AIn’t Forgetting.

Leveraging the Power of Artificial Intelligence in Elderly Care

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Abstract

The global demographic landscape has undergone a remarkable transformation in recent years, marked by an increasing aging population. This demographic shift poses unique challenges, especially in elderly care. As we witness a growing number of older individuals forced to or choosing to live in single-households, there is an urgent need to address the emerging complexities associated with aging-related conditions such as dementia. Integrating Artificial Intelligence in elderly care presents a novel and promising avenue to empower these individuals, offering them enhanced autonomy and an improved quality of life. In this article, the authors introduce their solution, Aura, an AI-powered system designed to address the unique needs of dementia patients. Aura not only serves as a medication dispenser but also fosters emotional support
and cognitive engagement, thereby enhancing the well-being and independence of dementia patients. This paper delves into the project 'In|Visible', which focuses on catering to the special needs of people developing signs of dementia.

Keywords: Medical Anthropology, Artificial Intelligence, Dementia, User Experience Design, Health Care, Industrial Design

Using AI to Empower Elderly Individuals

The demographic landscape of our world is undergoing a profound transformation characterized by an aging population. This shift is not confined to any region; it is a global phenomenon. The percentage of elderly globally increased from 8% in 1950 to 10% in 2000 and is projected to reach 21% by 2050 (Abhay Bm, 2014)[1]. This remarkable demographic shift represents not only the impressive gains in human longevity but also poses significant challenges for healthcare systems and societal structures. Taking a look into Germany, 6 million Germans over the age of 65 are living alone, states a press release of the German Federal Office of Statistics (DeStatis, 2023)[2]. As the global population ages, the demand for healthcare services grows, and the working-age population tends to shrink (Jarzebski, M.P., 2021)[3]. This shift brings to the forefront the concept of 'Aging in Place' – a growing preference among older people to live independently or in care homes. Aging in place, as defined by Wiles et al. (2012)[4], refers to the concept where older individuals have the choice to continue living in their homes, neighborhoods, and communities, maintaining functional, symbolic, and emotional attachments, thereby promoting a sense of attachment, security, and identity. However, this trend is accompanied by significant challenges, particularly for those affected by dementia.

Classification of Dementia

Dementia, a cognitive disorder, as defined by the International Statistical Classification of Diseases, 10th Revision (ICD-10, 2022)[5] and the Diagnostic and Statistical Manual of Mental Disorders (DSM-V), is a multifaceted syndrome characterized by a decline in memory, thinking, behavior, and the ability to perform everyday activities. It substantially impacts globally, reshaping the dynamics of care and support. As we delve deeper into the implications of this, it becomes evident that it not only affects the individuals directly experiencing these cognitive challenges but also extends its impact to families, caregivers, and the broader community. The need for innovative solutions to support the elderly in maintaining their independence while ensuring their safety and well-being becomes increasingly critical. This is particularly pertinent in the context of dementia, where the gradual loss of cognitive functions can significantly hinder an individual's ability to live independently.

Medication Management and Dementia

In the various specializations of elderly care, managing and supplying medication for dementia patients stands out as a particularly time-consuming and challenging task. The multifaceted nature of dementia care demands constant attention and a nuanced understanding of the patient's needs. Authors such as Gaßmann (2018)[6] highlighted that the average individual aged 60-70 takes approximately 8.5 medications daily. This means that the staff of a care home of 20

patients would have to prepare 170 different medicaments daily and give all of them to the right people at the right time. This translates to a substantial burden on care home staff, who must prepare and administer these medications to each patient correctly and timely.

Moreover, dementia patients often resist taking their medications, ranging from a lack of understanding of what is being offered to outright refusal. Caregivers, whether family members or professionals in care homes, often find themselves overwhelmed by the demands of medication management, which can lead to increased stress and potential errors. Furthermore, the cognitive decline associated with dementia, which intensifies feelings of disorientation and isolation in the elderly population, leads to an increased dependence on others for support and a consequent reduction in their sense of self-confidence.

Project

Therefore, the concept of aging in place is not just about the physical location of where one ages. Still, it encompasses a broader narrative about maintaining one's quality of life, dignity, and independence (National Library of Medicine, 2016)[7]. It challenges us to rethink the traditional paradigms of elderly care and to consider more inclusive, empathetic, and supportive approaches that align with the aspirations and needs of the aging population. That was the primary development goal of the educational design project 'In|Visible' in the bachelor's study program of industrial design. The project, supervised by Prof. Pelin Celik, Prof. Gerhard Kampe, and Paulina Stefanovic at HTW Berlin, addresses a significant and growing challenge in our society: the increasing number of elderly individuals living alone, particularly those showing signs of dementia. As the demographic shift leads to a higher proportion of older people, many of whom live in isolation, the prevalence and impact of dementia become increasingly prominent concerns. 'In|Visible' aims to empower these individuals towards greater autonomy and improved quality of life, focusing specifically on the nuanced needs of people with dementia.

Artificial Intelligence in Medical Applications

Within this evolving landscape of aging and independence, the intersection of technology and human-centered understanding emerges as a crucial area of exploration. This is where the innovative application of Artificial Intelligence (AI) and the principles of medical anthropology become pivotal. With AI, a prevalent topic is the potential replacement of human jobs by automation through robotics or AI. This issue often stirs a collective fear of job loss, a perceived threat of highly productive machines or AI potentially surpassing human intelligence. AI offers a promising avenue for creating solutions that are not only technologically advanced but also profoundly attuned to the psychological and emotional needs of the elderly, particularly those with dementia.

Meanwhile, medical anthropology provides a lens to understand how cultural, social, and environmental factors influence the aging population's health, well-being, and care preferences. The Project 'IN|Visible,' therefore, stands at this crossroads, where the technological progress of AI meets the empathetic and holistic approach of medical anthropology and design. It exemplifies how integrating these disciplines can lead to more refined, personalized, and effective care strategies. By leveraging AI, the project seeks to develop tools that can adapt to and address the unique challenges faced by individuals with dementia. At the same time, medical anthropology guides the design process to ensure these tools are culturally sensitive, inclusive, and supportive of the dignity and independence of older people.

Having established the broader context through Project 'IN|Visible' and the challenges it seeks to address due to the described lack of caretakers providing care and support to older adults. This problem centers around the intricate needs of dementia patients, particularly in terms of medication management and maintaining a sense of connection and normalcy in their lives.

Idea

The Problem

Despite advancements in care practices, the unique difficulties faced by individuals with dementia often remain unmet, leading to significant gaps in the quality of care provided. Our project identifies and aims to address these precise issues, recognizing that the growing number of elderly individuals living alone, especially those with dementia, requires more than just traditional care models. The Project aims to provide a solution that not only eases the burden of medication management but also fosters emotional support and cognitive engagement, thereby enhancing the well-being and independence of dementia patients. This specific focus on dementia care allows us to delve into the complexities of the condition and explore human-centered design solutions. Dementia, due to symptoms like a decline in cognitive function, poses unique challenges in care – from ensuring accurate medication adherence to providing consistent emotional and mental support. Our project addresses these needs by integrating technological innovation with a deep understanding of the human aspect of dementia care. In doing so, we aim to design modern technology connecting high-quality elderly care with the personalized care required by people with dementia.

The Idea of Aura

It is building upon the previously stated problems and challenges in elderly care, incorporating the burdensome task of medication management and addressing loneliness among the elderly, particularly for individuals with dementia. The concept of Aura emerges as a response to

these identified needs. Developed using insights from field research and testing AI speech models, Aura is designed to cater to the nuanced requirements of dementia patients specifically. This AI-powered system transcends the conventional role of a medication dispenser by adopting a more comprehensive approach to elderly care. Aura's primary function involves ensuring the timely and accurate dispensation of medication, a crucial aspect in dementia care where medication management can be a significant burden for caregivers and family members. This system streamlines the process and offers essential information to simplify medical routines for patients and caregivers. By doing so, Aura addresses the issue of medication errors, contributing to safer healthcare practices, as highlighted in the previous sections. Adding to its functional benefits, Aura symbolizes companionship and support for individuals with dementia. Its regular interactions and check-ins are designed to provide a sense of normalcy and routine, countering the disorienting effects of dementia. Such interaction is crucial, aligning with patients' emotional and psychological needs, helping maintain their dignity and independence. This aspect of Aura resonates with aging in place, where maintaining quality of life and autonomy is paramount.

The Development process of Aura

In developing Aura, the team adopted the 4-step human-centered design process (Harte et al., 2017)[12], a recognized method in product development characterized by its cyclical nature and emphasis on user-centricity. This approach includes understanding the user, specifying user requirements, producing design solutions, and evaluating these designs. In the following, you can see our application of this approach.

Specify the user and the context of use: The initial phase focused on empathetically understanding the needs of individuals with dementia, which was essential to grasp the complex challenges faced by this demographic.

Specify the user requirements: This phase involved a detailed definition of the problems identified previously. For Aura, this translated to addressing critical issues such as medication management, cognitive support, and enhancing life quality for dementia patients.

Produce design solutions: During this phase, creative solutions are generated. For Aura, this involved brainstorming ways to integrate AI technology to address the defined problems effectively.

Evaluate designs: Development of the Aura prototype incorporated AI capabilities for medication management and user interaction. This vital step included testing with real users to collect feedback and gauge the efficacy and areas needing improvement.

This systematic approach ensures that the development of Aura is user-centered, addressing the specific needs of dementia patients and their caregivers. It aligns with the project's goals of enhancing the autonomy and well-being of its users through innovative and empathetic design.

Specify the user and the context of use

The development of Aura using the design thinking process begins with the context phase to empathize with the user, which is crucial for understanding the user's perspective and experiences. This phase is not just about observation but involves immersive field research, which reveals deep insights into the daily lives and adaptive strategies of dementia patients. In the case of Aura, field research was conducted in several dementia care homes, providing an in-depth understanding of the daily challenges and behaviors of dementia patients. For example, the observed behavior of rummaging, where patients tend to move objects around, often reflects past hobbies or professions, offering insights into their past lives and identities. The caretakers had the idea to hang bags and similar items in different parts of the care home. And we could witness the patients moving them, picking them up like they were on a shopping trip. For example, a patient who used to work as a vet always chooses an oversized handbag. One of the caretakers told us it reminds him of the carrying box where small animals get moved. Such behaviors, including selecting specific objects like handbags that resonate with their past experiences, highlight the unique and individualized ways dementia patients interact with their environment.

Figure 1 Bags and props in a dementia care home. Photo: ©Scheffer, Somasundaram 2023)

Our research engaged closely with the care staff to understand their perspectives and challenges. The insights revealed the mental strain experienced by caregivers, mainly due to long shifts compounded by understaffing. This stress is further intensified when caring for dementia patients, who often require extra patience and attention. The care staff provided detailed explanations of the medication management process. Each patient has a personalized printed medication plan prepared by hand for the entire week. Furthermore, administering medication to patients was highlighted as a significant challenge. Due to confusion and cognitive impairment associated with dementia, convincing a patient to take their medication can be a time-consuming task, sometimes extending up to 45 minutes. Considering the limited time and resources available in care settings, this situation underscores a critical gap in our current care system – the need for efficient yet compassionate approaches to medication management. By empathizing with the users – in this case, both dementia patients and caregivers – the development of Aura could focus on addressing these specific needs and behaviors. This understanding of the caregiving environment emphasizes the need for innovative solutions to alleviate these burdens, streamline the medication process, and enhance the overall care experience for patients and staff.

Specify the user requirements

Having gained a deep understanding of the problems faced in dementia care, Aura's development shifted towards specifying user requirements. Central to this phase was the objective to create an AI-powered device adept at precise medication dispensing while catering to the broader social and emotional needs of dementia patients. The primary requirement identified was simplifying the complexity of medication management. Aura's design aimed to streamline this essential process, ensuring accurate dispensing of medications at appropriate times, thereby alleviating the load on caregivers and reducing medication error risks. Additionally, a significant requirement was addressing cognitive support. With dementia patients commonly facing disorientation, memory loss, and cognitive decline, Aura incorporated features for regular interactions, reminders, and engaging activities to boost mental faculties, thus responding to the multifaceted needs of dementia care.

Produce design solutions

In the ideation phase of Aura's development, a three-layer approach was adopted, encompassing the structuring of information architecture for the user experience, formulating an engaging user interface, and conceptualizing a physical design.

The Phase began with the naming of the device. Aura was chosen to evoke the sense of a constant, enveloping presence, a guiding force that always supports users. This idea was crucial in linking the various layers of the project, embodying the overarching theme of a supportive and ever-present aid. The user experience of Aura is separated into two parts as a link between patients and their network of family, caregivers, and doctors. Aura acts as a central hub, organizing and distributing data relevant to each party. For patients, the user journey is anchored in a Speech UI, while others interact through an app. Validation and Reassurance were instrumental in the design of the patient's AI interface. This strategic focus aimed to establish a stable and supportive environment, counteracting the disorientation often associated with dementia. Leveraging these principles, an AI system was developed as a user interface, providing the stability and consistency dementia patients need.

The challenge in creating the user interface was to develop a visual representation that would resonate with users, fostering a sense of connection to Aura. Initial experiments with human-like figures proved overly complex and distracting for users. The team eventually gravitated towards simplicity, settling on a circle for its straightforward yet profound symbolism of continuous presence and envelopment. Subtle animations, such as scaling and distortion, imbued the circle with a semblance of vitality, an essential characteristic for engendering a sense of liveliness and engagement.

This concept of 'aliveness' extended to the physical design of Aura, which drew inspiration from familiar objects like desk clocks and jukeboxes, fostering a sense of familiarity and comfort. The design incorporated organic elements along its sides, discreetly integrating the speakers and microphones. This design provided functional utility and contributed to the perception of Aura as a lifelike companion. The development of Aura's design involved combining traditional sketching techniques, both on paper and digitally, with cutting-edge tools like Virtual Reality (VR) and Generative AI. This approach was essential in visualizing the various aspects of Aura's physical form. The design team employed Generative AI technologies, particularly DallE-3[9] and Midjourney[10], to generate multiple iterations based on text prompts and initial sketches. This integration of AI in the design process provided valuable insights into potential design directions, helping to identify which elements were practical and which needed refinement. One challenge during this phase was the balance between detail and simplicity in the AI-generated images. The designs sometimes exhibited an overload of details or could have been more complex, lacking distinctive character. Despite these challenges, this phase was instrumental in shaping the initial conception of Aura's physical appearance, laying the groundwork for further refinement and development. Multiple iterations of the physical form were explored to achieve the desired impact on the user, ensuring that Aura's presence was both comforting and empowering.

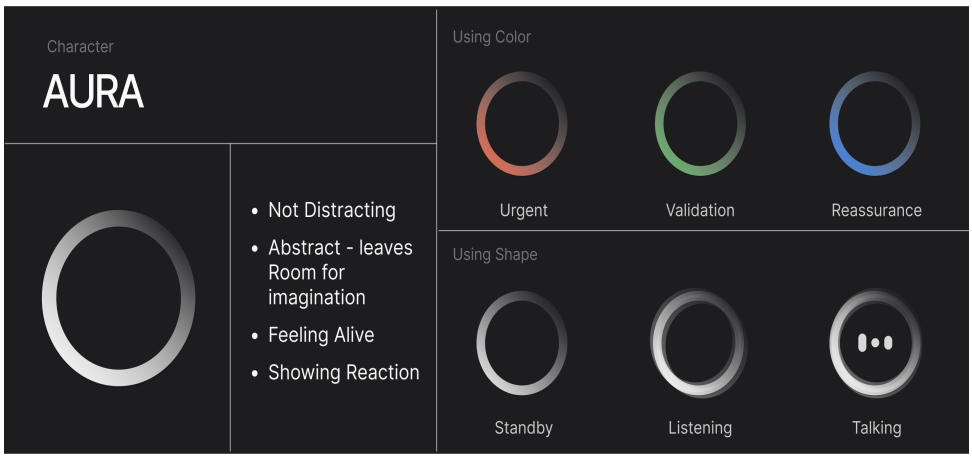

Figure 2 Aura - Shape ideation sketches. Graphic ©: Scheffer, Somasundaram 2023

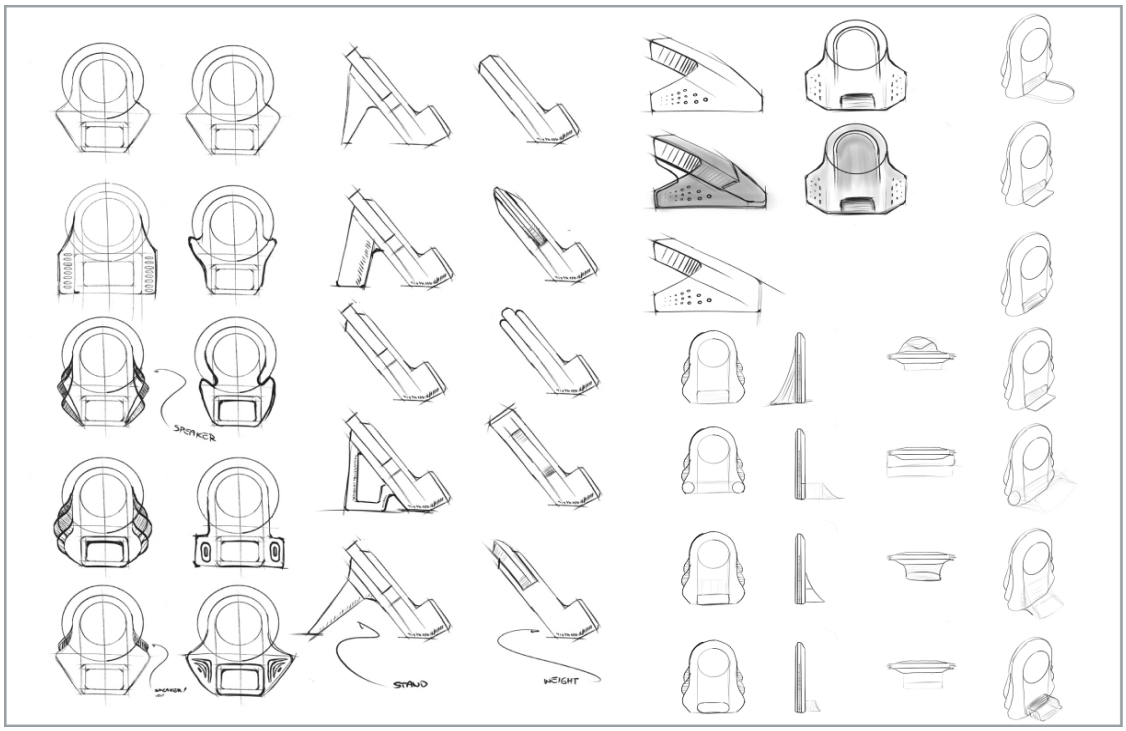

Figure 3 Aura - visual interface. Graphic ©: Scheffer, Somasundaram 2023

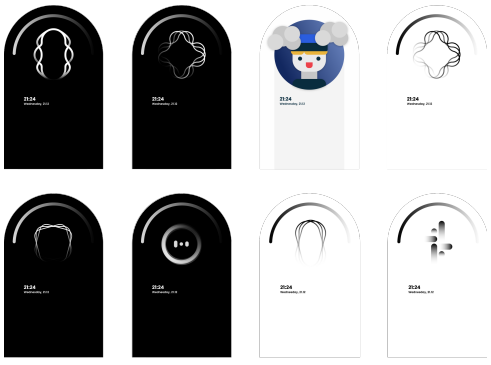

Figure 4 App UI wireframes. Graphic ©: Scheffer, Somasundaram 2023

Evaluate designs

The prototyping phase was integral in bringing Aura to life, blending various elements to test the concept's feasibility and effectiveness. Initially, we embarked on creating an AI system prototype, leveraging a model based on ChatGPT[8]. This prototype aimed to simulate user interactions with the AI, mainly focusing on how individuals with dementia would engage with the system. Simultaneously, the development of user interfaces was underway, tailoring separate, intuitive designs for patient interaction through a speech interface and caregiver, doctor, and family member interactions via an app interface. Each interface was designed with user-friendliness and accessibility at its core. The final piece of the prototyping was the physical product. This tangible embodiment of Aura's concept allowed for a thorough assessment of its design, ergonomics, and functionality. As highlighted by Camburn et al. (2017), the prototyping process is a cornerstone in product development, serving as a bridge between conceptual ideas and their practical realization (Camburn et al., 2017)[11]. It facilitates a deeper understanding of the product and supports effective communication between the development team and stakeholders. It also helps to test out theories and prove if they work in the practical field.

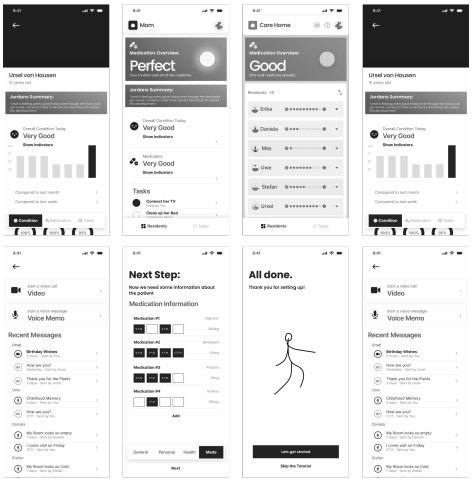

Figure 5 Interface Ideation. Graphic ©: Scheffer, Somasundaram 2023

For the user testing phase of Aura's development, we adopted a comprehensive approach to ensure the product's design and functionality met the needs of its intended users. This phase was crucial in refining Aura, mainly focusing on the interaction between dementia patients and the AI system. We initiated the process by testing various AI speech models based on ChatGPT[8] with a select group of patients to assess their reactions and gauge the interface's intuitiveness. One significant challenge encountered was helping patients distinguish when to speak and when to listen, as a loaded interface led to confusion. However, it was observed that patients were notably comforted by the calming voice of the model. One patient remarked that she felt as if she were conversing with a familiar friend, emphasizing the importance of a soothing and friendly AI voice in creating a positive user experience. To address these findings, we developed a simplified interface that mimics natural speech patterns, catering to the unique needs of individuals with dementia and the independently living elderly. Aura's design facilitates interactive engagement through routine check-ins, offering a reassuring presence and responding to daily inquiries about schedules and well-being.

Figure 6 Physical form testing Photo ©: Moritz Scheffer, Somasundaram 2023)

Moreover, Aura employs a combination of audio and visual cues to enhance medication adherence. For instance, the system might suggest, *"After taking your medication, we can listen to your favorite song!"* This method effectively intertwines treatment with enjoyable

activities, enriching the user experience. The final stage involved assessing the physical prototype, examining its stability and ease of pill retrieval, and determining the optimal size for practicality and user comfort. A key design feature emerged as side waves, ingeniously concealing the microphone and speakers while creating a visual impression of fluid waves or wings, contributing to the device's aesthetic appeal. To find the most effective design, we conducted user tests with three primary forms of Aura: one version lacking the wave feature and two variants incorporating the waves, one of which had a more squared shape. The feedback from these user tests was clear. Users strongly preferred the rounded shape with the waves, finding it more relatable and visually appealing than the squared version or the design without the waves. This apparent preference guided us in finalizing Aura's design, ensuring it resonates with users functionally and visually.

Figure 7 AI testing using Custom GPT`s. Photo ©: Scheffer, Somasundaram 2023

Each phase was pivotal in refining Aura's design, ensuring it meets its users' practical needs and preferences. Having navigated the design thinking process—from empathizing with users, defining the core issues, and ideating innovative solutions to prototyping and user testing—we have crystallized the essence of Aura. This journey has not only heightened the functionality and aesthetics of Aura but also deepened our understanding of its potential impact.

Results and Impact Assessment

Incorporating the challenges identified in the research, Aura's design and functionality have been tailored to address the specific needs and struggles of dementia patients and their caregivers. The aesthetic inspiration of Aura, drawn from classic desk clocks and jukeboxes, evokes a sense of familiarity, crucial for dementia patients who find comfort in recognizable objects. This familiarity is a direct response to the observed disorientation and anxiety among dementia patients, as previously discussed. The organic design along the sides, subtly incorporating speakers and microphones, not only adds to Aura's lifelike and calming presence but also aligns with our goal of creating a non-intrusive, empathetic companion for patients.

The medication dispensing system of Aura, featuring a removable wheel capable of holding up to 14 days of medication with doses dispensed four times a day, directly addresses the challenge of medication management highlighted in the introduction. This design simplifies the refill process for caregivers and family members, who often struggle with the time-intensive and error-prone task of medication management. Incorporating weight sensors and a camera in the ergonomic bottom dispenser ensures correct pill intake, addressing the risk of medication errors. The LED lights provide essential visual guidance, supporting the needs of visually impaired patients and assisting them in navigating through the device's functionality.

Introducing the Aura Pin was essential to the project to tackle the issue of patients being away from Aura during medication times. This handheld device, attachable to any textile surface and equipped with the same speech model as the central station, ensures constant companionship and timely reminders for medication intake. The Aura Pin effectively bridges the gap when the patient is in another room, providing a seamless and integrated solution to the problem of medication adherence in dementia care. This emphasizes the effect of Aura being present at all times and can be incorporated into daily routines.

Furthermore, Aura's impact extends to compiling detailed health data, which is invaluable for caregivers and medical professionals. This data collection and monitoring aspect of Aura aligns with the broader goals of enhancing elderly care by providing caregivers with the necessary tools and information to make informed decisions about patient care.

In evaluating the prospective impact of Aura on elderly care, it becomes evident that its introduction could revolutionize how caregivers, families, and dementia patients navigate the complexities of aging and cognitive health. The anticipated effects of Aura can be directly linked to the initial challenges outlined at the beginning of our study, particularly in the context of aging in place, medical anthropology, and the mental health struggles caregivers and patients face.

Possible Impact on Caregivers and Families

Aura is poised to significantly alleviate the burdens often shouldered by caregivers and family members. By automating what has traditionally been a time-intensive and error-prone process, Aura could drastically reduce medication management workload. This increased efficiency minimizes medication errors and frees caregivers to focus more on direct patient interaction and care. Consequently, Aura is anticipated to enhance the quality of care for dementia patients, easing the logistical strain on caregivers and family members. This alignment with the principles of medical anthropology suggests a more comprehensive approach to elderly care, addressing not just the physical but also the emotional needs of patients and their support networks.

Possible Impact on Dementia Patients

For dementia patients, the expected impact of Aura extends beyond mere technological assistance. It is envisioned as a source of emotional and cognitive support, an aspect underscored in our initial discussions about aging in place. The AI-driven interaction model, featuring a user-friendly interface and calming voice prompts, is designed to prevent loneliness. This aspect is crucial for dementia patients who often grapple with feelings of isolation and disconnection due to cognitive impairments. Moreover, by assisting in maintaining a structured medication routine, Aura aims to aid mental functioning and foster a sense of independence among patients. This support is essential in empowering dementia patients, enabling them to retain autonomy in their daily lives and enhancing their overall well-being and quality of life. Such an approach resonates with the initial findings from our research, emphasizing the need for solutions that support both the physical and emotional aspects of aging and dementia care.

Conclusion

The development of AURA, as an AI-powered pill dispenser, provides promising solutions in elderly care, mainly focusing on enhancing the care experience for dementia patients and their caregivers. This journey, grounded in the principles of medical anthropology and aided by the ability of artificial intelligence, has explored how technology can be harmoniously integrated with human-centric care.

Reflecting on the initial challenges identified—such as the demographic shift towards an aging population, the intricacies of dementia, and the stressors on caregivers—Aura emerges as a meaningful response. It embodies a synthesis of technology and empathy, specifically designed to

address the complex dynamics of medication management, cognitive support, and enhancing the quality of life for dementia patients.

It’s pivotal to reflect on the transformational role of AI within elderly care. Contrary to the initial fears of AI replacing human jobs, Aura gives us an insight into how AI can serve as a complementary tool, enhancing human capabilities in caregiving rather than supplanting them. This project illustrates that AI, particularly in elderly care, is not about diminishing the human element but augmenting it for improved efficiency and empathy. By automating routine tasks like medication management, Aura enables caregivers to devote more time to essential aspects of care that necessitate human empathy and compassion. This shift towards using AI as a supportive tool aligns with aging principles in place, emphasizing the importance of emotional and social support in elderly care. Aura's development and anticipated impact highlight AI's potential to address logistical challenges in healthcare and enrich the caregiving experience, providing a more fulfilling and compassionate environment for patients and caregivers.

Aura's development process, driven by design thinking principles, has underscored the importance of a user-centric design. Each stage, from empathizing with dementia patients and caregivers to prototyping with AI and testing, has contributed to a deeper understanding of the needs and preferences of its users. Aura's design, inspired by familiar objects, brings a sense of comfort and normalcy to dementia patients, addressing the disorientation and anxiety often associated with the condition. Its intuitive interfaces and engaging interaction model have affirmed that technological innovation must be genuinely effective in elderly care, underpinned by an empathetic understanding of the human experience.

Aura’s potential to scale and adapt to different cultural and socio-economic contexts presents an opportunity to make AI-powered healthcare solutions more accessible and effective globally.

Figure 8 Aura - Final Rendering ©Scheffer, Somasundaram, 2023)

In essence, the development of Aura reflects a profound understanding of the intersection between AI and elderly care. It highlights the technology's role not only as a facilitator of innovative solutions but also as an enabler of empathetic and holistic care approaches. The journey of Aura, from concept to realization, is a testament to the transformative power of integrating technology with an understanding of human needs in elderly care.

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