TÉCNICO LISBOA

ElectroCap Project Proposal

Integrated Tele-Geriatric Health Monitoring Hub

Advisors and Mentor

- Scientific Advisor:
- Scientific Co-advisor:
- Coordinator:
- Mentor:

- Orientador : Prof. Luís Caldas de Oliveira

2. Problem definition

Portugal is one of the most rapidly ageing countries in Europe, with a growing population over 65 requiring accessible and continuous healthcare.

Many elderly patients have non-urgent appointments scheduled far from their homes, facing barriers such as limited transportation and reduced mobility. These challenges contribute to missed appointments, delayed care, and increased inefficiency in healthcare services.

Although teleconsultations offer an alternative, they remain clinically limited. Physicians cannot collect essential physiological data, such as heart rate, respiratory sounds, or ECG signals, compromising diagnostic reliability and the quality of clinical assessment.

More than 4% of the Portuguese population (≈400,000 people) reported unmet medical needs due to barriers such as distance, costs, or waiting times.

Approximately 24% of the Portuguese population is aged 65 or older (≈2.5 million people).

More than 55% of elderly people in Portugal have at least one chronic condition. (≈1,4 milhões)

Solution beneficiaries

The elderly, as they would avoid long journeys to attend face-to-face appointments and could benefit from more comprehensive and effective teleconsultations.

Family members would no longer need to compromise professional and personal time for distant appointments, while gaining greater confidence in their relatives' health monitoring.

Doctors, who would be able to see more patients, have a more organized schedule, and conduct teleconsultations with more reliable diagnoses

And, possibly, the rest of **the population**, who could also benefit from using the same device in a teleconsultation context.

Technological solution

Wearable Biometric Acquisition Module

The proposed solution consists of a wearable platform for acquiring biometric signals to support teleconsultation. At this stage, the project focuses on defining the target signals and selecting appropriate sensing technologies, ensuring reliability, user comfort, and clinical relevance.

Real-Time Data Transmission

Biometric data are transmitted in real time to the cloud, where they are stored and processed. The information is then forwarded to the hospital server and is immediately available to the medical team during the teleconsultation.

Clinical Interface & Monitoring

The doctor at the hospital receives the patient’s vital signs in real time, properly organized. On the desktop interface, the heart rate graph and its corresponding values are displayed, as well as the respiratory rate values and both cardiac and respiratory sounds.

Technological solution

Why physiological data?

Stable Signal Acquisition

Reliable physiological monitoring requires consistent sensor placement and adequate signal quality to ensure clinically useful measurements.

Ease of Use

The system must minimize user interaction and complexity, particularly for elderly users with limited technological familiarity.

Simultaneous Monitoring

Remote consultations require the acquisition of multiple physiological signals in real time to support clinical assessment.

Clinical Consistency

Measurements must be repeatable across consultations to enable longitudinal comparison and support medical decision-making.

Competitors and previous work

Teladoc HEALTH

- ✓ **Provides teleconsultations**
- ✗ **No integrated physiological monitoring**

amwell

- ✓ **Clinical telehealth platform**
- ✗ **Requires multiple external devices**

Medtronic

- ✓ **Clinical-grade monitoring**
- ✗ **Expensive solutions**

Our key innovation is the integration of sensing, teleconsultation and a medical monitoring platform in one workflow.

Solution requirements

- **Requirements for Local Health Access Points**

To ensure the correct implementation of the telemonitoring system, local access points (e.g., parish councils, community centers, or social support units) must meet the following requirements:

Physical infrastructure –Private clinical space with adequate lighting, ventilation, soundproofing, and accessibility for people with reduced mobility.

Local equipment –Terminal compatible with the clinical platform, HD camera, two-way audio system, certified power supply, and device charging station.

Data Security and Protection – Secure authentication, end-to-end encryption, access control, and GDPR compliance.

Connectivity – Stable internet connection with low latency and redundancy system (4G/5G) to ensure service continuity.

Operationalization – Sanitization procedures, basic training for the local manager, and remote technical support.

Solution requirements

- **Technical System Requirements**

The system must integrate biomedical acquisition, secure communication, and data processing components, ensuring real-time transmission, reliable storage, and structured availability of information to healthcare professionals:

Hardware - Integrates biomedical sensors for respiratory rate, and auscultation, a processing unit for signal acquisition and preprocessing, temporary local storage, and a rechargeable battery with adequate autonomy, anticipating future certification as a medical device.

Local equipment -Terminal compatible with the clinical platform, HD camera, two-way audio system, certified power supply, and device charging station.

Communication - Ensures secure data transmission via Bluetooth/Wi-Fi/4G, with end-to-end encryption and fault tolerance mechanisms to ensure continuity in monitoring.

Cloud Platform - Enables real-time ingestion, secure storage, and automatic processing of biomedical signals, maintaining a structured history of measurements.

Clinical Interface - Provides real-time visualization of vital signs, access to clinical history, and report export, with the possibility of future integration with hospital systems (HL7/FHIR).

Technical challenges

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Functioning Between Different Users

The system must function correctly for different users, maintaining stable performance and allowing disinfection between uses.

Maintenance and Sensor Durability

Frequent use and disinfection can cause wear or loss of accuracy, requiring regular maintenance, possible replacements, and performance verification to ensure clinical reliability.

Reliable Biomedical Signal Acquisition

Obtaining reliable biomedical signals outside of a clinical environment is challenging due to noise, movement, and variations in sensor positioning, requiring stability in measurements.

Fault Detection and System Self-Diagnostics

Detecting sensor or system failures in real time is a challenge, requiring self-diagnostic mechanisms to identify abnormal readings, loss of contact, or hardware faults.

Hardware–Software–Clinical Integration

Coordinating the physical device, data processing, and the medical interface is a technical challenge, requiring synchronization to ensure reliable operation.

Battery Safety and Power Management

Ensuring battery autonomy while guaranteeing patient safety is a challenge, as lithium batteries may pose risks such as overheating or failure, requiring protective systems.

Data Security and Patient Privacy

Protecting sensitive biomedical data requires secure transmission, encryption, and compliance with healthcare data regulations.

Medical Device Certification and Regulatory Compliance

Meeting medical device standards is a challenge, requiring strict safety, reliability, and clinical validation requirements.

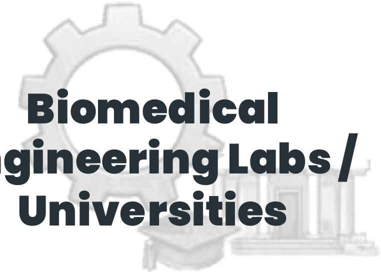
Partners


Parish Councils/Municipalities


Health technology companies


Pharmaceutical Companies


Hospital centres


Biomedical Engineering Labs / Universities

Testing and validation metrics

Testing Methods

- Functional system testing in a real environment;
- Use of the system by elderly users in teleconsultation scenarios;
- Evaluation of usability and ease of use

Validation

- Evaluation by a healthcare professional regarding the reliability of the solution;
- Collection of testimonials from elderly users;
- Analysis of the impact on users' quality of life

Key Metrics

- User satisfaction rate (%);
- Ease of use (rating scale);
- Perceived improvement in quality of life;
- Clinical validation of system reliability

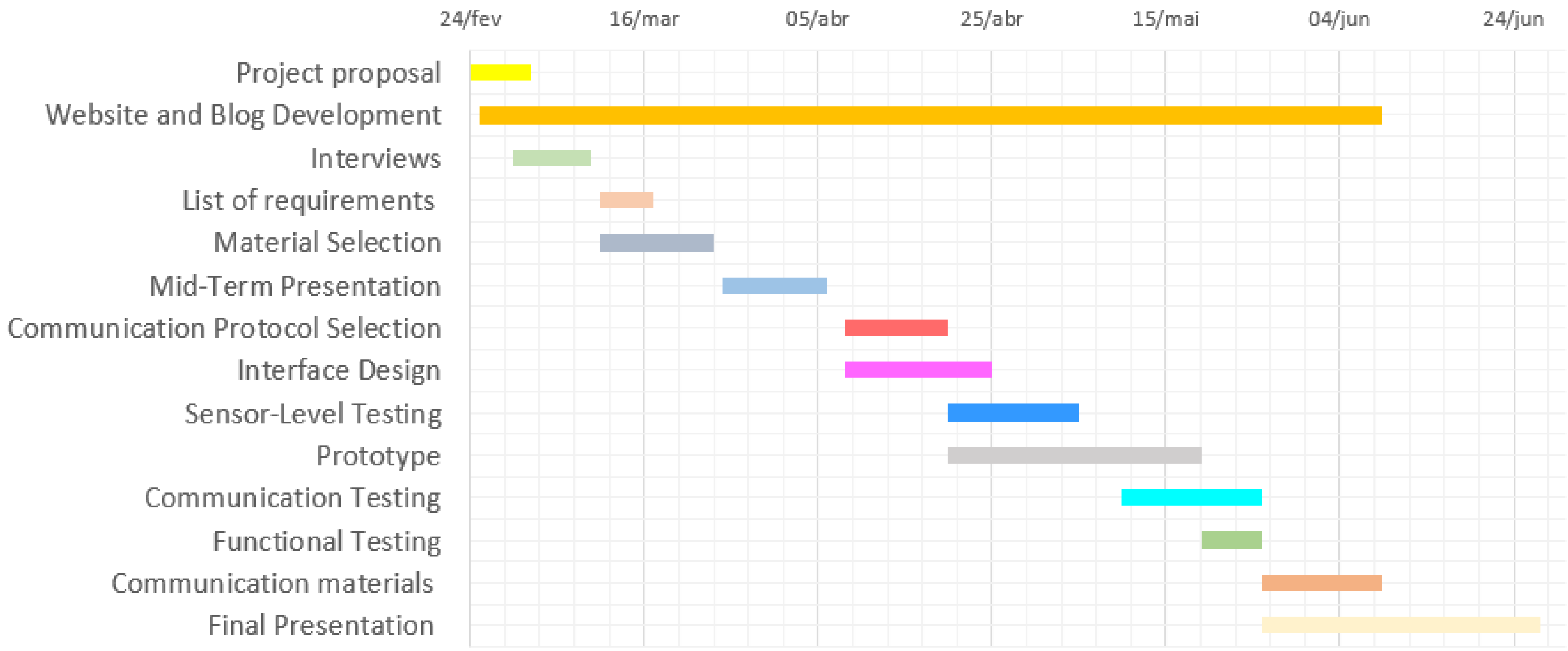
Division of labor (I)

Pedro	Filipa	Madalena
System Design & Coordination	**Software & Data Management**	**Telemedicine Platform & User Experience**
Overall System Architecture Design	Device–Cloud Communication Implementation	Teleconsultation Workflow & Interface Design
Hardware–Software Integration Coordination	Cloud Infrastructure Development	Clinical Data Structuring
Technical Liaison with Institutional Partners	Website Technical Development & Maintenance	Website, Blog & Video Content Development
System-Level Performance Verification	Data Transmission Stability Testing	Usability Testing Coordination

Division of labor (II)

Luís	Guilhereme
Operations & System Integration	**Testing, Validation & Performance Analysis**
System Integration Validation	Operational Scenario Definition
Partner Relations & Field Coordination	Sensor-Level Testing
Deployment Planning & Execution	Communication Testing Support
Operational Stress Testing	Field Performance Validation

Schedule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16/mar
05/abr
25/abr
15/mai
04/jun
24/jun
Project proposal
Website and Blog Development
Interviews
List of requirements
Material Selection
Mid-Term Presentation
Communication Protocol Selection
Interface Design
Sensor-Level Testing
Prototype
Communication Testing
Functional Testing
Communication materials
Final Presentation