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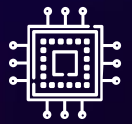
NAVISense Vest: Intelligent Multisensory Assistive Vest for Safe Navigation and Awareness



Problem definition

People with visual impairments and reduced mobility face challenges navigating safely and independently in complex environments.

Current solutions provide limited information, increasing the risk of collisions and disorientation.

There is a need for a smart wearable solution that improves safety, spatial awareness, and user autonomy.

Solution Beneficiaries

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People with Total or Partial Visual Impairment

Helps users navigate more safely, detect obstacles, and increase independence in daily life.

Older Adults with Mobility Difficulties

Supports orientation and movement, helping prevent falls and increasing confidence

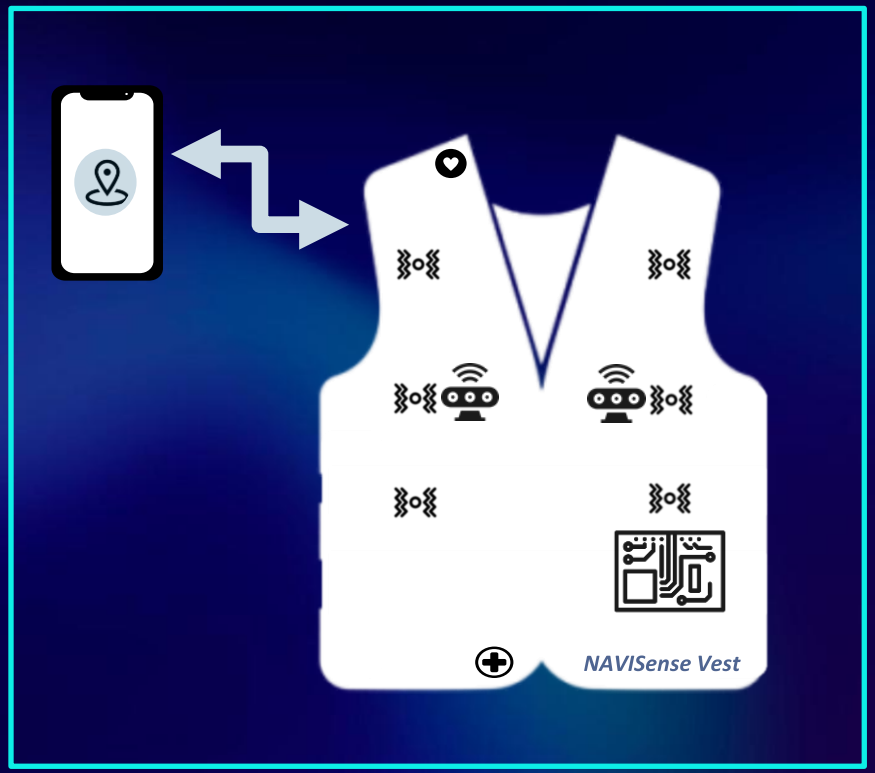
Workers in High-Risk Industrial Environments

Assists navigation in low-visibility areas, improving workplace safety

Rescue and Emergency Teams

Improves spatial awareness and increases safety during emergency operations

Technological Solution



Depth Sensors detect nearby objects and generate spatial distance data.

The vibration motors generates haptic feedback to inform the user about surrounding obstacles and their proximity.

Real-time user localization and route tracking.

Processing and communication components (ESP32 and auxiliary sensors) handle data processing, wireless communication, and system control.

The heart rate sensor monitors the user's physical state and helps detect abnormal stress or emergency situations.

The emergency button allows the user to instantly send an SOS alert with their live location to emergency contacts.

Team & Roles

Francisco Mariquitos

4G integration, Public Relations and Data Transmission, Vest Assembly

Raquel Barroso

Vest Design and assembly, component selection and Poster Design

Daniel Khom'yak

Website Design, Dashboard Design and Dashboard Elements

Prof. Francisco Alegria
Mentor

David Reimer

Demonstration Video, Public Relations, Material Selection

Tiago Pinto

Pitch Deck, Vest Design and Poster Design

Frederico Pinto

Dashboard Programming, Dashboard Design and Dashboard Elements

Duarte Marques
Advisor

Market Opportunities

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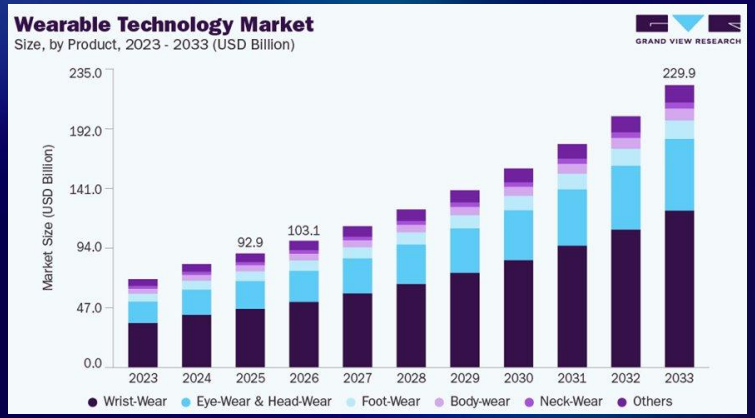
➢ **Relevant target market:**

More than 2.2 billion people live with some form of visual impairment, creating strong demand for navigation and safety solutions.

➢ **Economic impact:**

Productivity loss associated with visual impairment is estimated at around US$ 411 billion per year, highlighting the potential for assistive technologies.



➢ **Wearable market growth:**

The global wearable technology market is valued at US$ 92.9 billion (2025) and is projected to reach US$ 230 billion by 2033 (≈12% annual growth).

➢ **B2B safety opportunity:**

Workplace safety wearables represent about US$ 4.0 billion (2024) and are expected to grow to US$ 9.4 billion by 2030.

➢ **Scalable market potential:**

Applicable across multiple sectors: visual assistance, industrial safety, emergency response teams, and remote safety monitoring.

2.2 billion people

with a near or distance vision impairment

295 million people

have moderate to severe visual impairment

43 million people have blindness

Technical Challenges

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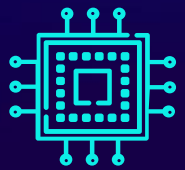
Multiple sensors and vibration motors consume significant energy.

Developing a wearable navigation system with multiple sensors, wireless connectivity, and real-time feedback while keeping the overall cost extremely low is a major challenge.

Bluetooth and 4G connection between vest -> smartphone -> satellite can drop due to interference or user movement.



Low-cost ultrasonic sensors can struggle with reflective surfaces, ambient noise, and angled obstacles.

Previous similar work

WeWALK Smart Cane

Smart cane with ultrasonic sensors and smartphone integration that provides haptic feedback for obstacle detection and navigation assistance.

Relies on a handheld device with limited spatial coverage, lacking full-body awareness and multi-sensor fusion for 360° obstacle detection.

Sunu Band

Wearable wristband using sonar technology to detect obstacles and provide intuitive vibration feedback based on distance.

Single-point sensing restricts environmental perception, offering reduced accuracy and no directional spatial mapping compared to distributed sensors.

Solution Requirements

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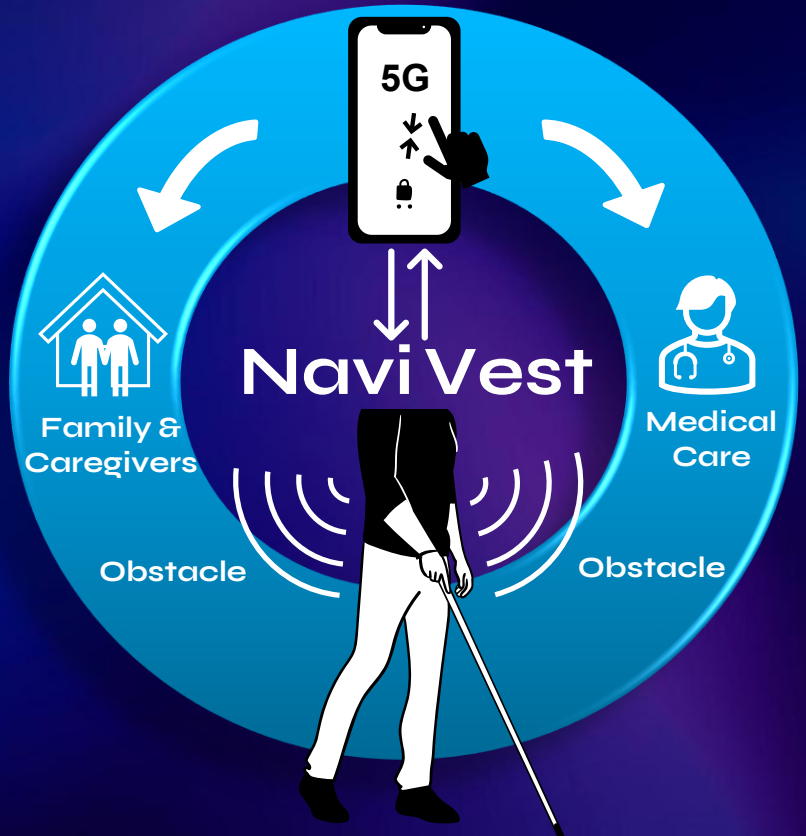

The system must detect obstacles reliably within a defined range (e.g., 20–350 cm) using low-cost sensors.

The vest must communicate with a smartphone via Bluetooth, and the smartphone must forward data to a cloud platform via 4G/5G.

Remote dashboards must display live device status, sensor readings, and alerts with minimal latency.

All components and materials must remain within a strict low-cost budget while maintaining system reliability.

Testing and Validation Metrics

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Sensor Performance:

- Detection Range (20-350 cm);
- Distance Accuracy;
- Field of View;
- Testing of Different Surfaces.

Power & Hardware:

- Battery Life Duration;
- Power Consuption;
- Thermal Stability;
- Restart & Recovery Behavior.

App & Website Testing:

- Live Data Display;
- Update Speed;
- Logging Allert Accuracy;
- Multi-device & Server Load Testing.

System Performance:

- End-to-end Latency;
- Transmission Delay;
- Delay under different WiFi conditions;
- Update Rate.

Communication & Data:

- Packet Loss;
- Data Transmission Delay;
- Buffering Capability;
- Data Integrity & Corruption Check.

Safety & Reliability:

- False Positive/Negative Rate;
- Directional Alert Accuracy;
- Environmental Testing;
- Testing of Different Surfaces;
- System Stability.

Meetings' feedback

Meeting with Bengala Mágica:

- ✓ Introduce a switch or adaptive control mechanism to regulate haptic motor intensity, allowing adjustment based on environment and user preference;
- ✓ Find a solution for stairs detection and holes;
- ✓ Implement real-time battery monitoring with user alerts.

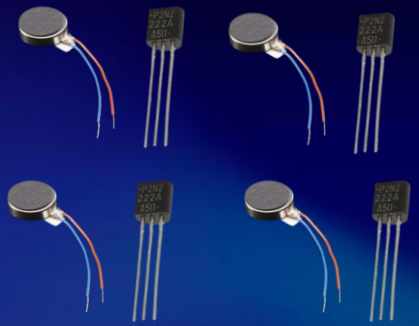
Meeting with Elderly Users:

- ✓ Introduction of an emergency button;
- ✓ Ensure the vest is lightweight and highly breathable to maximize comfort during prolonged use;
- ✓ Need for intuitive feedback patterns.

Technical and non-Technical Challenges

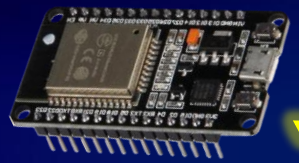
- Understanding user needs
- Wearability (comfort & compactness)
- Sensor and actuator placement
- Collaboration with associations
- Real-time multi-sensor data integration

Diagram of the proposed solution architecture



Vibration Motors and Transistors

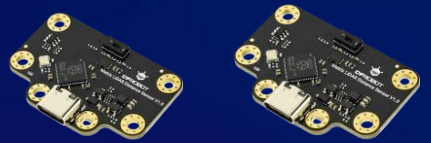
ESP32



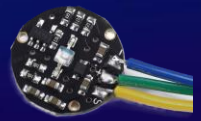
PWM Modulation

I2C Serial Communication

8x8 Matrix ToF 3D Distance Sensors



I2C Serial Communication



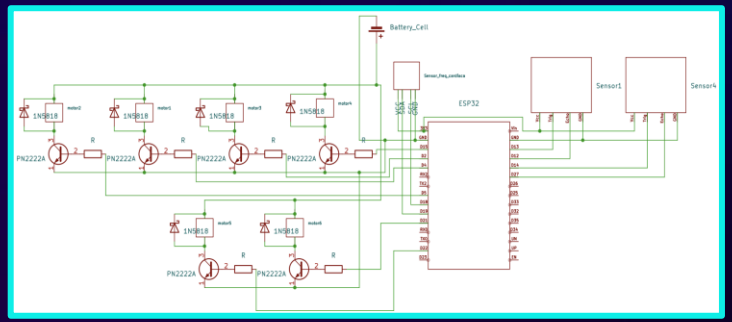
BPM heart Sensor

Power to Vibrating motors

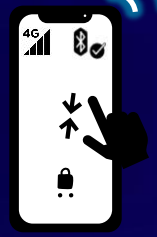
Power to ESP32

Li-On 3.6V, 6Ah Cell

KiCAD Electrical Scheme



Bluetooth Connection to ESP32 for sensor Data transmission



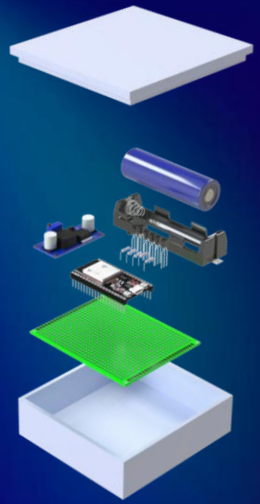
4G Connection to the Website

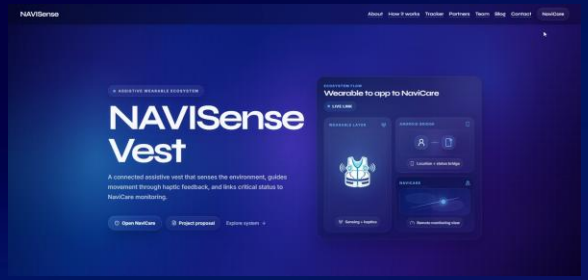
Live Location and Sensor Data Transmission

Website

Achievements attained

- ✓ Completed the functional vest prototype
- ✓ Developed the mobile app and website
- ✓ Produced the promotional video and final poster
- ✓ Updated the website and blog with project progress





- ✓ Improved sensor processing and obstacle detection code
- ✓ Integrated hardware, software and live monitoring features

Contributions of each member to the results

Francisco Mariquitos

- Assisted in component selection;
- Contacted several individuals and entities to obtain more info;
- Assisted in website design.
- Vest assembly and integration of all electronic components;

Raquel Barroso

- Component selection (sensors, motors, power system);
- Power management strategy.
- Vest assembly and integration of all electronic components;
- Contributed to the development of the poster

Daniel Khom'yak

- Website design and development;
- Blog system development;
- Software architecture design(communication between website and app).

David Reimer

- Assisted in material selection;
- Contributed in contacting several individuals and entities to obtain more info;
- Video editing.

Tiago Pinto

- Assisted in component selection (sensors, motors);
- Contributed to the development of the project pitch deck and poster.

Frederico Pinto

- App design and development;
- Software architecture design(communication between app and website).

Project Timeline

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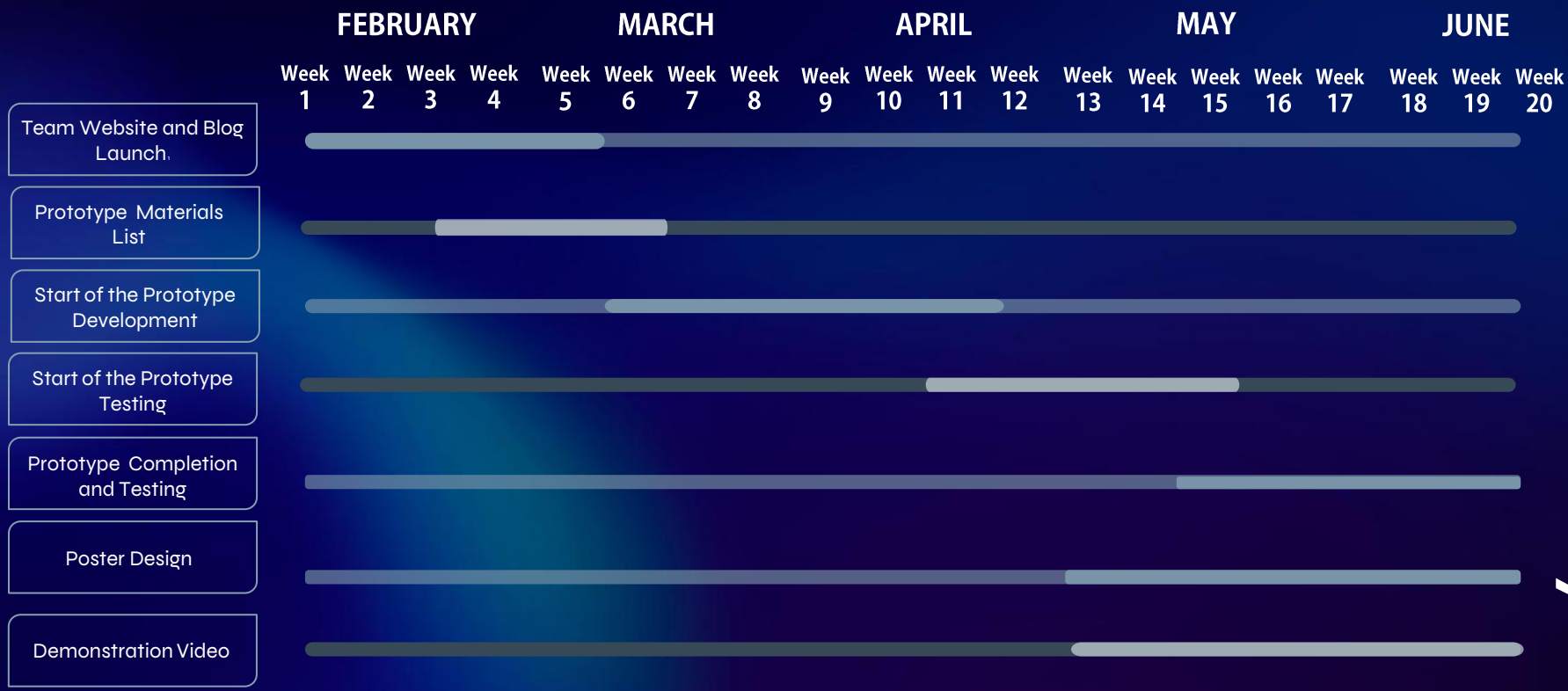

Electroday

Website and Video

https://web.tecnico.ulisboa.pt/·ist1106726/NAVISENSE/

https://youtu.be/8SJ3yxZUUkA