

[投稿: 研究ノート]

Seeing Without Watching

Ethical and Emotional Dimensions of AI-based Emotional Support Systems in Japan's Aging Society

監視なき見守り

日本の高齢社会における AI 感情サポートシステムの倫理的・情動的次元

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Abstract:

This study explores the ethical and emotional implications of AI-based emotional support systems in elderly care. Based on fieldwork in Chiba, Saitama, and Kanagawa Prefectures, it focuses on the “camera dilemma”—the tension between safety monitoring and human dignity. Findings reveal that while AI-based emotional support systems can foster comfort and social connection, they may also generate anxiety and stress linked to surveillance. The study proposes “seeing without watching,” an empathic-sensing framework that balances protection with dignity and redefines humane technological care in Japan’s super-aged society.

本研究は、高齢者ケアにおける AI 感情サポートシステム導入の倫理的含意を検討する。千葉・埼玉・神奈川県でのフィールドワークを通じて、安全確保のための監視と人間の尊厳との間の緊張関係である「カメラ・ジレンマ」に焦点を当てる。分析の結果、AI 感情サポートシステムは安心感やつながりを促進する一方、監視に伴う不安やストレスを生む可能性が示された。そこで本研究は「見守るが監視しない」という共感的センシングの枠組みを提案し、保護と尊厳を両立する人間中心のケア技術のあり方を日本の超高齢社会で再定義する。

Keywords:

AI-based emotional support systems, monitoring, dignity, camera dilemma

AI 感情サポートシステム、監視、尊厳、カメラ・ジレンマ

1. Introduction

1.1 Research Background

This study investigates the ethical and emotional implications of introducing AI-based emotional support systems into Japan’s long-term-care (LTC) environments. Drawing on multi-site fieldwork in care facilities, technology mediation centers, and administrative institutions across Chiba, Saitama, and Kanagawa Prefectures, it explores how residents, caregivers, and policymakers perceive the growing presence of artificial intelligence in daily caregiving practice. Semi-structured interviews with residents, caregivers, facility directors, and government officials were conducted to examine both the benefits and challenges associated with the use of AI-based emotional support systems.

Overall, the findings portray a complex landscape. On one hand, AI-based emotional support systems are widely acknowledged for their potential to enhance residents’ well-being, alleviate caregiver stress, and strengthen communication between families and facilities. Many older adults expressed curiosity and joy when interacting with robots such as PALRO or BOCCO emo, describing them as “companions” that offered comfort and a sense of connection. Caregivers likewise appreciated how these devices could provide entertainment and emotional reassurance—particularly during busy hours when human attention was limited. In addition, for facilities struggling with chronic staff shortages, camera-enabled monitoring systems were often viewed as practical tools that help ensure residents’ safety even when direct supervision was difficult.

Yet alongside these perceived benefits, the study revealed growing ethical and psychological unease. Among various design features, the presence of cameras emerged as the most divisive. Families and administrators tended to favor camera-equipped robots for safety monitoring and emergency detection, valuing their ability to “see” and record facility conditions. In contrast, many older adults reported feelings of unease, loss of privacy, and diminished dignity under constant observation. Care staff also described discomfort and performance pressure—feeling both supported and scrutinized by the same technology meant to assist them.

Paradoxically, the very technology designed to see and protect can also provoke anxiety, stress, and resistance. This “camera dilemma”—the tension between care and control, empathy and surveillance—became a central theme of this research. It serves as a conceptual lens through which Japan’s super-aging society negotiates the moral and emotional

boundaries between technological assistance and human dignity.

To understand why such tensions emerge, it is necessary to situate them within Japan's evolving demographic structure and the realities of its long-term care system.

1.2 Japan's Demographic Aging and the Long-Term Care Crisis

Japan is experiencing one of the world's fastest demographic transitions, characterized by rapid population aging. According to the Cabinet Office (2021), Japan's old-age dependency ratio has declined sharply and is projected to approach 1:1 by 2060, placing increasing pressure on the long-term care system. Social phenomena such as *kodokushi* ("lonely deaths") further highlight the urgency of developing sustainable long-term-care arrangements.

At the same time, the proportion of lifelong single individuals has increased significantly, leading to growing demand for formal care services (Children and Families Agency, 2024).

The long-term-care (LTC) workforce is already under considerable strain. According to the Ministry of Health, Labour and Welfare (2024), 2.15 million care workers were needed nationwide in 2022, and demand is projected to reach 2.4 million by 2026, leaving a shortage of roughly 250,000 workers. Caregiver burden is also substantial: 60.8% of co-resident caregivers reported stress or anxiety, while only 22.7% reported none (MHLW, 2010).

Together, these trends highlight the increasing pressure on Japan's long-term care system. Beyond institutional challenges, these structural changes also shape the psychological well-being and social experiences of older adults.

1.3 Mental Health Vulnerability and Loneliness among Older Adults

Mental-health issues among older adults have become a critical concern in Japan. The Ministry of Health, Labour and Welfare (2018) reported that individuals aged 65 and above account for 31.7 percent of mood-disorder diagnoses—significantly higher than any younger group. Suicide statistics from the Ministry of Health, Labour and Welfare (2020) further reveal that between 2009 and 2019, annual suicides among adults aged 75 and above ranged from 3,800 to 4,400, highlighting considerable psychological vulnerability in late adulthood.

Beyond clinical indicators, research emphasizes the physiological and social consequences of chronic loneliness.

Fang et al. (2025) found that prolonged depression and anxiety impair immune, cardiovascular, and metabolic functions, increasing the risk of chronic illness. Similarly, Guarnera et al. (2023) noted that reduced interpersonal interaction—particularly during the COVID-19 pandemic—has intensified social isolation among older adults.

These findings suggest that loneliness in later life is not merely an emotional condition but a multidimensional public health challenge involving psychological, physiological, and social dimensions. Addressing it therefore requires innovative approaches that can support emotional well-being and social connection in aging societies.

In this context, AI-based emotional support systems have attracted growing attention as potential tools to complement human care. By providing companionship, interaction, and emotional engagement, these technologies may help alleviate loneliness and support the psychological well-being of older adults, particularly in environments where human caregiving resources are limited.

1.4 AI-Based Emotional Support Systems, Surveillance Ethics, and Privacy Tensions

AI-based emotional support systems are increasingly regarded as technological responses to loneliness and emotional decline among older adults. In this study, these systems are defined as intelligent technologies that provide companionship and emotional support through dialogue, emotional feedback, and social interaction, including socially assistive robots, conversational AI, and other interactive digital tools.

Previous studies suggest that these technologies can enhance emotional support and social interaction in eldercare environments. For example, a systematic review and meta-analysis by Nichol et al. (2024) found that socially assistive robots are associated with reduced loneliness and increased social engagement among older adults. However, evidence regarding broader outcomes—such as quality of life, anxiety, and depression—remains mixed, indicating that the impact of these systems depends heavily on technological design, usage context, and care environments.

In practice, many AI-based emotional support systems incorporate monitoring functions such as cameras, behavioral recognition, or remote observation technologies. While these features can improve safety management and risk prevention, they may simultaneously influence older adults' perceptions of privacy, autonomy, and dignity.

Scholars have examined these concerns from perspectives including surveillance studies and care ethics. Surveillance research argues that digital technologies increasingly subject everyday activities to continuous observation and data collection (Haggerty and Ericson, 2017). Within eldercare environments, monitoring technologies reshape not only how caregivers observe residents but also how residents experience being observed (Mortenson et al., 2015).

Research in care ethics likewise emphasizes the need to balance safety, privacy, and dignity in technology-assisted care. Berridge et al. (2019), for instance, report that many long-term care administrators express concerns about installing cameras in residents' rooms, particularly when residents have cognitive impairments that complicate meaningful consent. Constant visual monitoring may also generate stress among both residents and care staff.

To address such risks, Cavoukian (2011) proposed the concept of Privacy by Design, which advocates embedding privacy protection directly into technological systems during the design stage. Nevertheless, the tension between safety monitoring and privacy protection remains difficult to resolve in real-world care environments.

Building on these discussions, this study conceptualizes the ethical tension surrounding camera-enabled monitoring in care technologies as the “camera dilemma.”

The camera dilemma refers to a situation in which technologies designed to enhance safety and efficiency through visual monitoring simultaneously risk undermining users' privacy, dignity, and psychological comfort.

By examining how different actors interpret and negotiate this dilemma, the study contributes to a deeper understanding of the ethical boundaries between technological assistance and human dignity in aging societies.

1.5 Research Objectives

Existing studies have identified ethical tensions among safety, privacy, and dignity in the use of care technologies. However, empirical research remains limited on how these tensions emerge in everyday caregiving contexts. In Japan's long-term care environment in particular, little systematic research has examined how camera-equipped AI-based emotional support systems are understood, accepted, and implemented by different actors.

Based on this research gap, the study addresses the following research questions:

- (1) How do actors at different institutional levels understand and evaluate the use of AI-based emotional support systems in Japan's long-term care environment?
- (2) Why do camera-equipped AI-based emotional support systems generate tensions among privacy, dignity, and safety in care institutions?
- (3) What institutional and economic factors influence the adoption of AI-based emotional support systems in Japanese long-term care settings?

2. Research Method

To address the research questions outlined above, this study adopts a qualitative research approach based on fieldwork conducted in five institutions across Chiba, Saitama, and Kanagawa Prefectures. A total of eight semi-structured interviews were conducted with participants from different institutional backgrounds, including residents, caregivers, facility directors, and policy-related personnel. The interview data were organized and analyzed using thematic analysis. To enhance the reliability of the findings, triangulation was employed by comparing interview data with field observations and relevant documentary materials.

To obtain a more comprehensive understanding of the issue, this study examines perspectives from three levels:

- (1) Micro—Care Service Provision Sector (1 institution): a frontline care institution where technologies are directly used in everyday caregiving practices.
- (2) Meso—Technology Mediation Sector (2 institutions): organizations that connect technology developers with care institutions and support the introduction of AI-based emotional support systems.
- (3) Macro—Government and Policy Sector (2 institutions): administrative institutions that shape the policy environment and provide institutional support for the adoption of care technologies.

2.1 Care Service Provision Sector

At the micro level, a long-term care facility in Kanagawa exemplifies how this tension unfolds in daily practice. The facility actively employs PALRO for communication and recreational activities, including group exercise and storytelling. However, the facility deliberately rejected camera-equipped models, despite their potential for user recognition and safety monitoring. According to the facility director, the decision was rooted in three interrelated concerns:

- (1) Privacy protection—Many residents, particularly women, feel uncomfortable being filmed, especially during dressing, toileting, or resting.
- (2) Psychological burden on staff—Constant visual monitoring generates anxiety among caregivers, who feel as if they themselves are under surveillance.
- (3) Data security—The facility cannot fully ensure that visual data would never be leaked or misused, making non-camera devices a safer ethical choice.

While PALRO's non-camera version limits certain functionalities, residents have responded with warmth and enthusiasm. Many describe feeling "accompanied" and "listened to," finding joy in daily conversations with the robot. "When I talk to the robot, it feels like someone is listening to me." (Resident).

For care staff, such responses provide emotional relief: when they are occupied, PALRO can sustain light conversation and maintain residents' engagement.

At the same time, several caregivers admitted that camera-equipped robots could make their work easier—particularly at night or in understaffed situations—because they could remotely confirm residents' movements and safety without entering every room. Yet they also emphasized that this convenience "comes at a psychological cost": residents may feel stripped of privacy, and staff themselves may feel constantly evaluated.

In this sense, the care facility becomes a stage for an ethical balancing act—between protection and intrusion, efficiency and empathy. The facility's decision to "see less in order to care more" symbolizes a deliberate prioritization of dignity over technological completeness.

2.2 Technology Mediation Sector

At the meso level, the study explored the perspectives of a technology mediation center staff in Kanagawa Prefecture, who acts as a bridge between AI developers and care institutions. The interviewee emphasized that aligning technological innovation with real-world caregiving environments remains highly challenging.

One major barrier is workforce instability. Many care workers are part-time or irregular staff, resulting in frequent turnover and limited access to consistent training. In addition, a considerable proportion of caregivers are older and have limited digital literacy, making it difficult for them to acquire or maintain the skills necessary to operate these technologies. Consequently, the introduction and sustained use of AI-based

emotional support systems at the frontline level remain difficult.

The cost factor further exacerbates this issue. For instance, the standard PALRO model costs 382,800 yen (tax included), while the Business Series Model III—designed for institutional use—costs as much as 737,000 yen. (Fujisoft Inc., 2023) Only a minor share of facilities can afford such expenditures, even with potential subsidies.

The interviewee also shared his personal experiences with two robots—PALRO and Bocco emo—highlighting their differences in functionality and user interaction. PALRO is equipped with a camera for facial recognition, allowing the system to actively search for users and remember registered personal information, such as birthdays or holidays, to offer greetings. In contrast, Bocco emo operates without a camera, relying on vibration sensors to detect movement and sending notifications when users leave or return home. Its companion smartphone application enables family members to monitor interactions and send voice messages that the robot reads aloud to the user, thus promoting intergenerational communication and emotional connection.

The interviewee described that, over time, both robots began to feel "like family members." As interactions accumulated, conversations grew more natural and personal, fostering a sense of companionship and familiarity.

A pertinent field visit to a care training center in Saitama Prefecture revealed similar patterns. Many caregivers experience high emotional stress, particularly when facing residents' deaths, and traditional stress management approaches often fall short. Although AI-based emotional support systems could help reduce this mental burden, financial and institutional limitations have so far prevented their widespread adoption. Most facilities acknowledge the potential of such technologies but remain constrained by insufficient public funding and policy incentives.

2.3 Government and Policy Sector

At the macro level, the study examined findings from a government agency in Chiba to understand administrative perspectives on the adoption of AI-based emotional support systems. Fieldwork confirmed the funding shortages and policy discontinuities highlighted in the introduction.

Although government subsidies for AI-based emotional support systems were maintained in 2024 through programs such as a regional care technology implementation subsidy, the maximum subsidy for communicative or therapeutic robots remained capped at 300,000 yen per unit—far below the market

prices of models such as PALRO and PARO—and the number of subsidized units was limited to no more than half of the facility’s registered user capacity. As a result, many care facilities continue to face substantial financial barriers to adoption (Chiba Prefecture, 2024). Although some companies have provided free or short-term trial units to sustain interest, the high purchase and maintenance costs still prevent the widespread and long-term implementation of AI-based emotional support systems.

Government officials also pointed to privacy and ethical concerns. “Families often request monitoring systems for safety, but facilities worry about privacy and staff pressure. It is always a difficult balance.” (Policy officer, government agency in Chiba). Families often prefer monitoring functions for safety assurance, yet this creates a dilemma: while cameras can provide reassurance, they simultaneously raise staff stress, resident discomfort, and data security risks.

As one official summarized, balancing innovation with privacy protection remains a persistent challenge in Japan’s caregiving policy landscape.

3. Findings and conclusion

3.1 Research Findings

Based on the multi-level analysis presented above, this study finds that interest in AI-based emotional support systems is steadily increasing across Japan’s long-term care (LTC) sector. Technology developers promote these systems through demonstrations and pilot projects, while facility directors and caregivers increasingly recognize their potential to reduce loneliness, ease workload, and provide companionship for residents. When staff are occupied, these systems can sustain simple conversations and offer reassurance, helping older adults remain emotionally engaged. Families also value the sense of connection and safety they provide, particularly for relatives living alone.

At the same time, the findings reveal a key ethical tension shaping their acceptance in care environments. Among all system features, cameras emerged as the most controversial element. Families and administrators often regard them as essential for safety and transparency, whereas many residents and caregivers perceive them as intrusive and psychologically burdensome. Care staff reported feeling both supported and monitored by the same devices. This paradox—where technological “seeing” promises protection while potentially undermining dignity—captures a central ethical dilemma in AI-

assisted caregiving.

Importantly, this tension differs from explanations commonly discussed in research on human reactions to artificial intelligence. Previous studies often attribute negative attitudes toward AI to distrust in algorithmic decision-making, such as algorithm aversion (Dietvorst et al., 2015), or to changes in evaluation when people believe AI is involved in decision processes (Reis et al., 2024).

In contrast, the discomfort observed in this study arises less from doubts about algorithmic capability than from the experience of visual surveillance enabled by cameras. Systems equipped with cameras are more likely to trigger concerns about privacy, dignity, and psychological pressure. Consequently, the social acceptance of AI-based emotional support systems depends not only on their functional performance but also on how technological “seeing” is ethically framed and emotionally experienced by caregivers and care recipients.

3.2 Challenges

Despite growing enthusiasm for AI-based emotional support systems, several significant challenges remain before large-scale implementation can become feasible.

3.2.1 Preserving Dignity in the Age of the Camera

Among the issues surrounding AI-based emotional support systems, a central challenge is preserving the dignity of older adults under technological observation. While the camera-based functions of AI-based emotional support systems can provide families with reassurance and enhance safety, many residents experience discomfort when cameras are present during daily activities, perceiving them as intrusions on privacy.

Care staff report similar unease. Although these monitoring functions may reduce workload and help prevent emergencies, they can also create a sense of being constantly evaluated, generating psychological pressure that may undermine trust and empathy in caregiving relationships.

Addressing this tension requires clearer ethical frameworks. Transparent communication, explicit consent, and appropriate guidelines are essential to ensure that AI-based emotional support systems support safety without compromising dignity.

3.2.2 Financial and Institutional Constraints

Even when ethical pathways are identified, financial and institutional barriers continue to hinder the widespread adoption of AI-based emotional support systems. Under Chiba

Prefecture's Care Technology Implementation Subsidy (Chiba Prefecture, 2024; Chiba Prefecture, 2025), financial support for communicative or therapeutic robots such as PALRO and PARO is capped at ¥300,000 per unit—well below market prices, which can reach ¥737,000 for the PALRO Business Series III. (Fujisoft Inc., 2023) Facilities must therefore cover 30–60% of the total cost themselves, excluding additional expenses for maintenance, training, and software updates.

Moreover, subsidies apply only to initial procurement and exclude recurring costs such as communication fees, cloud services, and device management. Because applications must be renewed annually and funding depends on yearly budgets, administrators are often reluctant to invest in technologies whose support may not continue.

As a result, despite ongoing policy promotion, the current subsidy framework—characterized by low caps and short-term funding cycles—discourages adoption, particularly among small and medium-sized care providers. Consequently, AI-based emotional support systems remain largely experimental rather than fully integrated into Japan's long-term care infrastructure.

4. Discussion—Seeing Without Watching

The findings reaffirm that Japan's use of AI-based emotional support systems in long-term care stands at an ethical crossroads. The “camera dilemma”—the tension between safety monitoring and the protection of dignity—suggests that these systems should move beyond visual surveillance toward empathetic sensing that detects presence or abnormal situations without continuous observation.

Although camera-equipped robots within AI-based emotional support systems, such as PALRO and PARO, can enhance interaction and emotional support, they often create discomfort among residents and caregivers. The issue is therefore not whether technology should “see,” but how AI-based emotional support systems perceive care environments.

Recent studies show that safety monitoring does not necessarily require cameras. Sensor-based systems can detect movement or irregular activity without collecting visual data. For instance, Shao et al. (2021) reported that a vibration- and pneumatic-sensor system achieved 94.4% walking-detection accuracy without cameras, ensuring safety while preserving privacy.

Such approaches shift monitoring from “being watched” to “being sensed,” aligning with dignity-centered care. In this sense, future AI-based emotional support systems should

prioritize non-visual sensing technologies that balance safety with privacy and dignity.

Acknowledgements

This study was supported by the Framework for the Promotion of Policy Studies by SFC Students. Additionally, sincere appreciation is extended to the professors and interview participants for the valuable advice they provided.

References

- Berridge, C., Halpern, J., Levy, K. (2019) “Cameras on beds: The ethics of surveillance in nursing home rooms”, *AJOB empirical bioethics*, 10 (1), p.55-62.
- Cabinet Office (2021) “White Paper on the Aging Society 2021 (Full Version), Chapter 1 Section 1: ‘Current Status and Future Outlook of Aging’”, [PDF] https://www8.cao.go.jp/kourei/whitepaper/w-2021/zenbun/pdf/1s1s_01.pdf (Accessed October 17, 2025)
- Cavoukian, A. (2011) “Patience, persistence, and faith: Evolving the gold standard in privacy and data protection”. In *IFIP International Information Security Conference*, Berlin, Heidelberg: Springer, p.1-16.
- Chiba Prefecture (2024) “FY2024 Subsidy for the Promotion and Establishment of Care Technology / Support for the Introduction of Care Robots”, *Elderly Welfare Division, Chiba Prefecture*, <https://www.pref.chiba.lg.jp/koufuku/kaigorobot> (Accessed October 13, 2025)
- Chiba Prefecture (2025) “FY2025 Subsidy for the Promotion and Establishment of Care Technology / Support for the Introduction of Care Robots”, *Elderly Welfare Division, Chiba Prefecture*, <https://www.pref.chiba.lg.jp/koufuku/kaigorobot/kaigorobotjyouhou.html> (Accessed October 13, 2025)
- Children and Families Agency (2024) “Document 2: Current Situation and Issues Regarding Marriage”, [PDF] https://www.cfa.go.jp/assets/contents/node/basic_page/field_ref_resources/f27802a2-0546-424d-ac61-ac0641d67d38/cf9b37be/20240719_councils_lifedesign-wg_f27802a2_02.pdf (Accessed October 17, 2025)
- Dietvorst, B. J., Simmons, J. P., Massey, C. (2015) “Algorithm aversion: people erroneously avoid algorithms after seeing them err”, *Journal of experimental psychology: General*, 144 (1), p.114.
- Fang, W., Fan, S., Zheng, H., et al. (2025) “How to improve mental health in the older adults through AI-enhanced physical activity: An emerging research topic”, *Humanities and Social Sciences Communications*, 12, 862. <https://doi.org/10.1057/s41599-025-05155-6>
- Fuji Soft Incorporated (2023) “PALRO Business Model Product Information”, <https://palro.jp/product/business.html> (Accessed October 13, 2025)
- Guarnera, J., Yuen, E., Macpherson, H. (2023) “The impact of loneliness and social isolation on cognitive aging: a narrative review”, *Journal of Alzheimer's Disease Reports*, 7(1), p.699-714. <https://doi.org/10.3233/ADR-230011>
- Haggerty, K. D. and Ericson, R. V. (2017) “The surveillant assemblage”, In *Surveillance, crime and social control*, Routledge., p.61-78.
- Ministry of Health, Labour and Welfare (2010) “Comprehensive Survey of Living Conditions 2010: IV. Status of Caregiving – Concerns and Stress of Primary Caregivers Living Together”, <https://www.mhlw.go.jp/toukei/saikin/hw/k-tyosa/k-tyosa10/4-4.html> (Accessed October 17, 2025)
- Ministry of Health, Labour and Welfare (2018) “Figure 1-2-9: Status of Patients with Mental Illness [2018 White Paper on Health, Labour and Welfare]”, <https://www.mhlw.go.jp/stf/wp/hakusyo/kousei/18/backdata/01-01-02-09.html> (Accessed October 17, 2025)
- Ministry of Health, Labour and Welfare (2020) “Section 4: Situation Surrounding Suicide among the Late Elderly Population”, [PDF] Office for Promotion of Suicide Countermeasures, Ministry of Health, Labour and Welfare. <https://www.mhlw.go.jp/content/r2g-2->

- 4.pdf (Accessed October 17, 2025)
- Ministry of Health, Labour and Welfare (2024) “Required Number of Care Workers Based on the 9th Long-Term Care Insurance Business Plan”, [PDF] https://www.mhlw.go.jp/stf/newpage_41379.html (Accessed October 17, 2025)
- Mortenson, W. B., Sixsmith, A., Woolrych, R. (2015) “The power (s) of observation: Theoretical perspectives on surveillance technologies and older people”, *Ageing & Society*, 35 (3), p.512-530.
- Nichol, B., McCready, J., Erfani, G., Comparcini, D., Simonetti, V., Cicolini, G., et al. (2024) “Exploring the impact of socially assistive robots on health and wellbeing across the lifespan: an umbrella review and meta-analysis”, *International Journal of Nursing Studies*, 153, 104730.
- Reis, M., Reis, F., Kunde, W. (2024) “Influence of believed AI involvement on the perception of digital medical advice”, *Nature Medicine*, 30 (11), p.3098-3100.
- Shao, S., Yamamoto, K., Kubota, N. (2021) “An elderly monitoring system based on multiple ultra-sensitive vibration and pneumatic sensors”, *Journal of Advanced Computational Intelligence and Intelligent Informatics*, 25 (4), p.423-431. <https://doi.org/10.20965/jaciii.2021.p0423>

[受付日 2025. 11. 22]
[採録日 2026. 3. 25]

