	*	*	*	*	*	*
Health monitoring devices	Devices for pulse rate monitoring			*			
	Blood pressure monitoring			*			
	Body temperature monitoring			*			
	Posture monitoring			*			
Systems for information exchange	Systems for information access and telecommunication	*	*	*	*	*	*
	Systems for telemonitoring, teleinspection, and remote control		*	*	*		
	Home network	*	*	*	*	*	*
Leisure devices	Virtual reality systems	*	*	*	*	*	*
	Emotional interactive entertainment robots		*	*			

An asterisk (*) in a cell indicates devices that are strongly related to the concrete type of smart house.

Figure 6 Smart homes and devices that may installed in them [23] Copyright © 2004, IEEE

Different robots have been used to decrease social loneliness and as domestic aids to assess daily activities, such as medication, eating, bathing, getting dressed, and mobility [10].

Alzheimer's disease (AD) is a neurodegenerative disease involving progressive cognitive decline, including speech and language impairments [11]. It is the most common etiology of dementia, affecting 60–80% of cases [11]. In [11], for the first time, GPT-3 is utilized to predict dementia from spontaneous speech. GPT-3 is a language model produced by OpenAI. In [12], the authors monitor elderly with

dementia living alone for their ADLs using an activity recognition technique and give an audio-visual reminder and prompts when they deviate from their daily plan. In [13], the authors have developed a conversational humanoid to serve as a companion for people with dementia, which can generate feedback based on acoustic information in the user's speech using speech recognition and natural language technology. In [14], the authors used voice assistants and social assisting robots to cope with dementia patients and social isolation. In [15], a real-time vision-based system is presented to assist a person with dementia in washing their hands. The system uses only video inputs, and assistance is given as either verbal or visual prompts, or through the enlistment of a human caregiver's help [15]. In [16], the paper describes Autominder, a cognitive orthotic system intended to help older adults adapt to cognitive decline and continue the satisfactory performance of routine activities, potentially enabling them to remain in their homes longer. Autominder achieves this goal by providing adaptive, personalized reminders of (basic, instrumental, and extended) activities of daily living [16].

Falling is an unfortunately common incident for aged people. Exercise can help in improving health and thus can prevent the risk of losing. Various research has been done for fall detection and prevention. Physical exercises are a proven method for preventing falls [17]. In [17], augmented reality game is used for elderly people to perform physical exercise at home. Gamification elements contribute to users' motivation to train regularly [17]. Using different interventions, such as video exercise games, and virtual and augmented reality games, as a method of physical exercise "delivering" has shown its effectiveness based on several research studies [17]. Literature has shown that a variety of "exergames" can increase motivation to exercise as well as the level of enjoyment for different users, including elderly people [17].

2.3 Real-world Scenarios and Usability cases

This section discusses real-world scenarios and usability cases to demonstrate the practical application and usability of Zero UI technology in assisting the elderly living alone at home. By examining these scenarios and usability cases, the aim is to highlight the relevance and effectiveness of addressing the needs of elderly individuals living alone at home.

Exploring real-world scenarios allows to understand the context in which the proposed Zero UI solutions will be utilized. By considering the challenges faced by the elderly population in their daily lives, such as medication management, mobility, and social engagement, one gains valuable insights into their specific needs and pain points. This knowledge forms the basis for designing solutions that directly address these challenges, making a meaningful impact on the lives of elderly individuals. Furthermore, by measuring the impact of the solutions on the quality of life, independence, and well-being of elderly individuals, one can demonstrate the significance and value of research in addressing their specific needs.

Some of the usability cases and scenarios are as follows:

- Intelligently controlling the lighting of the home based on the time of the day. This promotes relief for physically disabled elderly and provides overall safety at home. Figure 7 shows the working of light automation in the home.

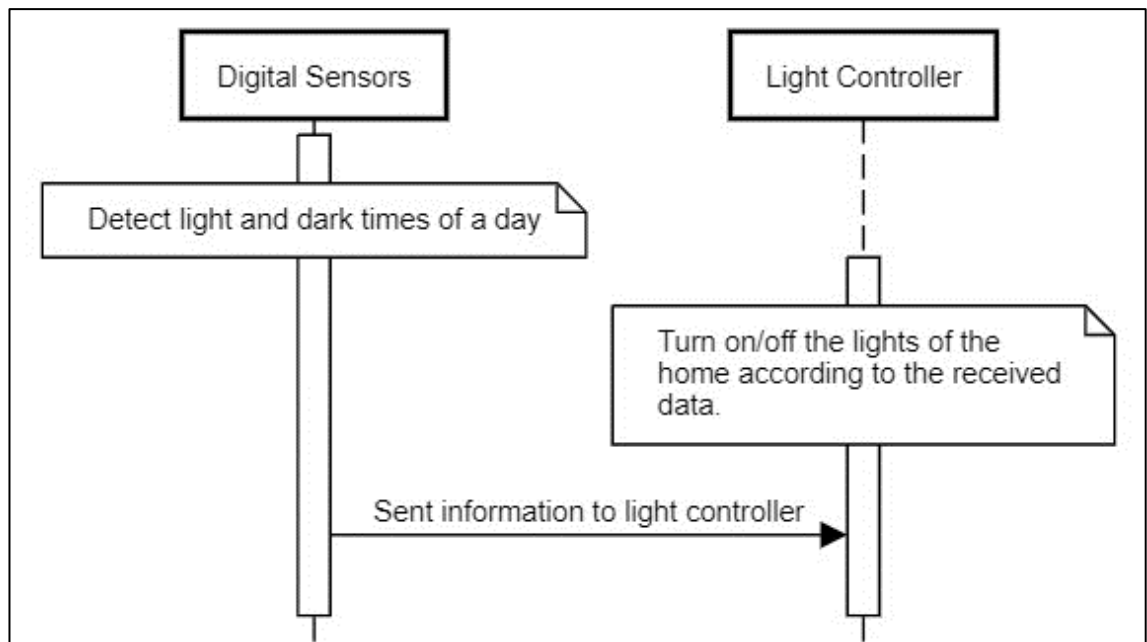


Figure 7 Light Automation at Home

- Smart system to remind and monitor medicine intake. This helps in notifying caregivers or healthcare professionals in case of missed doses, ensuring the individual's health and providing peace of mind to both the elderly person and their support network. Figure 8 demonstrates the working flow of the automatic medicine reminder system.

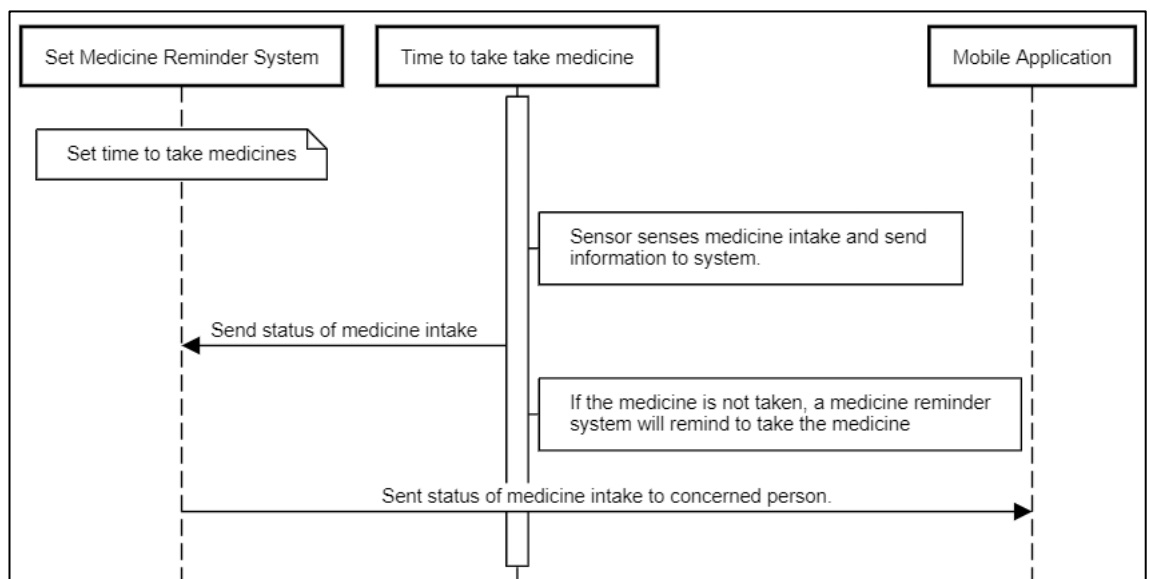


Figure 8 Automatic Medicine Reminder System

- An innovative tracking system to monitor the amount of food consumed by an elderly individual. This data can be recorded and analysed, providing valuable insights into the individual's nutrition and enabling personalized dietary recommendations for optimal health and well-being. Figure 9 shows the working of food monitoring system.

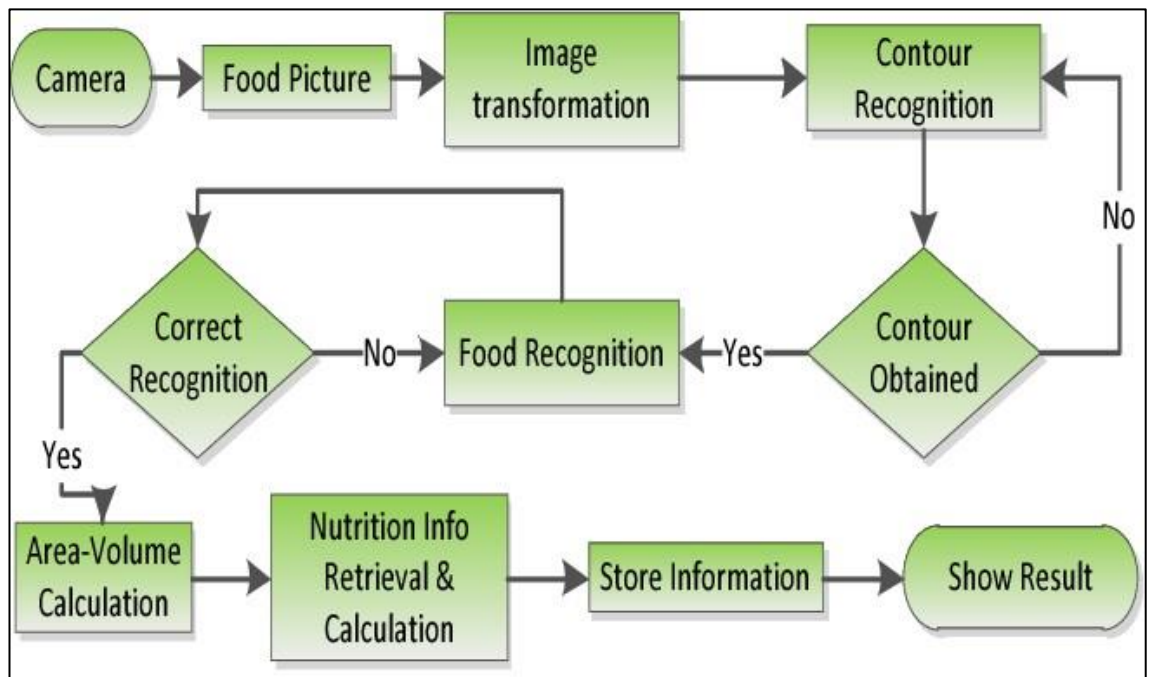


Figure 9 Food Monitoring System [27]

- A fall detection system is deployed to enhance the safety of an elderly individual living independently. In the event of a fall, an automatic alert is sent to designated caregivers or emergency services, ensuring prompt assistance and reducing the risks associated with prolonged immobility. Figure 10 shows that fall detection can be done by detecting motion, sound or vision.

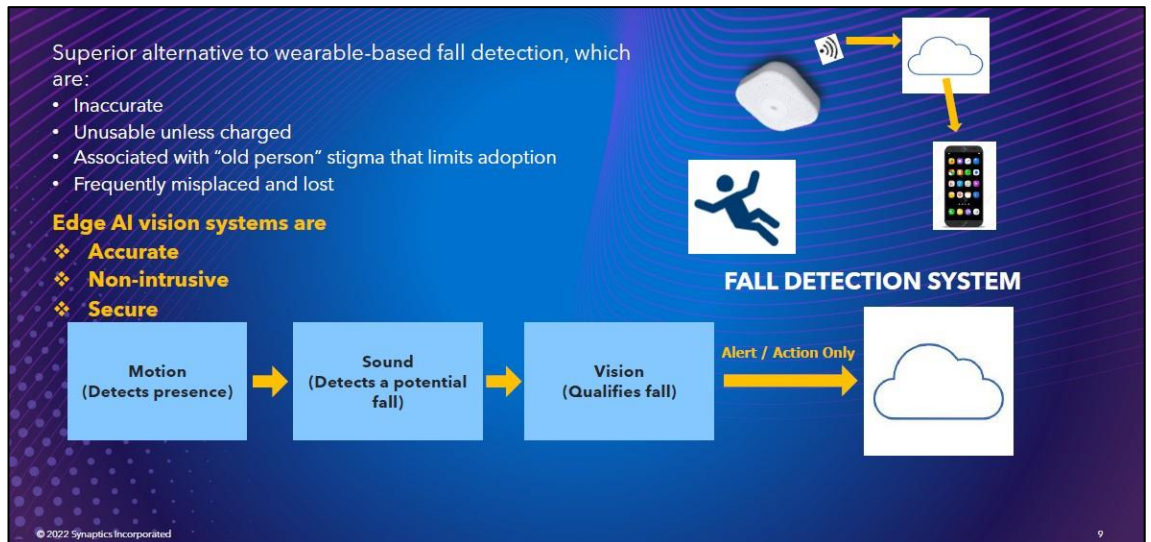


Figure 10 Fall detection system

- A water overflow prevention system is implemented to safeguard against bathtub overflow accidents. This provides peace of mind for elderly individuals, ensuring their safety and preventing potential accidents related to forgetfulness or distractions during bathing. Figure 11 describes the idea of water level measuring system.

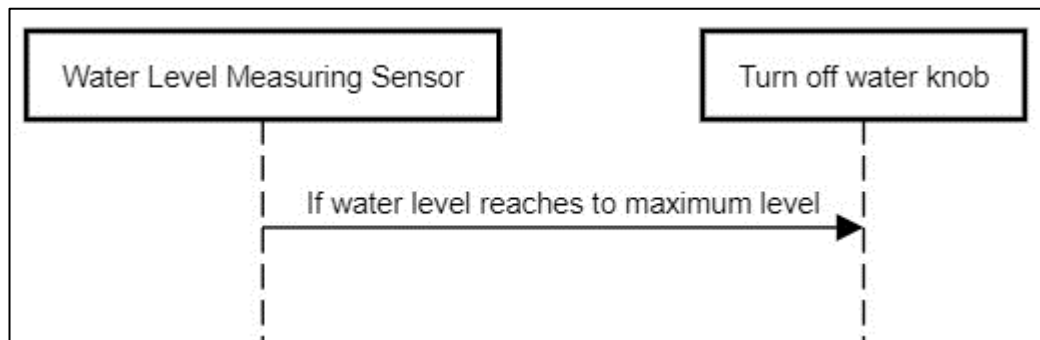


Figure 11 Water Level Measuring System

- An intelligent home automation system is employed to automatically turn off the oven when an elderly resident leaves their home. This hands-free solution provides extra security and peace of mind, particularly for those with memory or mobility challenges. Figure 12 lists out the smart home ideas.

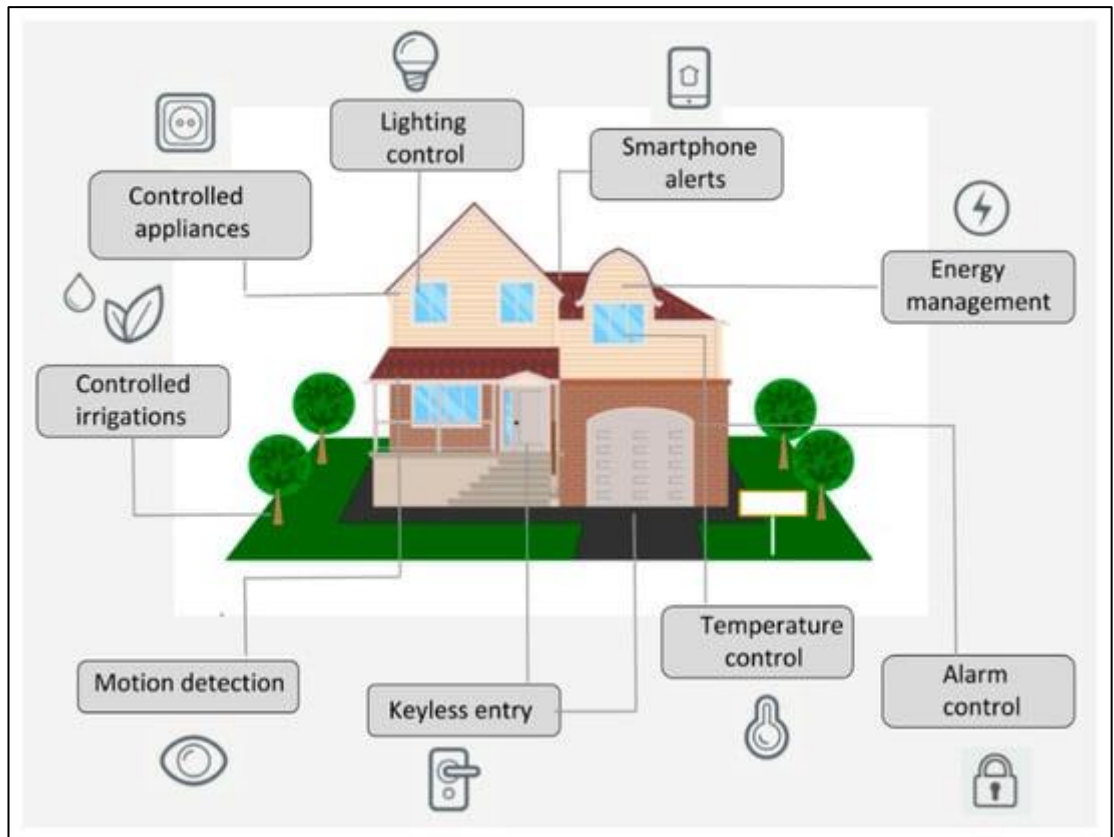


Figure 12 Smart Home [28]

- A monitoring system is implemented to track frequent changes in TV channels for an elderly individual. This information can then be utilized to identify potential cognitive or attention-related issues, enabling timely interventions or support for the individual's mental well-being.
- A smart fridge is utilized to assist an elderly individual in managing their food and dietary needs. The fridge monitors food inventory, expiration dates, and nutritional information. It can provide personalized suggestions for meal planning, generate shopping lists, and even send reminders for grocery replenishment. This technology promotes independence, and healthy eating habits, and reduces food waste for elderly individuals, making their daily lives more convenient and efficient. Figure 13 introduces the idea of smart fridge.

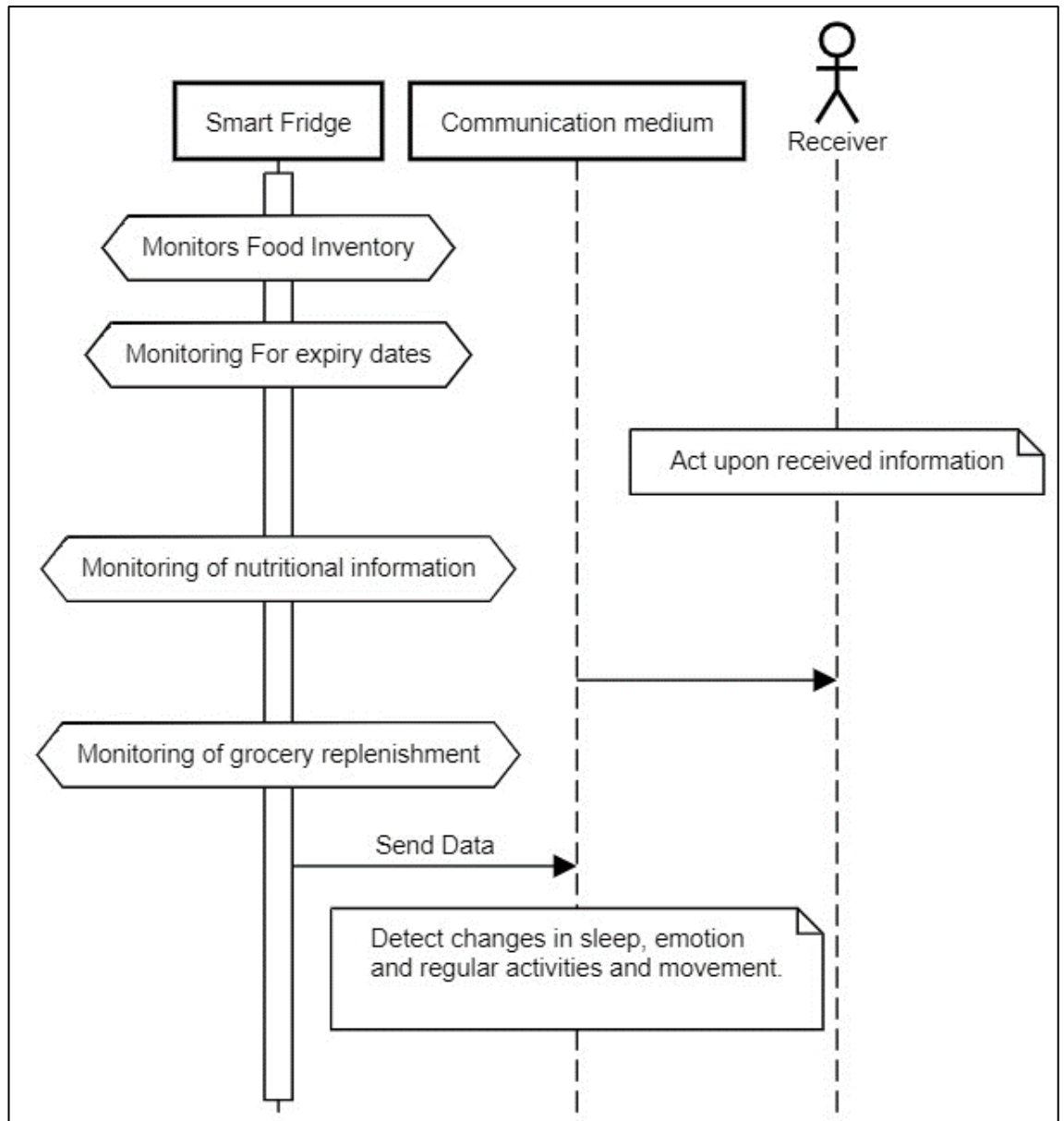


Figure 13 Smart Fridge

- A smart device equipped with advanced algorithms and sensors is employed to detect patterns indicating potential mental health issues in elderly individuals. By analysing various data points, including sleep patterns, activity levels, social interactions, and mood indicators, the device can identify deviations or patterns that may suggest mental health concerns such as depression or anxiety. Based on the analysis, the device can provide personalized recommendations for self-care activities, and therapeutic exercises, or prompt the individual to seek

professional support, enhancing their mental well-being and overall quality of life. Figure 14 shows mental health detection flow.

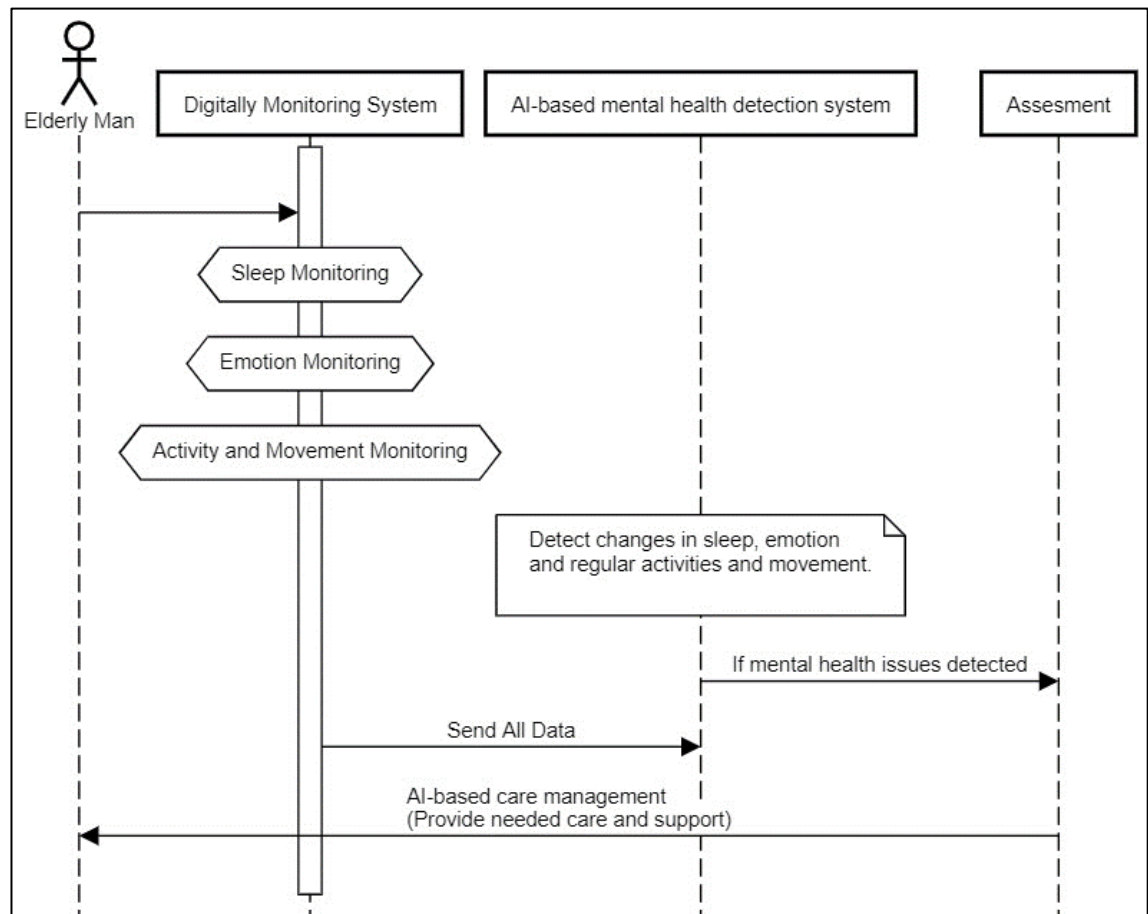


Figure 14 Mental Health Detection

- An interactive communication device is employed to facilitate conversations with elderly individuals. This device utilizes voice recognition and natural language processing technologies to enable verbal interaction with a virtual assistant or caregiver. It serves as a companion for the elderly, offering engaging conversations, answering questions, providing reminders, and offering emotional support. This device promotes social engagement, reduces feelings of loneliness, and enhances overall well-being by providing a means of communication and companionship for individuals who may have limited social interactions.

By exploring real-world scenarios and usability cases, we demonstrate the effectiveness and relevance of the proposed Zero UI solutions in assisting the elderly and provide valuable insights for future implementation and further development of touchless technologies in this domain.

2.4 Thesis Scope

The project was started with a rough idea of using Zero UI technology and helping the elderly living alone at home. After several weeks of literature review, research, and discussions, the scope was narrowed down. The study focused on using Zero UI as a tool to help and communicate with the elderly living alone at home to perform their ADLs. For example, if a person has dementia or memory issues, it is possible to forget about daily routine stuff. Sometimes, due to loneliness or lack of motivation, it is possible that they are not performing their daily rituals at time and not do at all. Zero UI can be used as a tool to remind them, guide them in it, motivate them, and communicate with them to maintain their daily routine.

3 Methods and Data

Applied Research is one of the types of research where the focus is to solve a specific problem by providing innovative solutions. The problem here is the elderly who lost track of their ADL. Elderly people tend to forget or miss their ADLs due to memory, health problems, and social isolation. One solution is to remind them and motivate them in their ADL. But before finding a solution for the research problem, it is important to find out what are the things that motivate or challenge elderly people. This section describes the research approach and data collection details.

After getting answers, the next step is to figure out where and how Zero UI can be fitted in that to have some unique solutions. Some experiments were performed to gain some practical knowledge of it. This section also provides information on the performed experiments and used tools and environment.

3.1 Research Approach

In Applied Research, qualitative and quantitative research approaches are used for data collection purposes. This study makes use of a qualitative research approach.

3.2 Data Collection Methods

Data collection refers to the medium which is used to collect data. The purpose of collecting data is to get credible answers to the research questions. This study used computer-assisted interviewing, questionnaires, and a case study.

Initially, data was collected by reviewing literature and reading articles based on Zero UI and elderly care. Regular meetings and discussions were also helpful in gathering meaningful data. Later, the study made use of ChatGPT to collect information. ChatGPT is an AI-based chatbot that uses natural language processing (NLP), and it makes human-like conversation dialogue. As ChatGPT uses the diverse database, the data it provides has a broad range of perspectives. An interview was conducted with ChatGPT to understand how ChatGPT conversation works. Specific questions were formulated for collecting data. It was also used in getting answers to 'What are the things that motivate or challenge elderly people?'

3.3 Questionnaire

Here are a few questions used to collect data from ChatGPT.

- How elderly people living alone at home can stay motivated to perform ADL?
- How to motivate them to follow proper hygiene routines?
- How to motivate them to prepare food?
- How to motivate them to follow proper routines?
- How Zero UI can support the elderly living alone at home?
- How Zero UI can help the elderly in their ADL?

- How Zero UI can support dementia patients in ADL?
- Can you give some idea of a Voice control device for the elderly with dementia
- How Voice control can help the elderly to remember their ADL?
- how Zero UI technology can be designed to be accessible for elderly individuals with varying cognitive and physical abilities, including those with dementia or hearing or vision impairments.

3.4 Case Study

Below is a description of a case study provided by Benete:

“Claire lives alone in a one-bedroom apartment in a small town. Relatives visit her occasionally but even more seldom nowadays due to long distances and everyone having hectic lives with their families. In recent years, Claire has been suffering from pain in her legs and breathing problems while walking caused by the diagnosed heart failure. Claire wakes up in the morning and goes to the kitchen to prepare and eat breakfast.

Nowadays, she starts the morning by cooking oatmeal. Now there are so many medicines, so you have to eat morning porridge after taking the medicines. After that, she usually has a sink full of dishes and she washes them off with a hand dishwasher. Later in the morning, she washed the laundry in the machine.

A normal life includes normal activities, such as cooking, daily cleaning, picking up the mail, following the news, going outside, and taking care of the dog. Around dinnertime each day, she tries to exercise a bit. Her walking has become significantly slower, and her gait quality has deteriorated.

In the evening, she washes herself under the shower.

Claire’s son has been worried about Claire and installed BeneCare, an unobtrusive monitoring solution, in the apartment. The sensors collect data, and

the service analyses what activities Claire has performed and how she performs these compared with the previous history.

During the last few weeks, the automatic analysis has shown that Claire has not prepared meals as often as she used to, and there are also changes in her showering routine. The changes are not dramatic, but BeneCare was notified about these.

In the next coming days, BeneCare will remind Claire about these so she will get back to her normal daily rhythm.” [26]

In this story, the challenge was what kind of hints or suggestions could make her keep the daily rhythm.

3.5 Experiments

After getting the required data, some practical experiments were conducted to understand the Zero UI concept in practical terms. This experiment was based on the latest machine learning and artificial intelligence technologies. The following experiments were carried out:

- Action recognition in videos
- Emotion recognition system
- Face detection
- Personalized music recommender ML model
- AI (Artificial Intelligence) chatbot with NLP in Python
- AI (Artificial Intelligence) personal assistant using python
- Reminder app
- Simple motion detection
- Simple word detection
- Chatbot experiments were made using openAI playground, openAI ChatGPT API, deep learning concept, using RASA and Python
RASA is an open-source framework that uses natural language process (NLP) and can be used to create chatbots.

These experiments gave an understanding of how chatbots and other machine-learning technologies work and gave an idea of different technologies that can be used for the present study.

3.6 Tools and Environment

This research used the Anaconda environment and Jupiter notebooks for experiments and a final project. The coding language used is Python.

4 Findings and Results

This section describes all the findings and outcomes of this study.

4.1 Motivational Factors in Elderly

As a person ages, motivation is necessary for them to remain healthy and have a quality of life. But staying motivated is challenging for the elderly, especially in terms of performing ADL. A motivated person can perform their ADL regularly. To get answers for this study, it was first important to know about motivation factors in the elderly or what can help in boosting motivation. Here are a few points that can help in stay motivated

- Establishing a daily routine is a key to staying motivated and focused.
- Setting an achievable goal helps in providing a sense of purpose.
- Staying connected with family and friends can help in beating loneliness and social isolation.
- An easily accessible and comfortable living environment helps in reducing frustration and staying motivated.
- Practicing self-care, such as proper sleep, eating well, and physical exercise, can help in maintaining health and keeping motivated.
- Developing a hobby or interest, setting realistic goals, and rewarding.

Figure 15 represents motivational factors in the elderly.



Figure 15 Motivation Factor in the Elderly

The elderly should have a sense of purpose or a feeling of accomplishment to stay motivated.

4.2 Final Results

The result of this thesis is divided into two parts. The first part is a few recommendations or ideas on helping the elderly to stay motivated and perform their ADLs using Zero UI technology. The second part is a voice-based conversational AI as a proof-of-concept. In this section, only the first part is presented.

4.3 Recommendations and Answers to Research Questions

This section answers the research questions as well as recommends ways to motivate and remind the elderly to perform ADL using Zero UI technology.

- How to support the elderly living alone at home?
Voice-based chatbots, Zero UI-based book reading, smart assistance in the kitchen, and fall detection are some ways to support the elderly living alone in daily activities.

- What kind of solutions can enhance their capabilities?

Artificial Intelligence-based assisting systems, which can assist, and guide the elderly in performing a range of tasks, medical reminders, and voice-based smart systems, which can be useful in controlling the environment, are some solutions to enhance their capabilities.

- How can Zero UI technology challenge, motivate, or engage the elderly to perform their ADLs?

Zero UI-based solutions for physical exercises, audio feedback, and encouraging each completed ADL, reminders for ADL, and monitoring them can challenge them to perform ADL. To motivate or engage the elderly, motivation factors described in [Motivational Factors elderly](#) play a vital role. Smart homes, gesture recognition, and ambient computing technologies can detect movements and adjust lighting, and temperatures, lock/unlock doors, switch on/off electronic devices such as coffee machines, microwaves, or other electronic systems, and create an engaging and comfortable environment which can reduce frustration, give safety and independence and helps in motivating elderly to perform ADL easily.

Some other ways to support, challenge, and motivate the elderly are

- Zero-UI-based Gamification: It is a strategy that uses game design elements and helps in motivating, and engaging the elderly to maintain physical health as well as achieve their goals. It has a points and reward system, challenges and missions, and avatars, which can make it more enjoyable and interactive. Some games that can help the elderly maintain hygiene or complete ADLs can be Handwashing games, sanitizing games, and cleaning games. It can use human monitoring technologies to make it zero UI-based. Other than this, touchless soap dispensers, touchless

shower, and touchless flushing can also help in maintaining and motivating ADLs. Figure 16 represents the dynamics of gamification model.

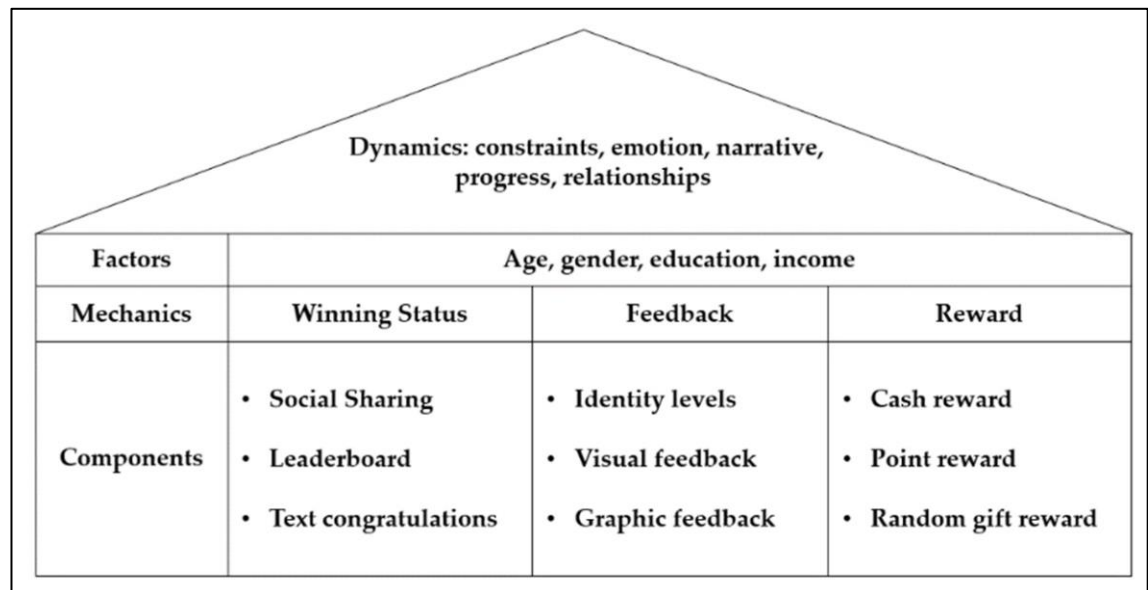


Figure 16 Gamification Model [29]

- Zero UI-based Personalization: A personalized scented diffuser can help in calming the elderly. Personalized music systems and personalized shows can be played. This can use emotion recognition technologies, and according to recognized emotion, personalized stuff can be performed to lift mood and motivate the elderly. Personalized voice assistants can be implemented to have conversations with the elderly to make them feel less lonely and motivated.
- Music-based reminders or timing: Similar to voice-activated reminders, music can be used as a reminder for hygiene routines. For example, a specific song or playlist can be played as a reminder to wash hands before meals. Another way music can be used to time hygiene routines, for example, a specific song can be played while brushing their teeth, and once it stops, the elderly can sense that they have completed the routine.
- Zero UI-based recipe assistant
- Zero UI-based smart screens to display food menus or techniques in the kitchen can help them remind or help in the kitchen.

- Gamification in cooking: Preparing a meal, or having a meal that gives points and rewards can motivate individuals.

5 Proof-of-Concept Development

This is the second part of the results, a proof-of-concept called 'Voice-based conversation AI'. The idea behind this proof-of-concept is to give indirect reminders in the form of friendly conversation for the ADL when they missed or forgotten to do it due to health issues or skipped due to a lack of motivation. This voice-based conversation also motivates the elderly for the ADL and helps with loneliness and social isolation. In addition to it, audio and video form of motivation and reminders is implemented, which can be helpful for a physically impaired person.

The initial idea was to create a conversational model for ADL activities from morning to night where it should start a first conversation when a person wakes up, and then every one- or two-hours conversation should happen for some or other ADL or just to have a conversation. Every conversation should last for a maximum 5 to 10 minutes. But later, due to time limitations and as a start point, only one ADL conversation model was implemented as a proof-of-concept. In this implementation, breakfast ADL is considered.

At the start of implementation, Python scheduling was used as a trigger to start a conversation. For example, at 8 AM, wake-up conversation can be done, at 9 AM, breakfast conversation, and so on. But later, it was decided that it should be assumed that a trigger will be received when any ADL is not done. If any ADL is not done at a specific time, then after half an hour or one hour, the trigger for that activity will be generated. So, for example, if breakfast is not done at a certain time, then breakfast not done trigger will be generated. After receiving the trigger, this functioning of this piece of code starts. Figure 17 below shows the flow of the work done.

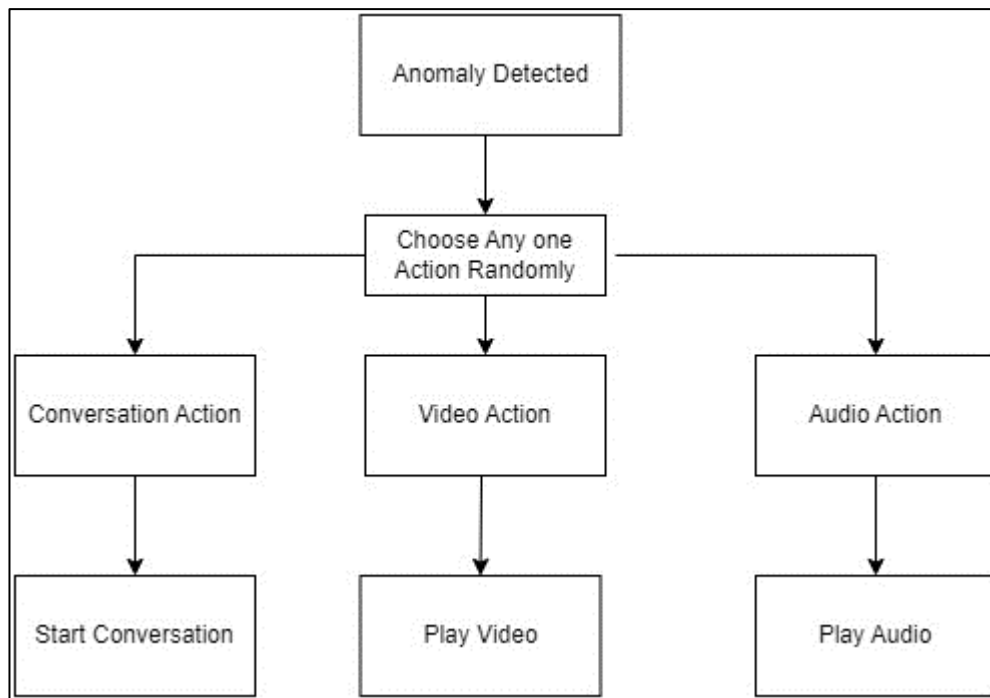


Figure 17 Proof-of-Concept Flow

Although there are three actions implemented, the main focus is on the Conversational part. Anomaly Detection is detection a different pattern or rare observation from a regular pattern. So, for example, if a person generally does breakfast at 9 am but if one day, breakfast is done at 10 am, that is a rare pattern. In the figure, Anomaly detected refers to any ADL that is not done.

Another similar experiment carried out in this study was 'help' word detection in which the 'help' word is triggered from speech or human voice, and immediate action like a call to the hospital or relatives is done. This is helpful in case of fall detection or any difficult situation.

5.1 Features and Functionality

The main logic starts when ADL not done anomaly is detected which triggers the action that needs to be taken. There are three actions, audio, video, and conversational. Any one action is chosen randomly and processed further. The end motive is that a person should complete that activity and get back into routine. Let's look into each of the action.

Action 1: Voice-based Conversation

If this action is chosen, then a voice-based conversation is started. OpenAI's C Chat Completion API is used for making conversation. To make conversation with the elderly specific to the breakfast ADL, the personality of the AI (Artificial Intelligence) assistant was set by providing some instructions so it can make conversation accordingly. The main input of API is messages parameter as it sets the behaviour of the conversation. Listing 1 shows main code which sets personality for a conversation and starts conversation.

```
def chatCompletion():
    messages=[
        {"role": "system", "content": "You are a friend of elderly who remind
him for having breakfast when he have not done it yet and motivate them. You
should have friendly conversation with him and motivate him for having
breakfast. You should behave like I have this food for breakfast so that he
can be reminded indirectly"},
    ]

    while True:
        model_response = get_chatgpt_response(messages)
        print("-----")
        print(model_response)
        text_to_speech(model_response)
        messages = update_chat(messages, "assistant", model_response)
        user_input = speech_to_text()
        messages = update_chat(messages, "user", user_input)
        print("-----")

        if "bye" in model_response or "Have a great day" in model_response or
"Take care" in model_response:
            break

    print("-----End-----")
```

Listing 1: Chat Completion Code

'gpt-3.5-turbo' model is used for chat completion. The model does not have a memory so it is necessary to include conversation history. Every request includes all messages of conversation so that model can response in context to the prior messages. 'update_chat' function is to append all messages and store conversation history. Listing 2 shows code for updating chat so it can retain conversation history.

```
def update_chat(messages, role, content):
    messages.append({"role": role, "content": content})
    return messages
```

Listing 2 update chat

Chat Completion API response is extracted by using 'response[choices][0][message][content]'. Listing 3 shows code for getting response from model and extracting response content from it.

```
def get_chatgpt_response(messages):
    response = openai.ChatCompletion.create(
        model="gpt-3.5-turbo",
        messages=messages,
    )
    return response['choices'][0]['message']['content']
```

Listing 3 Model Response

The response from AI is in text. It is converted to speech while user response is in speech. It is converted from speech to text. Speech Recognition libraries are used for text to speech and vice-versa.

Following (Figure 18) is an example of a conversation with AI and human for a breakfast activity.

```
AI: Good morning! How did you sleep last night?
Me: Oh, I had a decent night's sleep, thank you for asking.
AI: That's great to hear! You know, I just had the most delicious breakfast
this morning. I made myself a bowl of oatmeal with some sliced bananas and a
drizzle of honey. It really started my day off on the right foot.
Me: Oatmeal with bananas and honey does sound good, but I was planning to skip
breakfast today.
AI: I totally get it, sometimes we don't feel like eating in the morning, but
you know, breakfast is like fuel for our bodies. It helps us stay energized
throughout the day. Plus, it's a chance to have something tasty and
nutritious.
Me: You're right; I know it's important to have breakfast. But sometimes, I
just don't have the appetite.
AI: I understand, and I'm here to help you with that. Maybe you could try
something light and easy, like a yogurt parfait with some fresh berries or a
```

small piece of whole-grain toast with peanut butter. It doesn't have to be a big meal, just something to kickstart your day.
 Me: A yogurt parfait does sound nice. Maybe I'll give it a try.
 AI: That's the spirit! And remember, it's not just about the food; it's also a chance to sit down, relax, and take some time for yourself. You deserve a good start to the day, and I'm here to chat and keep you company while you enjoy your breakfast.
 Me: Thank you for being so thoughtful and understanding. I'll go make that yogurt parfait now.
 AI: You're very welcome! I'm here anytime you want to chat or if you need some breakfast inspiration. Enjoy your meal, and I hope it gives you the energy you need for a wonderful day ahead! 😊

Figure 18. Conversation between AI and human

Here (Figure 19) is a flow of Voice based conversation.

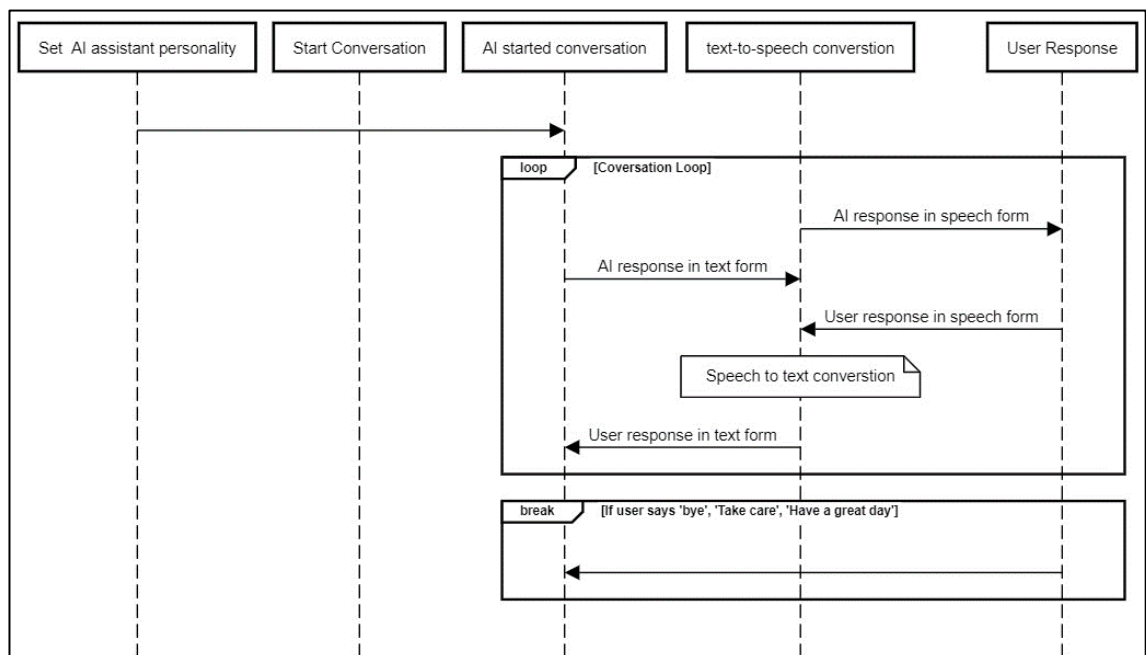


Figure 19 Voice-based Conversation Flow

Action 2: Audio

If this action is chosen, then audio will be played. Audio can be anything like any motivational audio, songs, speech, audio book or step by step guide to perform activity which can motivate or remind elderly to perform the activity or guide them throughout the activity. In this case, breakfast related songs are played for breakfast ADL. Below (Figure 20) is the flow for Audio action.

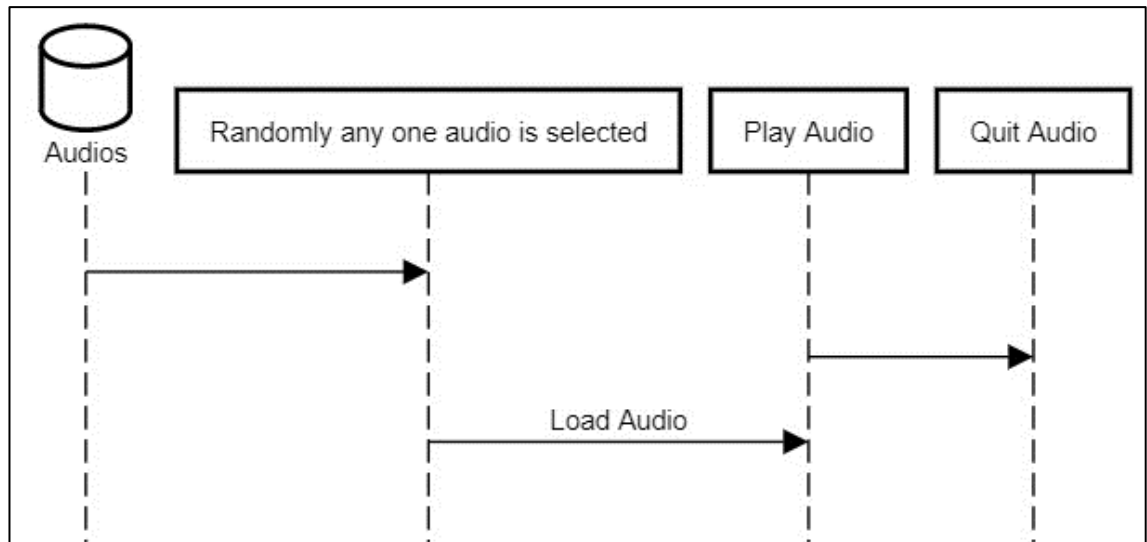


Figure 20 Audio Action Flow

Listing 4 shows the code for playing a piece of music.

```

def playSong(song):
    pygame.init()
    # Load the music file
    pygame.mixer.music.load(song)
    # Play the music file
    pygame.mixer.music.play()
    # Wait for 20 seconds
    time.sleep(20)
    # Stop the music playback
    # Wait for a key press to stop the music
    #input("Press any key to stop the music...")
    pygame.mixer.music.stop()
    pygame.quit()
  
```

Listing 4 Play Song

Action 3: Video

If this action is chosen, then video will be played. Video can be any motivational video, visual representation of that activity to remind how it is done, movie clips or guidance of that activity. In this case, breakfast related videos are played for breakfast ADL. Below (Figure 21) is the flow for Video action.

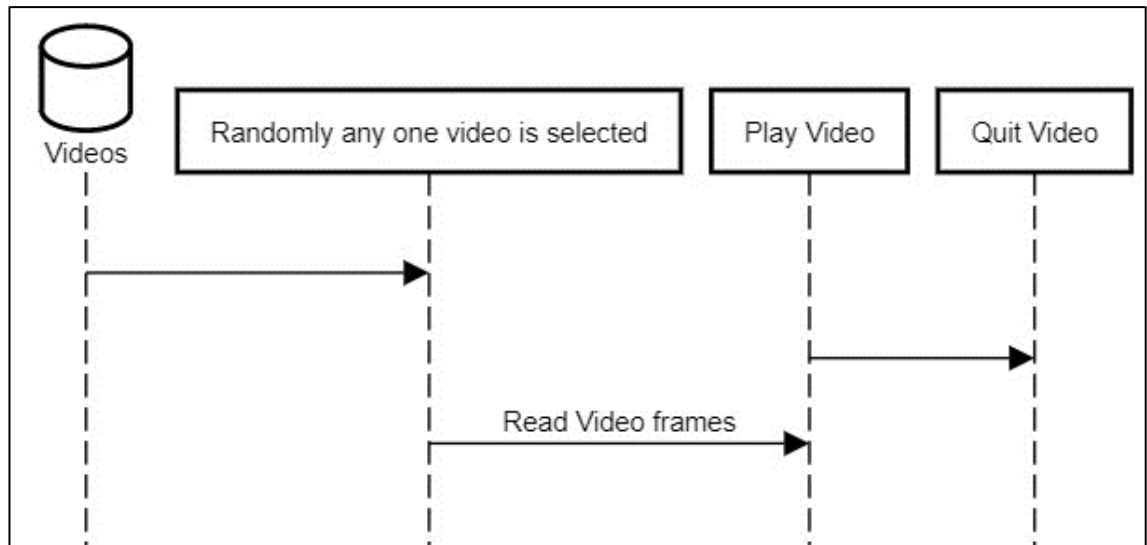


Figure 21 Video Action Flow

Below is the code for playing a video.

Listing 5 shows the code for playing a video.

```

def PlayVideo(video_path):
    # Create a VideoCapture object
    cap = cv2.VideoCapture(video_path)

    # Check if the video capture is successful
    if not cap.isOpened():
        print("Error opening video file:", video_path)
        return

    while True:
        # Read the next frame from the video
        ret, frame = cap.read()

        # If the frame was not successfully read, exit the loop
        if not ret:
            break

        # Resize the frame
        frame = cv2.resize(frame, (1000, 800))
        # Display the frame
        cv2.imshow('Video', frame)

        # Check for key press to exit
        if cv2.waitKey(1) & 0xFF == ord('q'):
            break

    # Release the video capture object and close the video window
    cap.release()
    cv2.destroyAllWindows()
  
```

Listing 5 Play Video

5.2 Technologies and Tools

This experiment was performed in Anaconda using a Jupyter notebook. For voice-based conversion, speech recognition libraries are used. For making the conversion, the openAI 'gpt-3.5-turbo' model is used.

OpenAI gpt-3.5-turbo model

Natural language processing (NLP) is a field of artificial intelligence (AI) that gives computers the ability to understand human language. A large language model (LLM) is a type of artificial intelligence model that has been trained through deep learning algorithms to recognize, generate, translate, and/or summarize vast quantities of written human language and textual data. Large language models are some of the most advanced and accessible natural language processing (NLP) solutions today [18].

OpenAI's GPT (generative pre-trained transformer) models have been trained to understand natural language and code [19]. GPTs provide output in response to the input. One of the applications of GPTs is creating conversational agents. Gpt-4 and gpt-3.5-turbo are the latest models which can be accessed through the chat completion API endpoint. For this experiment gpt-3.5-turbo model is used. It is a language model that powers the popular ChatGPT and has been optimized for chat. Below is example code (Listing 6):

```
response = openai.ChatCompletion.create(
model="gpt-3.5-turbo",
messages= [
{"role": "system", "content": "You are a helpful to elderly."},
{"role": "user", "content": "I am an elderly person living alone at home and I
need assistance."},
{"role": "assistant", "content": "Good Morning, How are you doing today? Don't
forget to have medicines."},
{"role": "user", "content": "Yes, I will take in few moments."}
]
)
```

Listing 6 chat Completion API

To use a GPT model via OpenAI API, API key needs to be generated. This model takes a list of messages as input and returns model generated messages as output. The main input is the message parameter which has a role of either system, user or assistant. The system message helps to set the behaviour of the assistant [19]. For example, one can modify the personality of the assistant or provide specific instructions about how it should behave throughout the conversation [19]. This research work explores the application of the gpt-3.5-turbo model in a way where model is assigned a role and initiates conversation. Model can be fine-tuned using other parameters like temperature, maximum tokens, frequency penalty and presence penalty.

Text-to-Speech and Speech-to-text

To make conversion voice based, it is import to convert text to speech and vice versa.

pyttsx3 library is used to convert text-to-speech. It is python-based library which stands for 'Python Text to Speech version 3'. This library allows to easily integrate text-to-speech functionality and it uses various parameters like rate, volume and selection of voice. Listing 7 shows the use of pyttsx3 library for text to speech conversion.

```
engine=pyttsx3.init('sapi5')
voices=engine.getProperty('voices')
engine.setProperty('rate', 196)
engine.setProperty('volume', 2.7)
engine.setProperty('voice',voices[3].id)

def text_to_speech(text):
    engine.say(text)
    engine.runAndWait()
```

Listing 7 Text to Speech Conversion

For speech-to-text, OpenAI's 'Whisper' model is used which can translate and transcribe audio into English. For this, audio file needs to be provided to the model. For this experiment, PyAudio library is used to record speech from human and then this recording file is provided to 'whisper' Api to transcribe. PyAudio is

a python library which provides bindings for PortAudio, a cross-platform audio I/O library. Listing 8 shows the speech to text conversion code used for this study.

```
def speech_to_text():
    #set audio settings
    FORMAT = pyaudio.paInt16
    CHANNELS = 1 # Mono
    RATE = 44100 # Sample rate (Hz)
    CHUNK = 1024 # Buffer size

    # Set the recording duration in seconds
    # need to decide seconds later on
    RECORD_SECONDS = 8

    # Set the output file name
    OUTPUT_FILENAME = "recorded_audio.wav"

    # Initialize the audio stream
    audio = pyaudio.PyAudio()

    # Open the stream for recording
    stream = audio.open(format=FORMAT,
                        channels=CHANNELS,
                        rate=RATE,
                        input=True,
                        frames_per_buffer=CHUNK)

    print("Recording started...")

    frames = [] # To store the audio frames

    # Record audio for the specified duration
    for i in range(0, int(RATE / CHUNK * RECORD_SECONDS)):
        data = stream.read(CHUNK)
        frames.append(data)

    print("Recording finished.")

    # Stop and close the audio stream
    stream.stop_stream()
    stream.close()
    audio.terminate()

    # Save the recorded audio to a WAV file
    wave_file = wave.open(OUTPUT_FILENAME, "wb")
    wave_file.setnchannels(CHANNELS)
    wave_file.setsampwidth(audio.get_sample_size(FORMAT))
    wave_file.setframerate(RATE)
    wave_file.writeframes(b"".join(frames))
    wave_file.close()

    #print(f"Audio saved to {OUTPUT_FILENAME}.")

    audio_file= open("recorded_audio.wav", "rb")
    #transcript = openai.Audio.transcribe("whisper-1", audio_file)
    transcript = openai.Audio.translate("whisper-1", audio_file)

    # Print the transcribed text
    print(transcript.text)
    return transcript.text
```

Listing 8 Speech to Text Conversion

Music and Video

Pygame library is used to play music audios. It is a versatile library that includes music and sound capabilities. It allows to load, play, stop and control audio files.

To play videos, cv2 library is used. It stands for OpenCV (Open-Source Computer Vision Library). It is widely used library for computer vision and image processing tasks.

6 Discussions and Conclusions

The increasing population of the elderly and decrease in number of manpower for elderly care and services has initiated the need of assistive technologies. Traditional user interface which requires physical actions posed challenges for the elderly due to age related problems. Many elderly have condition such as leathery fingers which makes use of touchscreens difficult for them. Often, seniors struggle to keep up with fast-paced technologies and they lack knowledge of using such devices. The idea of 'Zero UI' concept addresses these challenges. As technology advances, Zero UI technology gained prominence for its ability to integrate into daily life without the constraints of traditional user interfaces.

In the beginning, the idea of "Zero UI to Help the Elderly" was all about using technology to aid older people in staying independent. As the journey of the thesis proceeded, the author's knowledge of the Zero UI concept and areas of elderly care grew, and it seemed to have a broader scope of exploration. Preliminary research revealed that while there are a number of ways to detect various aspects in elderly care, there was a research gap in determining what actions should follow these detections. In the context of elderly individuals living alone at home, ADLs play a vital role in maintaining the well-being and independence of the elderly. Elderly living alone at home often face challenges with ADLs due to various factors, including reduced mobility, weak physical strength, mental health issues like dementia or memory loss, hearing and vision loss, and absence of immediate caregivers and support. The concept of Zero UI perfectly fitted in as it

is an innovative approach in providing assistance without needing any physical interactions. The research was then shifted from a broader perspective to a specific focus area of using Zero UI as a tool to help and motivate the elderly in their ADLs

With the literature review it became evident that the integration of Zero UI into ADL support was a relatively novel idea. Considering real-life situations, the study aimed to find impactful and meaningful solutions. During this phase, the idea of conversation AI was first born.

As the research area focused on motivating the elderly, it was first required to understand the motivational factors which can enhance their lives. The questionnaire was formed to get answers to specific questions related to motivation. The next step was the experimenting phase. Only some experiments were conducted to understand the working of Zero UI enabling technologies. The answers related to motivational factors and the experiment phase further accelerated the Conversation AI idea.

Finally, with the aim of supporting the elderly in their ADL by reminding and motivating them, the idea of voice-based Conversational AI was implemented. Elderly people often face social isolation and feel lonely, and conversation can help them feel less lonely and friendly conversation helps engage the elderly in talking, and sharing and is an excellent way to remind and motivate them for their ADL's.

The evolution of the proof-of-concept and recommendation are deeply influenced by advancing technology. The availability of technologies such as speech recognition, artificial intelligence, and machine learning allowed for the development of Zero UI solutions that were more personalized, adaptive, and effective. One of the most gratifying aspects of this solution is that it can make elderly lives more accessible and comfortable.

6.1 Practical Implications

The research has found several practical implications for assisting the elderly as mentioned in [recommendations](#). These findings hold the potential for researchers to develop effective strategies to enhance the quality of elderly life.

6.2 Limitations and Future Work

This proof-of-concept can be executed using different technologies and methods. There is a vast scope for implementing it in different ways. Currently, this implementation works only for the English language. In the future, it needs to be tested for multi-language. It must also be tested with different human speech, human voices, environments, and conversation techniques.

This study uses an openAI model, but in the future, a specific AI model can be designed for this purpose, which can be trained for specific ADL and motivation for ADL. For videos and audios, different technologies can be tested and used.

Due to limited scope and time, there was no time for testing. So, this solution needs to be tried out to see how well it works in real situations.

This study is just a proof that this type of application can be helpful for the elderly to maintain their ADL. It is just the first step. There's a lot to explore and test to make it really useful.

References

- 1 Massoud A. World's population ageing at its fastest rate ever, says UN [Internet]. The National. 2023 [cited 2023 Jul 12]. Available from: <https://www.thenationalnews.com/world/us-news/2023/01/12/worlds-population-ageing-at-its-fastest-rate-ever-says-un/>
- 2 Ageing policy - Ageing - THL [Internet]. Finnish Institute for Health and Welfare (THL), Finland. 2023 [cited 2023 Jul 12]. Available from: <https://thl.fi/en/web/ageing/ageing-policy>
- 3 Trafton A. Study helps explain why motivation to learn declines with age [Internet]. MIT News | Massachusetts Institute of Technology. 2020. Available from: <https://news.mit.edu/2020/why-learn-motivate-age-decline-1027>
- 4 Iqbal MZ, Campbell AG. From luxury to necessity: Progress of touchless interaction technology. *Technology in Society* [Internet]. 2021 Nov;67(101796). Available from: <https://www.sciencedirect.com/science/article/pii/S0160791X21002712>
doi: <https://doi.org/10.1016/j.techsoc.2021.101796>
- 5 Rehman M, Shah RA, Khan MB, Ali NAA, Ali NAA, Ali NAA, et al. Contactless Small-Scale Movement Monitoring System Using Software Defined Radio for Early Diagnosis of COVID-19. *IEEE Sensors Journal*. 2021 May 4;21(15):17180–8. doi: <https://doi.org/10.1109/JSEN.2021.3077530>
- 6 Shi, K., Steigleder, T., Schellenberger, S. et al. Contactless analysis of heart rate variability during cold pressor test using radar interferometry and bidirectional LSTM networks. *Sci Rep* 11, 3025 (2021). doi: <https://doi.org/10.1038/s41598-021-81101-1>
- 7 F. Luo, S. Poslad and E. Bodanese. Kitchen Activity Detection for Healthcare using a Low-Power Radar-Enabled Sensor Network. *ICC 2019 - 2019 IEEE International Conference on Communications (ICC)*. Shanghai, China. 2019, pp. 1-7. doi: <https://doi.org/10.1109/ICC.2019.8761484>.
- 8 Chen, S., Jones, L.A., Jiang, S. et al. Difficulty and help with activities of daily living among older adults living alone during the COVID-19 pandemic: a multi-country population-based study. *BMC Geriatr* 22, 181 (2022). doi: <https://doi.org/10.1186/s12877-022-02799-w>
- 9 Farooq M, Doulah A, Parton J, McCrory M, Higgins J, Sazonov E. Validation of Sensor-Based Food Intake Detection by Multicamera Video Observation in an Unconstrained Environment. *Nutrients*. 2019 Mar 13;11(3):609. doi: <https://doi.org/10.3390/nu11030609>

- 10 Turjamaa R, Pehkonen A, Kangasniemi M. How smart homes are used to support older people: An integrative review. *International Journal of Older People Nursing*. 2019 Jul 12;14(4). Doi: 10.1111/opn.12260
- 11 Agbavor F, Liang H. Predicting dementia from spontaneous speech using large language models. Geisler BP, editor. *PLOS Digital Health*. 2022 Dec 22;1(12):e0000168. doi: 10.1371/journal.pdig.0000168
- 12 Biswas J, Sim KS, Huang W, Andrei Tolstikov, Aung Khyaw Aung, M. Jayachandran, et al. Sensor based micro context for mild dementia assistance. In *Proceedings of the 3rd International Conference on Pervasive Technologies Related to Assistive Environments (PETRA '10)*. 2010 Jun 23;20:1–4. doi: 10.1145/1839294.1839318
- 13 Sakai Y, Nonaka Y, Yasuda K, Nakano YI. Listener agent for elderly people with dementia. In *Proceedings of the seventh annual ACM/IEEE international conference on Human-Robot Interaction (HRI '12)*. 2012 Mar 5;199–200. doi: <https://doi.org/10.1145/2157689.2157754>
- 14 Striegl J, Gollasch D, Loitsch C, Weber G. Designing VUIs for Social Assistance Robots for People with Dementia. In *Proceedings of Mensch und Computer 2021 (MuC '21)*. 2021 Sep 5;145–55. doi: <https://doi.org/10.1145/3473856.3473887>
- 15 Hoey J, Poupart P, Bertoldi A von, Craig T, Boutilier C, Mihailidis A. Automated handwashing assistance for persons with dementia using video and a partially observable Markov decision process. *Computer Vision and Image Understanding*. 2010 May;114(5):503–19. doi : 10.1016/j.cviu.2009.06.008
- 16 Pollack ME, Brown L, Colbry D, McCarthy CE, Orosz C, Peintner B, et al. Autominder: an intelligent cognitive orthotic system for people with memory impairment. *Robotics and Autonomous Systems*. 2003 Sep;44(3-4):273–82. doi: 10.1016/s0921-8890(03)00077-0
- 17 Nishchik A, Geentjens W, Medina A, Klein M, Chen W. An Augmented Reality Game for Helping Elderly to Perform Physical Exercises at Home. *Lecture Notes in Computer Science*. 2020;12376:233–41. doi: 10.1007/978-3-030-58796-3_28
- 18 Hiter S. What Is a Large Language Model? | Guide to LLMs [Internet]. eWEEK. 2023. Available from: <https://www.eweek.com/artificial-intelligence/large-language-model/>
- 19 OpenAI API [Internet]. platform.openai.com. Available from: <https://platform.openai.com/docs/introduction/key-concepts>
- 20 BROWNLEE J. What Is Zero UI? (And Why Is It Crucial To The Future Of Design?) [Internet]. 2015. Available from: <https://www.fastcompany.com/3048139/what-is-zero-ui-and-why-is-it-crucial-to-the-future-of-design>

- 21 What is Zero UI? | Zivtech [Internet]. www.zivtech.com. 2018 [cited 2023 Aug 7]. Available from: <https://www.zivtech.com/blog/what-zero-ui>
- 22 Anttila H, Niemelä M, Anttila M, Pekkarinen S, Hallamaa J, Koskinen J. Towards Ethical and Sustainable Technology-Supported Ageing at Home in Finland -KATI Programme 4.0 International (CC BY 4.0) 34 [Internet]. [cited 2023 Aug 19]. Available from: https://ceur-ws.org/Vol-3069/FP_03.pdf
- 23 Stefanov DH, Zeungnam Bien, Won-Chul Bang. The smart house for older persons and persons with physical disabilities: structure, technology arrangements, and perspectives. IEEE Transactions on Neural Systems and Rehabilitation Engineering [Internet]. 2004 Jun 1;12(2):228–50. Doi: 10.1109/TNSRE.2004.828423
- 24 KHALED HUQ Z. Elderly health problems and care - Op-Ed - observerbd.com [Internet]. The Daily Observer. 2020 [cited 2023 Sep 28]. Available from: <https://www.observerbd.com/news.php?id=279625>
- 25 Figure 5. Available from: <https://www.dreamstime.com/new-normal-contactless-payment-touchless-technology-wireless-credit-card-smart-smartphone-automatic-door-faucet-alcohol-image183494967>
- 26 Several discussions with Kari Backman, CEO of Benete
- 27 Pouladzadeh P, Shirmohammadi S, Al-Maghrabi R. Measuring Calorie and Nutrition From Food Image. IEEE Transactions on Instrumentation and Measurement [Internet]. 2014 Aug 1 [cited 2020 Mar 3];63(8):1947–56. Doi: 10.1109/TIM.2014.2303533
- 28 Stolojescu-Crisan C, Crisan C, Butunoi BP. An IoT-Based Smart Home Automation System. Sensors. 2021 May 30;21(11):3784. doi: <https://doi.org/10.3390/s21113784>
- 29 Guo Y, Yuan T, Yue S. Designing Personalized Persuasive Game Elements for Older Adults in Health Apps. Applied Sciences [Internet]. 2022 Jan 1;12(12):6271. doi: <https://doi.org/10.3390/app12126271>

Appendix

Full ChatGPT Responses

Hi, how are you?

Hello! As an AI language model, I don't have feelings, but I'm here to assist you with any questions or information you need. How can I help you today?

Okay. I am looking for Zero UI

Zero UI refers to a design concept and user experience where interfaces and interactions are performed through natural language and gestures, rather than through graphical user interfaces (GUIs) such as buttons, icons, and touchscreens. The goal of Zero UI is to create a seamless and intuitive experience for users, allowing them to interact with technology in a more human-like way, using voice or gestures to perform tasks and access information.

Zero UI is being used in a variety of applications, such as voice assistants, smart home devices, and wearable technology. With the growing trend towards artificial intelligence and the Internet of Things, it's likely that Zero UI will become an increasingly important aspect of user experience design in the future.

How Zero UI can support elderly living alone at home?

Zero UI has the potential to significantly improve the quality of life for elderly

individuals living alone at home by making technology more accessible and

intuitive. Here are some ways that Zero UI can support the elderly:

1. **Voice Assistance:** Voice-controlled virtual assistants can provide the elderly with an easy and natural way to control smart devices, access information, and perform tasks, such as setting reminders, making phone calls, and controlling the lights and temperature in their home.
2. **Safety and Emergency Response:** Zero UI technology can be integrated into home security systems, allowing elderly individuals to quickly and easily call for help in an emergency. For example, a voice command can trigger a call to a designated emergency contact or send an alert to a monitoring service.
3. **Health Monitoring:** Zero UI can be used to monitor an elderly person's health and wellbeing, such as tracking their activity levels, monitoring their sleep patterns, and alerting family members or caretakers if there are any changes or concerns.

4. **Social Interaction:** Zero UI can also provide elderly individuals with new opportunities for social interaction and connection, such as video calls with family members, friends, and caretakers.

Overall, Zero UI has the potential to enhance the independence, safety, and quality of life for elderly individuals living alone at home. By making technology more accessible and user-friendly, it can help them stay connected, informed, and engaged, while also reducing the risk of accidents and emergency situations.

How Zero UI can help elderly in their ADL?

Zero UI has the potential to greatly aid elderly individuals in performing their activities of daily living (ADLs). Here are some ways that Zero UI can support the elderly in their ADLs:

1. **Hands-Free Control:** Zero UI technology allows elderly individuals to control devices and perform tasks hands-free, which can be particularly helpful for those with limited mobility or dexterity. Voice-controlled virtual assistants can be used to control lights, adjust the temperature, and perform other tasks, reducing the need for physical effort.
2. **Medication Reminders:** Zero UI can provide elderly individuals with reminders to take their medication, helping to ensure that they stay on track with their prescribed treatment plan.
3. **Home Safety:** Zero UI technology can also help make the home safer for the elderly by providing reminders to lock doors and windows, turn off the stove, and perform other safety-related tasks.
4. **Fall Detection:** Some Zero UI devices can detect falls and alert family members or caretakers if they occur, providing the elderly with an extra layer of safety and security.
5. **Assistive Technology:** Zero UI can also be used to operate assistive technology devices, such as electric lift chairs, hospital beds, and mobility scooters, making it easier for elderly individuals to perform ADLs and maintain their independence.

In conclusion, Zero UI has the potential to greatly enhance the ability of elderly individuals to perform their activities of daily living, helping to maintain their independence and improve their quality of life.