Literature Review – CareRing Project

# 1. Introduction

The CareRing system is a privacy-preserving, edge-based solution to detect and support loneliness mitigation among seniors or individuals with limited mobility, using multi-room sensor fusion and explainable daily indices. This review investigates: (a) competing and analogous solutions in the market, and (b) open-source software, hardware, and libraries relevant to the technical development.

# 2. Marketing Perspective: Competing Products & Gaps

## 2.1 Existing Market Products

Several products aim to monitor elderly individuals, primarily focusing on physical safety or fall detection.

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| --- | --- | --- | --- | --- |
| Product Name | Type | Key Features | Price (Approx.) | Market Limitation |
| CarePredict Tempo | Wearable | Tracks location, activity, voice patterns | $450+ | Privacy concerns, wearable discomfort |
| Amazon Alexa Together | Voice Assistant | Daily check-ins, fall detection | Subscription | Constant listening; poor motion tracking |
| Vayyar Home | mmWave Radar | Fall detection, room usage tracking | $250+/room | No emotional inference |
| Nobi Smart Lamp | Ceiling Light | Fall detection, reminders | €2,490 | High cost |
| Sentinare 2 | Edge AI Camera | Pose estimation, activity summary | $300–400 | Uses video; privacy trade-off |
| Caregiver Smart Solutions | IoT Sensors | Tracks fridge/toilet use, bed | $400–$600 | No emotional detection |

## 2.2 Market Gaps Identified

- Lack of loneliness-specific tools  
- Privacy concerns with camera/audio systems  
- Overreliance on wearables  
- Uninterpretable alerts reduce caregiver trust

## 2.3 Market Opportunity

CareRing fills a gap by providing emotionally intelligent sensing without video/audio, interpretable alerts, and low-cost, multi-room sensing.

# 3. Technical Perspective: Reference Designs & Open Source

This section reviews open-source and reusable components for both hardware and software.

## 3.1 Hardware Components and Reference Designs

Please see “CareRing Hard Ware Design.docx”

<https://github.com/Replica004/CareRing/blob/main/Hardware/CareRing%20Hardware%20Design(Updating).docx>

## 3.2 Software and Libraries

|  |  |  |  |
| --- | --- | --- | --- |
| Module / Platform | Development Environment | Primary Development Languages | Key Technologies / Tools |
| Embedded Device (ESP32-S3) | ESP-IDF (Official) | C/C++ | Wi-Fi Communication, MQTT/HTTP Protocol, AWS IoT SDK (for C/C++) |
|  |  | Python (MicroPython) | MicroPython Firmware |
| Cloud Server / Backend (AWS) | AWS Management Console / Local IDE | Python / Node.js | AWS IoT Core (Device Ingestion), Lambda (Data Processing), DynamoDB/RDS (Data Storage), API Gateway |
| Mobile App (iOS & Android) | Visual Studio Code or Android Studio/Xcode | Dart (Flutter) or JavaScript (React Native) | Flutter or React Native, RESTful API Calls, MQTT (for real-time notifications) |
|  |  | Swift / Kotlin (or Java) | Xcode (iOS) / Android Studio (Android) |

## 3.4. Similar Open Projects for Reference

|  |  |  |
| --- | --- | --- |
| Project | Link / Summary | Usefulness |
| Home Assistant | home-assistant.io | Sensor integration ideas, MQTT flows |
| OpenHAB | openhab.org | Modular rules engine |
| AALTOS | GitHub | Sensor fusion for elder care |
| ESPHome | esphome.io | Simplified sensor firmware, partial relevance |
| OpenEEG / OpenVibe | openeeg.sourceforge.net | Edge signal processing concepts |

# 4. Summary of Insights

- ESP-IDF and FreeRTOS form a strong firmware base.  
- MQTT and JSON data formatting already well supported.  
- Speech presence via WebRTC VAD avoids audio privacy issues.  
- Market lacks solutions targeting loneliness specifically.  
- CareRing meets unmet need with explainable alerts and privacy-focused sensors.

# 5. Recommendations

1. Leverage ESP32-IDF, MQTT/TLS, and edge feature extraction to protect privacy.  
2. Target under-monitored groups in LTC/home settings, focusing on psychosocial signals.  
3. Consider PaaS model with optional dashboard subscription.  
4. Keep alerts explainable and controllable to avoid alert fatigue.

# 6. References

• Espressif ESP32-S3 Docs: https://www.espressif.com/sites/default/files/documentation/esp32-s3\_technical\_reference\_manual\_en.pdf  
• HX711 Datasheet: https://cdn.sparkfun.com/datasheets/Sensors/ForceFlex/hx711\_english.pdf  
• FreeRTOS Documentation: https://www.freertos.org/Documentation/02-Kernel/07-Books-and-manual/01-RTOS\_book  
• WebRTC VAD Library: https://webrtc.googlesource.com/src  
• OpenHAB: https://www.openhab.org/  
• Home Assistant: https://www.home-assistant.io/  
• Hughes et al. (2004). Short scale for measuring loneliness: https://doi.org/10.1177/0164027504268574