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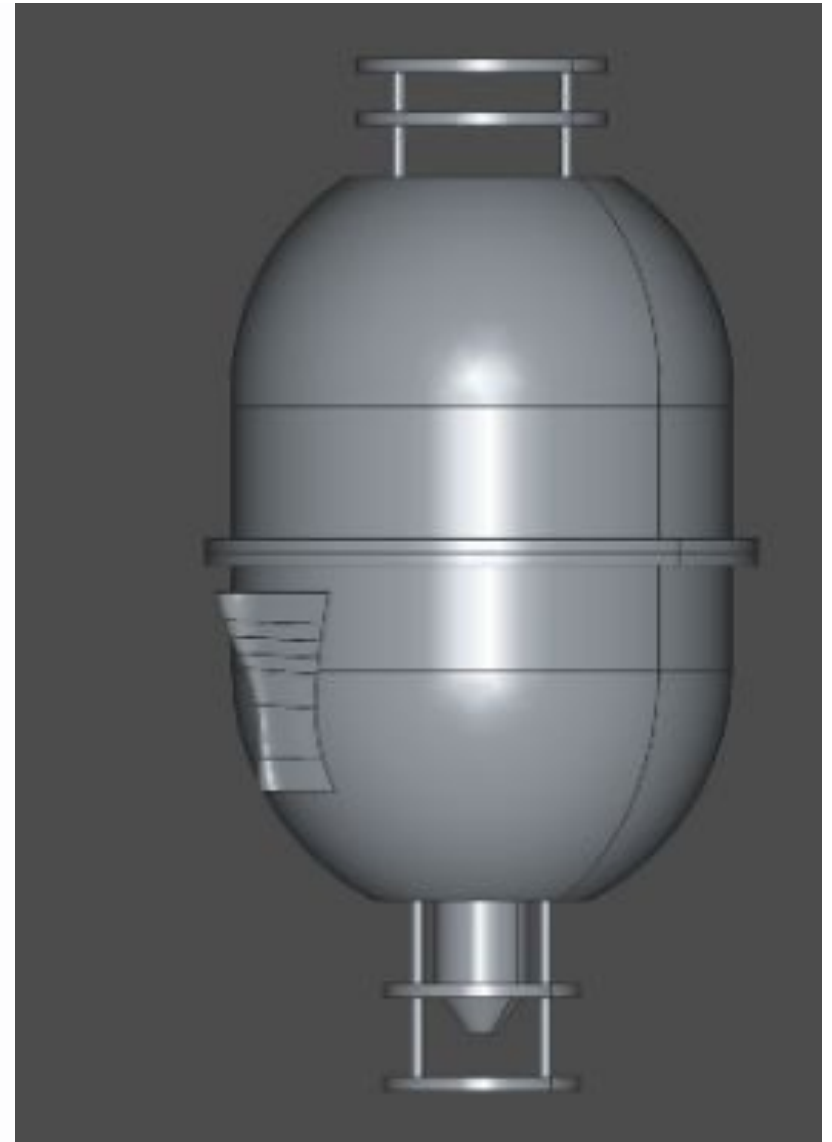
MoBI: Intelligent Buoy for Marine Environmental Monitoring

An integrated system combining smart buoys and autonomous technology for sustainable marine resource management and climate change mitigation.

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About me

Mariella Sole

Academic career

2010 – M.Sc. in Telecommunication Engineering

2014 – Ph.D. in Computer Science and Electronic Engineering

2014–Present – Researcher and Technologist at the Department of Electrical and Electronic Engineering (DIEE), University of Cagliari

Research Focus: Design and development of IoT devices for environmental monitoring



The Challenge

Marine Monitoring Crisis

Sustainable management of natural resources requires accurate, real-time environmental data collection in challenging maritime conditions.

Traditional monitoring systems struggle with:

- Limited connectivity in remote areas
- High operational costs
- Inconsistent data quality





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MoBI System Overview



Dual Processing

Raspberry Pi 3B+ and Arduino
Mega 2560 for robust data
handling



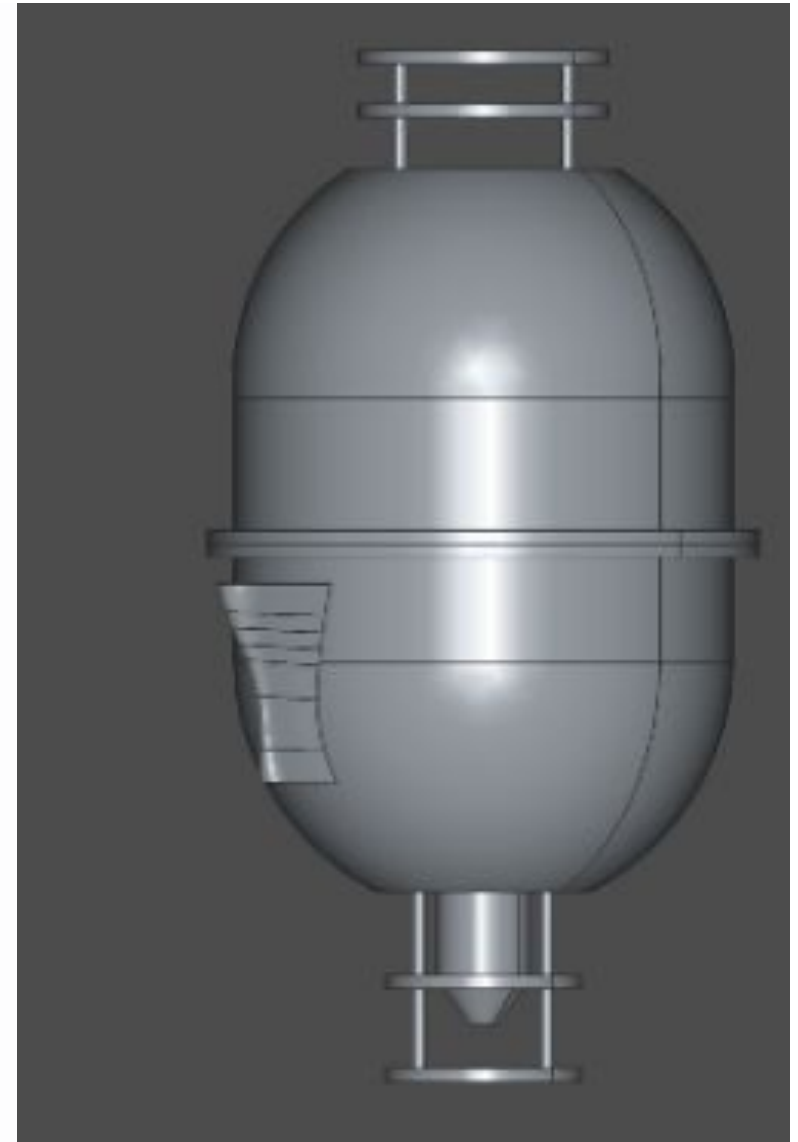
Multi-Sensor Array

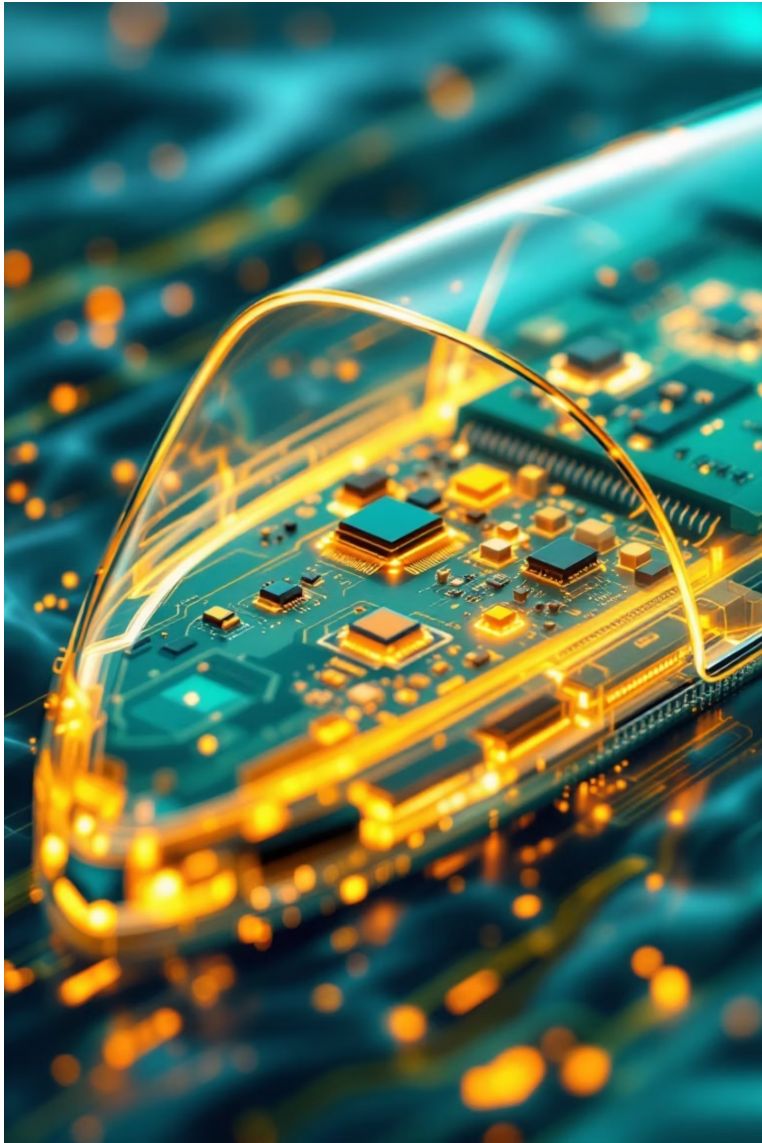
GPS, accelerometer, gyroscope,
magnetometer, and
environmental probe



Redundant Communication

4G/LTE primary with LoRa backup for continuous connectivity





Innovative Architecture

01

Hardware Integration

Raspberry Pi manages high-level tasks while Arduino handles real-time sensor acquisition via UART protocol

02

Power Management

Stabilized 5V supply with 12V voltage booster for probe, charge controller ensures continuous operation

03

Structural Design

3D-printed HDPE hull provides waterproof protection with modular design for easy maintenance

04

Data Resilience

Local SD card storage ensures no data loss, enabling deferred transmission when connectivity fails

Dual Communication Strategy

4G/LTE Primary

High data transfer rates, low latency, wide coastal coverage for immediate transmission

LoRa Backup

Long-range, low-power fallback for remote areas with limited cellular coverage

Local Storage

SD card logging ensures data preservation when both channels fail

Operational Workflow



Initialization

System startup, sensor calibration, GPS fix acquisition



Navigation

Buoy moves to target coordinates, distance monitoring



Acquisition

Environmental and wave data collection at measurement point



Transmission

Data sent via 4G or LoRa, verification and retransmission



Environmental Data Collection

WMP6 Multiparametric Probe

Real-time monitoring of critical water quality indicators:

- Temperature
- pH levels
- Electrical conductivity
- Dissolved oxygen
- Turbidity

Three consecutive readings averaged per cycle, with stabilization period for accurate saltwater measurements. Data stored in JSON format with GPS coordinates and timestamps.





Wave Dynamics Monitoring

1

Phase 1: Detection

Accelerometer tracks Z-axis fluctuations to identify wave cycles

2

Phase 2: Analysis

Period measured between successive peaks, height estimated via double integration

3

Phase 3: Validation

Reliable detection of waves >5-10cm, averaged over configurable time window

4

Phase 4: Storage

Georeferenced data in JSON format for transmission and analysis

Field Test Results

10m

GPS Accuracy
Average positional
deviation from target
points

100%

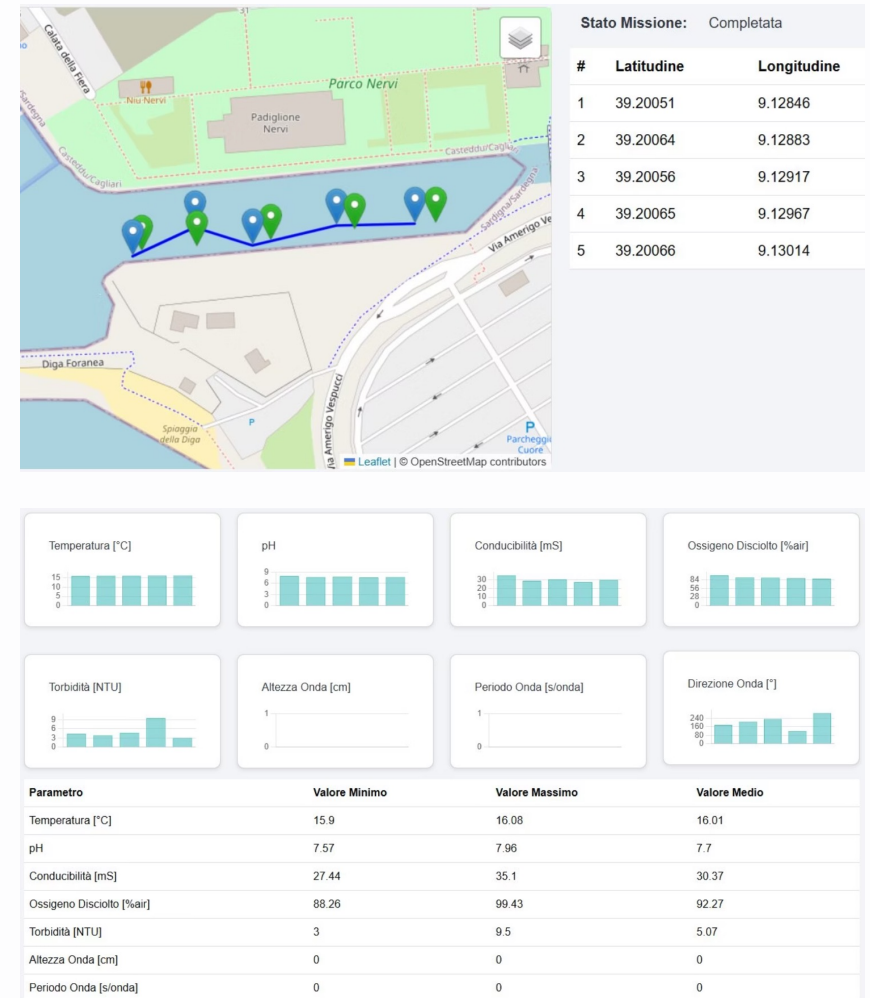
Data Integrity
Successful
transmission and
recovery with
redundant systems

5cm

Wave Detection
Minimum reliable wave
height measurement
threshold

Testing Location: Coastal area of Cagliari (Sant'Elmo pier and Palma channel), January-March 2025

Key Findings: System demonstrated robust performance with stable environmental measurements, effective dual communication, and zero hardware failures. 3D-printed HDPE hull maintained complete waterproof integrity throughout deployment.





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Impact and Future Directions

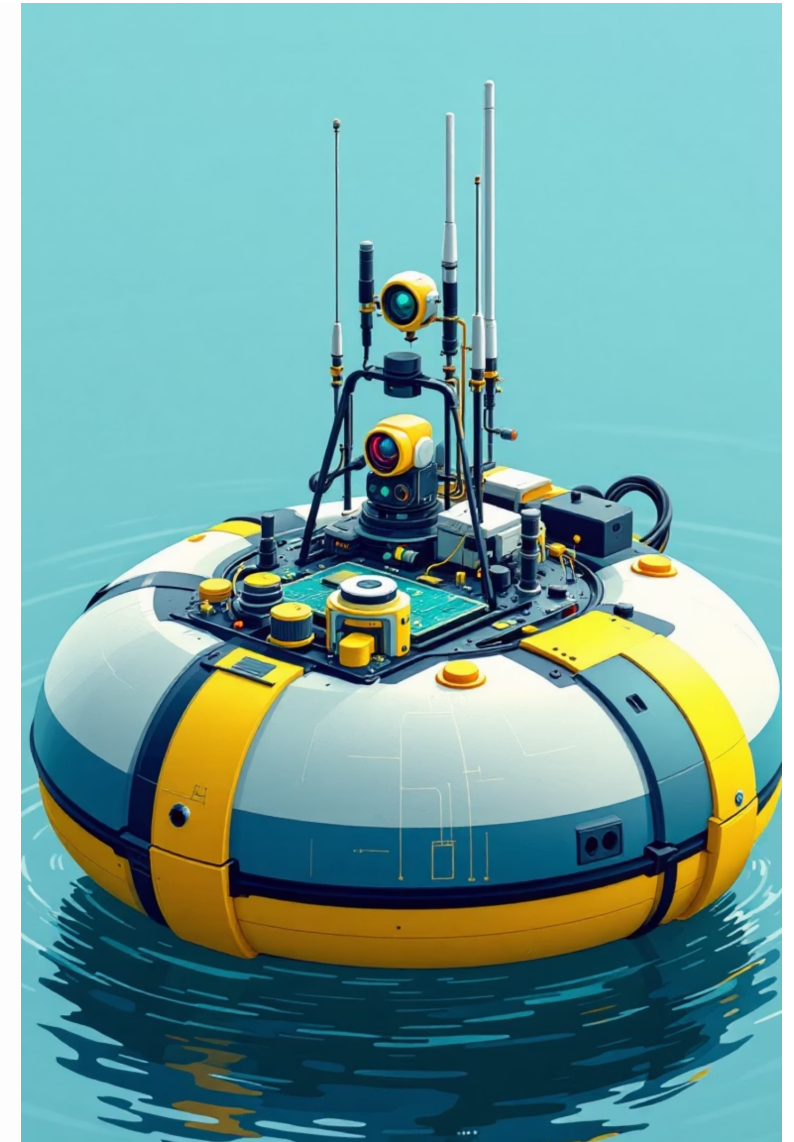
Proven Capabilities

- Reliable data acquisition in challenging marine conditions
- Seamless cloud integration with real-time dashboards
- Modular design enables easy maintenance and upgrades
- Cost-effective solution for coastal monitoring

Next Steps

- Optimize power management for extended missions
- Enhanced wave algorithm for calm conditions
- Expanded sensor protocol compatibility
- Automated long-term mission management

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Thank you for your kind attention

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