

Design and Preliminary Deployment of a Frugal Smartwatch Monitoring Platform for Dementia Care

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Abstract—Preserving residents’ freedom of movement while ensuring their safety is a major challenge in specialised dementia care units. This paper presents the design, implementation and preliminary real-world deployment of a smartwatch-based monitoring platform developed through a Living Lab approach involving healthcare professionals and researchers. The proposed solution combines commercial WearOS smartwatches, Wi-Fi fingerprinting for indoor symbolic localisation, GPS for outdoor continuity and an institution-managed software platform preserving data sovereignty. Preliminary deployments in specialised dementia care units supported an initial assessment of its compatibility with caregivers’ operational practices. Rather than maximising localisation accuracy, the proposed architecture aims to provide localisation information that is sufficient to support care decisions while reusing the existing institutional infrastructure.

Index Terms—Smartwatch, Indoor Localization, Dementia Care, Person-Centred Care, Ambient Assisted Living, Living Lab, Healthcare IoT.

I. INTRODUCTION

Healthcare organisations are increasingly recognised as complex socio-technical systems in which healthcare professionals, patients, technologies and institutional rules continuously interact [1]. In such environments, introducing new technologies affects not only technical infrastructures but also professional practices, workflows and care delivery. The ongoing digital transformation of healthcare therefore raises not only technological challenges but also organisational ones, making successful adoption as important as technical performance [2], [3].

Long-term care facilities are experiencing profound demographic changes. Residents are admitted later in life, often presenting reduced autonomy in their daily activities together with an increasing prevalence of major neurocognitive disorders. Preserving their freedom of movement has consequently become a major challenge. While mobility contributes to autonomy, social participation and quality of life, it also increases the risks of falls, wandering, disorientation and leaving the facility without appropriate support. Traditionally, specialised

dementia care units have addressed these risks through secured environments and restricted circulation. However, such measures may reduce residents’ autonomy and reinforce an institutional model centred on control rather than preserved abilities.

Recent home-like and person-centred care approaches advocate a different balance between safety and autonomy. Nursing homes are considered as living environments where residents’ preferences, habits and remaining abilities should be preserved whenever possible. In this context, supporting mobility becomes a key challenge for healthcare professionals.

Several technological solutions have been proposed to support residents’ mobility, including RFID bracelets, Bluetooth beacon systems and proprietary anti-wandering platforms. While these solutions address specific use cases, they generally rely on dedicated hardware, closed software ecosystems or cloud-based services, limiting interoperability, increasing deployment and maintenance costs, and creating long-term dependence on a single vendor.

In contrast, recent generations of commercial smartwatches have evolved into open wearable computing platforms, similarly to smartphones. They provide programmable environments capable of hosting custom healthcare applications while integrating wireless connectivity, inertial sensors, physiological monitoring and indoor/outdoor positioning capabilities within a single device. These developments create new opportunities to develop specialised services independently of hardware manufacturers, to reuse commodity devices, and to progressively extend system functionalities without modifying the underlying hardware platform.

However, deploying such open wearable platforms in specialised dementia care units still raises important challenges regarding their integration into routine care. Beyond localisation continuity, issues such as battery lifetime, alert reliability, data protection, infrastructure deployment and long-term acceptance by healthcare professionals remain key barriers to their adoption.

This paper presents the design, implementation and prelimi-

nary real-world deployment of a smartwatch-based monitoring platform intended to support residents' mobility in specialised dementia care units. The proposed solution combines commercial WearOS smartwatches, Wi-Fi fingerprinting for indoor localisation, GPS for outdoor continuity and a software platform deployed on an institution-managed infrastructure (either on-premise within the facility or on a private infrastructure shared across the Hôpital Saint-Thomas de Villeneuve (HSTV) organisation), thereby preserving data sovereignty.

Rather than proposing a new localisation algorithm, the objective is to investigate how an open wearable platform can be integrated into a home-like care approach [4] while remaining compatible with caregivers' operational practices. In this perspective, localisation is considered as one component of a broader socio-technical system supporting decision-making rather than as an objective in itself.

The present work focuses on the functional deployment of the platform in a real care environment. A formal quantitative evaluation of the localisation subsystem is currently being conducted through complementary controlled experiments in both simulated and operational environments. Therefore, the main contributions of this paper are threefold:

- the design and implementation of an open and frugal smartwatch-based monitoring platform reusing the existing institutional Wi-Fi infrastructure and preserving data sovereignty through institution-managed deployment;
- the preliminary deployment and functional validation of the complete monitoring chain in specialised dementia care units, highlighting the technical and organisational conditions required for its integration into routine care;
- the identification of design lessons and future research directions regarding localisation technologies, participatory design and the deployment of wearable monitoring systems supporting person-centred care.

Unlike most existing work focusing primarily on localisation algorithms or wearable devices, this paper investigates how an open smartwatch-based monitoring platform can be designed, deployed and progressively integrated into routine dementia care. The objective is not to maximise localisation performance, but to understand how symbolic localisation can effectively support caregivers' decision-making while preserving residents' autonomy and limiting the need for dedicated infrastructures.

II. RELATED WORK

Wearable localisation technologies have attracted increasing attention for supporting people living with dementia. Research has progressively evolved from simple outdoor tracking devices towards integrated monitoring platforms combining localisation, physiological sensing and decision support. The literature can be organised into three complementary perspectives. First, numerous studies investigate localisation technologies and their respective strengths and limitations. Second, several works explore the use of wearable localisation systems in dementia care. Finally, a growing body of research emphasises that the effectiveness of these technologies depends not only

on their technical performance but also on their integration into everyday care practices and organisational workflows.

A. Localization technologies

Numerous technologies have been investigated for indoor and outdoor localisation, including GPS, Wi-Fi fingerprinting, Bluetooth Low Energy (BLE) and Ultra-Wideband (UWB) [5]–[8]. GPS remains the preferred solution for outdoor positioning, whereas indoor localisation continues to suffer from radio propagation effects, environmental dynamics and deployment constraints. Wi-Fi fingerprinting benefits from existing wireless infrastructures but requires calibration and regular updates, while BLE offers lower deployment costs at the expense of positioning accuracy. Recent surveys conclude that no single technology simultaneously satisfies the requirements of accuracy, scalability, energy efficiency and deployment simplicity, advocating hybrid approaches combining multiple sensing modalities together with contextual information [9], [10].

B. Wearable localisation for dementia care

Early studies focused on GPS devices supporting outdoor walking for people living with dementia. These works demonstrated improved caregiver reassurance and greater autonomy while identifying practical challenges related to battery management, false alarms and intervention procedures [11], [12]. Indoor localisation has subsequently been explored using BLE-based infrastructures, particularly in dementia villages where symbolic localisation and geofencing better match caregivers' operational needs than centimetre-level positioning [13]. More recently, commercial smartwatches have enabled multifunction monitoring platforms combining localisation, physiological monitoring and communication services [14]. In parallel, qualitative studies have progressively shifted the focus from technological performance towards person-centred care, highlighting that wearable technologies should primarily support residents' autonomy rather than increase surveillance [15].

C. From localisation technologies to care integration

Beyond localisation accuracy, recent work increasingly recognises that successful deployment depends on organisational integration. Responsibilities for charging devices, managing alerts and interpreting localisation data must be clearly defined, while alerts themselves require contextual interpretation based on residents' mobility habits, clinical condition and care environment [12], [15]. Consequently, wearable localisation systems should be regarded as socio-technical infrastructures supporting caregivers' decision-making rather than standalone tracking devices. A recent systematic review similarly highlights the potential of off-the-shelf wearable technologies for person-centred dementia care, while identifying configuration complexity, accessibility and support requirements as persistent barriers to adoption [16].

Although previous work (e.g., [13], [14]) demonstrates the feasibility of wearable localisation technologies, relatively few

TABLE I
EVOLUTION OF WEARABLE LOCALISATION SYSTEMS FOR DEMENTIA CARE.

Ref.	Generation	Main contribution
[11], [12]	Outdoor GPS tracking	Demonstrates the feasibility of GPS-assisted walking while highlighting organisational challenges related to charging, alert management and intervention procedures.
[13]	Indoor localisation	Introduces BLE-based symbolic localisation and geofencing for dementia villages, supporting residents' mobility inside specialised care environments.
[14]	Smart wearable platforms	Combines localisation, physiological monitoring and communication capabilities within multifunction wearable devices. Evaluation mainly focuses on technical feasibility.
[15]	Person-centred care	Shows that freedom and safety should be balanced through personalised support rather than surveillance, emphasising residents' values and acceptability.
This work	Living Lab approach	Combines indoor/outdoor symbolic localisation, on-premise processing and participatory co-design to integrate wearable technologies into a home-like care model supporting residents' autonomy and caregivers' daily practices.

studies investigate their integration into routine care practices within specialised dementia care units while preserving data sovereignty and supporting home-like care models. This paper addresses these challenges through the deployment of an open smartwatch-based platform designed using a Living Lab approach and integrated into the daily organisation of a specialised dementia care unit.

III. LIVING LAB CO-DESIGN AND DESIGN REQUIREMENTS

The proposed platform emerged from a participatory design process conducted within the Hospitalité Living Lab (HSTV), in collaboration with IMT Atlantique and healthcare professionals from specialised dementia care units. Co-design and experimentation activities were supported by JINNOV, a French *tiers-lieu* dedicated to digital health experimentation¹. This work is part of the broader HSTV programme, which promotes a home-like care approach where technology supports residents' autonomy and continuity of care rather than surveillance [17].

A. Co-design process

The platform requirements were identified through an iterative co-design process combining a technology watch, market

¹JINNOV is a French *tiers-lieu* for digital health experimentation, i.e., a collaborative environment where healthcare professionals, researchers, engineers, companies and end users jointly co-design, prototype and evaluate innovative solutions under real-world conditions.

analysis and workshops with healthcare professionals from the *Maison de Moncontour* specialised dementia care unit.

Discussions rapidly moved beyond localisation accuracy to focus on everyday care situations: locating a resident inside the facility, ensuring continuity between indoor and outdoor environments, reducing unnecessary searches, limiting false alarms and preserving residents' freedom of movement. These operational needs were progressively translated into the technical requirements guiding the proposed architecture.

B. Functional requirements

Indoor localisation was identified as the highest priority, reflecting caregivers' daily need to quickly locate residents within the facility. Outdoor localisation was considered complementary to ensure continuity during outdoor activities.

Participants also highlighted the need for configurable alerts adapted to residents' profiles, basic physiological monitoring, fall detection and interoperability with existing healthcare information systems. Data sovereignty emerged as another key requirement, leading to a preference for local processing and storage of sensitive information. Reusing the existing Wi-Fi infrastructure was also considered essential to reduce deployment costs and facilitate future large-scale adoption.

Table II summarises the functional requirements identified during the co-design process.

C. Technology watch and market analysis

The market analysis confirmed that existing commercial solutions generally address only a subset of the identified requirements. GPS devices mainly support outdoor localisation, BLE-based systems require dedicated infrastructures, and integrated proprietary platforms remain costly, difficult to customise and often dependent on cloud services.

These observations motivated the development of an open architecture combining commercial WearOS smartwatches, Wi-Fi-based indoor localisation and an on-premise software platform preserving institutional control over sensitive data.

Table III summarises the main characteristics of the solution families considered during the technology watch.

D. Design rationale

The proposed architecture was specifically designed to support HSTV's home-like care approach, where localisation is considered as a means of supporting residents' autonomy rather than an end in itself. During the Living Lab activities, healthcare professionals consistently emphasised the importance of providing contextual information supporting decision-making rather than maximising positioning accuracy.

Then, rather than selecting the localisation technology providing the highest positioning accuracy, the design process focused on identifying the solution offering the best compromise between operational usefulness, deployment cost, infrastructure reuse and long-term maintainability. Wi-Fi fingerprinting was therefore selected because it reuses the existing wireless infrastructure already available in nursing homes, requires no dedicated localisation hardware and is able to

TABLE II
FUNCTIONAL REQUIREMENTS IDENTIFIED DURING THE CO-DESIGN PHASE

Expected function	Priority	Operational need	Limitations observed in existing solutions
Indoor localisation	High	Quickly locate a resident within the facility	Often unavailable or requiring a dedicated proprietary infrastructure
Outdoor localisation	Medium	Ensure continuity of monitoring during outdoor movements	Available, but often associated with subscription-based or cloud services
Individualised alerts	Medium	Adapt notifications to resident profiles and team practices	Limited configuration and dependence on teleassistance centres
Physiological monitoring	Medium	Provide complementary information to contextualise interventions	Limited indicators and weak interoperability
Fall detection	Medium	Facilitate rapid intervention in case of a critical event	Proprietary and poorly configurable algorithms
Remote audio communication	Low	Allow an exchange with the resident when needed	Considered less of a priority by professionals
Data sovereignty	High	Keep data within the facility	Processing generally performed in the cloud
Reuse of existing infrastructure	High	Avoid installing new equipment	Frequent need to deploy specific beacons or gateways
Interoperability and scalability	High	Facilitate integration with existing information systems	Proprietary ecosystems and limited openness
Cost control	High	Enable progressive and sustainable deployment	High recurring costs and supplier dependence

TABLE III
COMPARISON OF SOLUTION FAMILIES CONSIDERED DURING THE MARKET ANALYSIS

Solution family	In. loc.	Out. loc.	Fall	Physio.	Alerts	Local data	Dedicated infra.	Interop.	Identified limitations
Classic teleassistance bracelets	No	Yes	Yes	No	Low	No	No	Low	Limited functions and supplier dependence
Commercial GPS watches	No	Yes	Yes	Yes	Medium	No	No	Low	Cloud-based data and limited openness
Bluetooth / BLE beacon systems	Yes	No	No	No	Medium	Variable	Yes	Medium	Deployment and maintenance of a dedicated infrastructure
RFID / anti-wandering systems	Yes	No	No	No	Low	Variable	Yes	Low	Limited positioning and proprietary ecosystems
Integrated proprietary systems	Yes	Yes	Yes	Variable	Yes	Rarely	Often	Low	High cost and limited scalability
Proposed architecture	Yes	Yes	Yes *	Yes	Yes	Yes	No	High	Wi-Fi calibration and specific development required

* Fall detection is currently based on the commercial smartwatch's built-in functionality. The proposed platform receives and processes fall events but does not implement a dedicated fall-detection algorithm.

provide symbolic room-level localisation that is compatible with caregivers' operational needs.

These discussions resulted in the following design principles:

- reuse of the existing Wi-Fi infrastructure;
- seamless indoor/outdoor continuity through Wi-Fi and GPS localisation;
- on-premise processing of sensitive data;
- modular software architecture supporting future extensions;
- configurable alerts adapted to residents' individual care pathways.

The resulting platform should therefore be viewed as a socio-technical infrastructure supporting caregivers' daily work while preserving residents' dignity, autonomy and freedom of movement.

IV. SYSTEM ARCHITECTURE

The proposed platform follows a modular architecture designed to support wearable monitoring while remaining compatible with the technical and organisational constraints of specialised dementia care units. Rather than relying on dedicated localisation infrastructures, the platform reuses commercially available smartwatches and the institution's existing Wi-Fi

network. The platform is organised around wearable sensing, connectivity, backend and data services, and the caregiver dashboard, with security mechanisms applied across these components (Fig. 1). This architecture was designed to favour interoperability, progressive deployment and data sovereignty while allowing future extensions such as contextual localisation, BLE-assisted positioning or behavioural analysis.

A. Wearable Layer

Commercial WearOS smartwatches constitute the sensing layer of the platform. They continuously acquire physiological measurements (heart rate), inertial information and Wi-Fi observations while also providing outdoor positioning through GPS when available.

For indoor environments, the smartwatch periodically performs Wi-Fi scans during residents' movements. The resulting radio observations are securely transmitted to the backend together with contextual information such as heart rate or fall events. Fall events are generated by the smartwatch's built-in fall-detection functionality and transmitted to the backend for integration into the monitoring and alerting workflow.

A dedicated calibration mode allows healthcare professionals to associate Wi-Fi fingerprints with predefined rooms or care areas, forming the reference database used for symbolic indoor localisation.

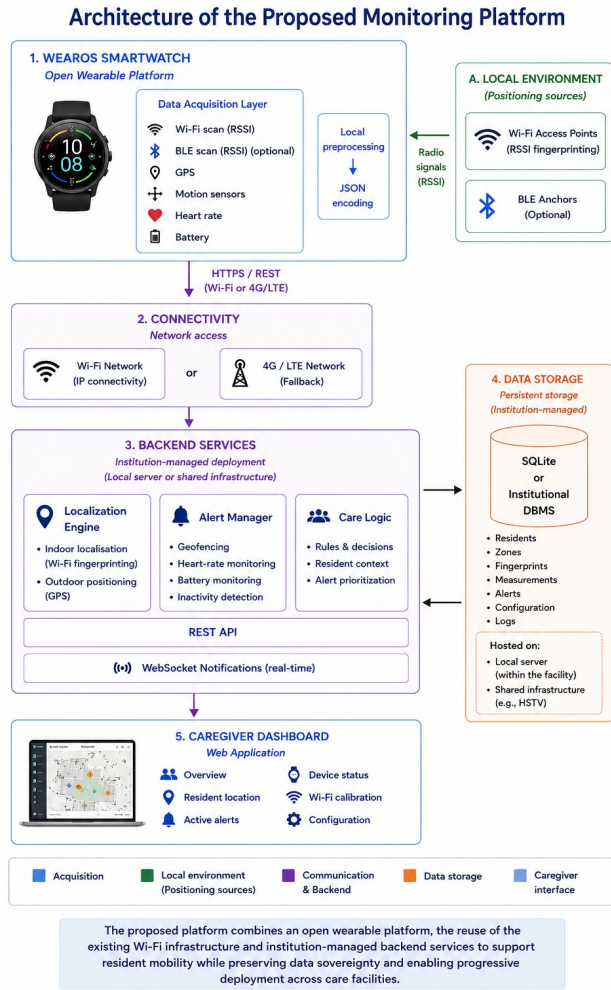


Fig. 1. System architecture of the proposed HSTV monitoring platform. Solid arrows denote synchronous HTTP/REST communication (wearable to backend) and WebSocket push (backend to dashboard). The security layer applies cross-cutting controls—TLS encryption, authentication, and on-premise network containment—to all inter-layer communication channels.

B. Backend Layer

The backend receives smartwatch observations, estimates residents' current location, stores monitoring data and manages alert generation. Indoor localisation relies on Wi-Fi fingerprinting, where live scans are compared with previously calibrated fingerprints corresponding to predefined rooms or care zones. The objective is to identify the resident's current area rather than to compute precise Cartesian coordinates.

The current implementation uses a weighted nearest-neighbour classification method, although the platform has been designed to remain independent of the localisation algorithm. This modularity facilitates future investigations of alternative localisation methods, including hybrid Wi-Fi/BLE approaches.

The current indoor localisation engine uses a weighted k -nearest-neighbour classifier ($k = 7$). Each live Wi-Fi scan is represented by the RSSI values associated with observed access-point identifiers and compared with calibrated room- or zone-level fingerprints using a weighted Euclidean distance.

The nearest fingerprints contribute to a weighted vote for the corresponding semantic zone. This deliberately lightweight method was selected as an initial implementation; a detailed evaluation of the localisation subsystem is outside the scope of the present paper and is currently being conducted separately.

The backend also analyses physiological information and predefined safety rules to generate alerts that are immediately transmitted to connected caregiver dashboards.

C. Dashboard Layer

Healthcare professionals interact with the platform through a web-based dashboard displaying residents' current location, device status and active alerts. Localisation is represented symbolically at room or zone level using the facility floor plan, allowing caregivers to rapidly identify residents' whereabouts without requiring precise metric positioning.

Real-time map visualisation. Each incoming WebSocket message updates the in-memory resident state: zone identifier, localisation confidence, last-seen timestamp, and current BPM. The interface renders this state as a real-time occupancy map, associating each resident—identified by their registered watch ID—with their most recently inferred zone. Zone colour coding reflects the configured risk level (*safe*, *warning*, *danger*), providing caregivers with an at-a-glance spatial overview of all monitored residents without requiring manual interaction. In the current prototype, each smartwatch is registered to a resident profile through this watch ID. This provides logical device-to-resident association but does not prevent physical interchange of watches. Operational procedures for device allocation and identity verification should therefore be considered in operational deployment.

Alert management. Safety-critical events (falls, physiological anomalies, and proximity to danger zones) are surfaced as timestamped notification cards in a dedicated alert panel. Each alert carries a severity level (*low*, *medium*, *critical*), a human-readable message, and an acknowledgement workflow: caregivers can mark alerts as reviewed, recording their username and a timestamp in the database. Unacknowledged alerts remain prominently visible until acted upon. This acknowledgement trail supports post-incident review and regulatory audit requirements common in healthcare settings.

Usability. The interface is designed for rapid interpretation under operational conditions: colour-coded zone overlays, concise resident identifiers, and sorted alert queues minimise cognitive load. No specialist technical knowledge is required to interpret the display, and the absence of page refreshes—enabled by the WebSocket architecture—ensures that the view remains current without user intervention.

D. Security and Institution-Managed Deployment

All communications between the smartwatch, backend and caregiver dashboard are protected using encrypted channels and authenticated access. Sensitive information remains under the control of the healthcare institution through deployment on an institution-managed infrastructure, either locally within

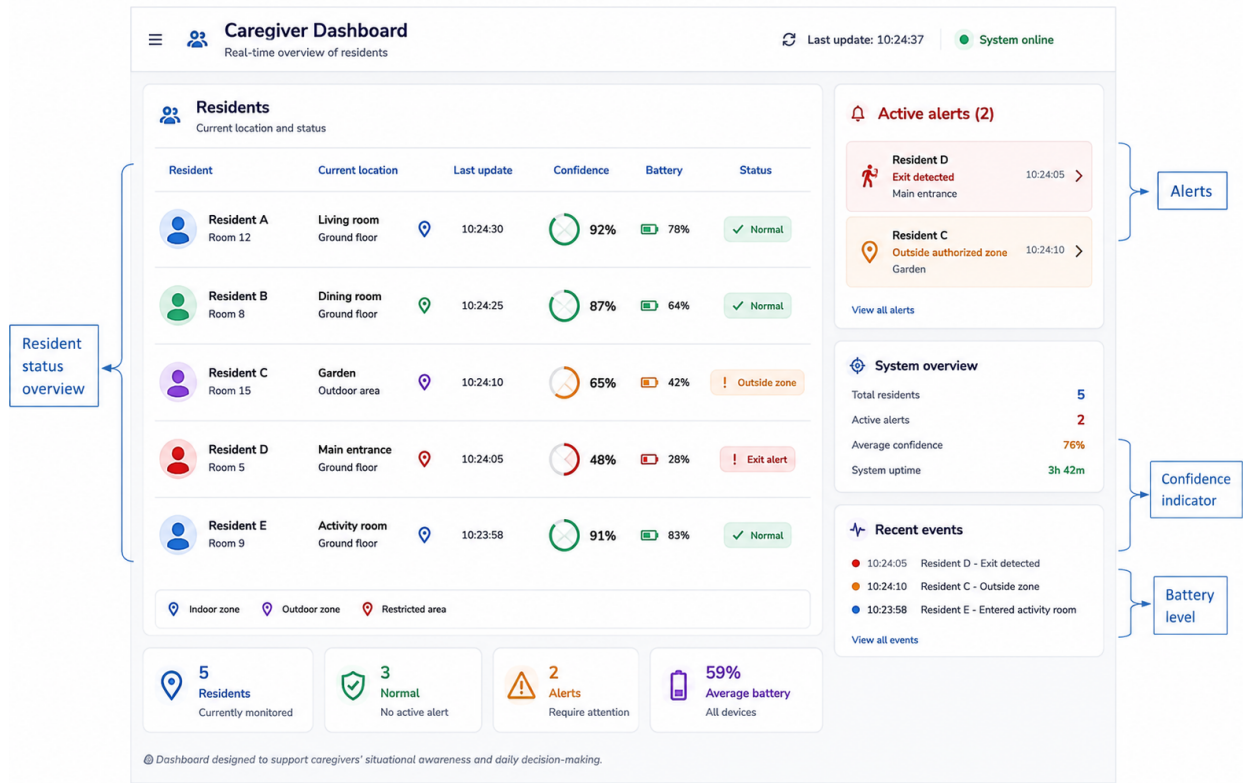


Fig. 2. Illustrative caregiver dashboard used to monitor residents' location, alerts and device status. The interface has been editorially simplified, translated into English and anonymised to improve readability while preserving the original functionality.

the facility or on a secure private infrastructure shared across the HSTV organisation.

This deployment strategy supports compliance with healthcare data protection regulations while avoiding dependence on third-party cloud providers. It also enables the platform to reuse the existing institutional Wi-Fi infrastructure for both communication and indoor localisation, thereby limiting deployment costs and avoiding dedicated localisation hardware. Security controls are applied uniformly across all three functional layers rather than being confined to a single boundary, reflecting a defence-in-depth posture appropriate to the sensitivity of the health data processed by the system.

This deployment strategy addresses healthcare data-governance requirements (e.g., GDPR in European jurisdictions), while reducing dependence on external service providers and enabling the institution's IT department to manage access control, software updates and backup procedures. Furthermore, the platform is designed to reuse the existing institutional Wi-Fi infrastructure for both communication and indoor localisation, avoiding the deployment of dedicated localisation hardware. The use of commodity hardware and open-source software components also limits vendor lock-in and facilitates progressive deployment across multiple facilities.

V. PRELIMINARY DEPLOYMENT AND FUNCTIONAL VALIDATION

A. Experimental Conditions

The proposed platform was deployed in two specialised dementia care units within the HSTV organisation. During this preliminary phase, the smartwatches were worn by caregivers rather than residents in order to test the system under realistic environmental and mobility conditions without involving residents at this stage. The objective of this first deployment phase was to validate the complete monitoring chain under real operating conditions and to assess its compatibility with caregivers' daily practices.

Commercial WearOS smartwatches were configured for continuous monitoring and connected to the institution-managed backend through the existing Wi-Fi infrastructure. Healthcare professionals participated in the installation, calibration of monitored areas and functional evaluation of the dashboard.

This preliminary phase was deliberately conducted with caregivers in order to validate device wearing conditions, connectivity, calibration procedures and the end-to-end monitoring workflow before involving residents in a dedicated study. The deployment was intentionally exploratory. It was designed to assess the operational feasibility of the platform rather than to conduct a controlled quantitative evaluation of localisation performance.

B. Functional Validation in Real Conditions

The prototype was functionally tested in specialised dementia care units, with caregivers wearing the smartwatches and moving through the monitored areas. The complete monitoring chain operated successfully, from smartwatch sensing and Wi-Fi scan acquisition to backend processing and real-time visualisation on the caregiver dashboard.

These preliminary trials were intended to validate the implementation and refine the experimental protocol. They provide the basis for a future study in which residents will wear the devices under an appropriate ethical and organisational framework.

In addition to validating the monitoring chain, preliminary device-level measurements indicated an autonomy exceeding 9 hours under the current continuous monitoring configuration. Although the smartwatch application has not yet been specifically optimised for energy consumption, this autonomy is compatible with a typical daytime shift in specialised dementia care units, making daily charging compatible with existing care routines.

The system provided symbolic room- or zone-level localisation rather than precise Cartesian coordinates, consistently with caregivers' operational needs. During the preliminary trials, the prototype was able to follow caregivers' movements between monitored areas and to continuously update their last known location. Heart-rate transmission, fall-event reporting and dashboard notifications also operated as expected in the nursing-home environment.

Informal feedback collected during deployment indicated that symbolic localisation was consistent with caregivers' expectations, who mainly required rapid identification of the area where a resident was located rather than precise positioning within a room.

Although encouraging, these observations remain qualitative. The deployment was not conducted using a controlled ground-truth protocol, and therefore does not allow formal conclusions regarding localisation accuracy, latency or long-term reliability.

C. Ongoing Technical Evaluation

A complementary technical evaluation of the localisation subsystem is currently underway. Controlled experiments are being conducted both in simulation and in operational environments in order to characterise the localisation performance under reproducible conditions.

These experiments investigate the influence of residents' mobility, wireless propagation conditions and building configuration on symbolic room-level localisation. They also evaluate whether the current Wi-Fi fingerprinting approach provides sufficient reliability for caregivers' operational needs rather than pursuing the highest possible positioning accuracy.

Future work will additionally investigate hybrid localisation combining Wi-Fi fingerprinting with BLE beacons in order to improve robustness in areas where Wi-Fi observations alone may become insufficiently discriminative.

VI. DISCUSSION

The preliminary deployment confirms that the proposed platform can support resident monitoring in specialised dementia care units using commercially available smartwatches and the existing institutional infrastructure, without requiring dedicated localisation hardware. However, beyond its technical feasibility, the experiment highlights that localisation technologies should not be evaluated solely according to positioning accuracy. Consistent with previous work [12], [15], localisation only becomes meaningful when interpreted within the residents' clinical and organisational context. Information such as mobility habits, authorised areas, care plans and individual risk profiles often provides greater support for caregivers' decision-making than centimetre-level positioning accuracy. These observations suggest that assistive technologies for dementia care should primarily be designed to meet operational needs rather than to maximise technical performance.

The study also confirms that the successful deployment of wearable monitoring systems is primarily an organisational challenge. Device charging, alert management, maintenance and integration into existing care routines require clearly defined responsibilities and continuous collaboration between healthcare professionals and technical teams. The Living Lab approach adopted in this work supported the progressive refinement of both the technical solution and its integration into everyday care practices.

These observations naturally led to a frugal architectural design. Rather than introducing dedicated infrastructures or proprietary ecosystems, the proposed platform relies on commodity smartwatches, reuses the existing institutional Wi-Fi infrastructure, adopts open-source software components and preserves data sovereignty through institution-managed deployment. Beyond reducing deployment costs and limiting vendor lock-in, such choices contribute to the robustness of the overall care system. Following Hamant's perspective [18], robustness should not be understood as maximising performance under ideal conditions, but as maintaining acceptable operation despite the continuous variability of care environments, including residents' evolving conditions, staff turnover, organisational changes and imperfect sensing conditions. From this perspective, frugality becomes a design principle for building robust socio-technical systems capable of evolving with care practices while preserving residents' autonomy and supporting the long-term sustainability of digital health services.

The present study nevertheless has several limitations. The deployment was intentionally designed as a functional validation rather than as a controlled performance evaluation. Consequently, localisation performance was not quantitatively assessed in the real care environment. Ongoing work therefore combines simulation-based experiments with controlled field evaluations to characterise the technical performance of the localisation subsystem and to determine whether symbolic room-level localisation provides sufficient operational value for caregivers. Future work will also investigate the appropriation of the platform by healthcare professionals, residents and

their families, as well as the impact on professional practices and care organisation.

A further limitation concerns device acceptability and adoption. Residents with major neurocognitive disorders may remove, forget or refuse to wear the smartwatch, and this issue was not evaluated in the present study. The future resident study will therefore assess wearing tolerance, adoption, charging procedures and the conditions under which caregivers may need to assist with device management.

VII. CONCLUSION AND FUTURE WORK

This paper presented the design, implementation and preliminary real-world deployment of a smartwatch-based monitoring platform supporting residents' mobility in specialised dementia care units.

The preliminary deployment confirmed the functional feasibility of the complete monitoring chain and indicated that commercial smartwatches used as open development platforms, together with the existing institutional Wi-Fi infrastructure, can support symbolic localisation compatible with caregivers' operational practices. The objective is not to maximise localisation accuracy, but to provide sufficiently reliable information while preserving data sovereignty and limiting additional infrastructure.

Beyond demonstrating technical feasibility, this work shows that successful deployment depends as much on organisational integration, stakeholders cooperation and participatory design as on localisation performance. The Living Lab approach made it possible to align technological developments with caregivers' operational needs and with a home-like care model preserving residents' autonomy and freedom of movement.

Future work will first conduct controlled experiments in both simulated and real care environments to formally evaluate the localisation subsystem and determine whether symbolic room-level localisation provides sufficient operational value for caregivers. These studies will also investigate context-aware localisation combining positioning, behavioural and clinical information, hybrid Wi-Fi/BLE localisation, personalised geofencing policies and behavioural anomaly detection.

From a system perspective, the platform will be progressively extended through integration with healthcare information systems and evaluated across multiple nursing homes to assess its scalability, interoperability and long-term organisational impact in different care contexts.

Finally, future research will investigate the long-term adoption of the platform and its integration into routine care practices. Particular attention will be paid to the appropriation of the system by healthcare professionals, residents and their families, as well as to its impact on professional practices, the competencies required for its effective use and the organisation of care pathways.

Ultimately, the long-term value of such technologies will depend not only on their technical performance but also on their ability to support person-centred care while being sustainably integrated into everyday professional practices.

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