

WAVE TRACKER

Coastal Wave Measurement Sensor and Data Logger

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The Problem

Understanding the Core Issue

Waves are a fundamental part of coastal dynamics, influencing shoreline stability, maritime operations, and climate research. However, obtaining accurate and reliable wave data near the coast remains a challenge. Before developing a solution, we need to ask:

- Why do we need better coastal wave data?
- What problems arise due to a lack of precise wave measurements?
- Are current methods insufficient, and if so, why?



The Problem

✓ Coastal Hazards & Infrastructure Risks

Waves significantly impact coastal erosion, flooding, and storm surges.

Without precise data, engineers struggle to design effective coastal defenses.

Unreliable wave measurements hinder early warning systems for extreme weather.

✓ Limitations of Current Measurement Technologies

Buoy-based systems are expensive, require frequent maintenance, and are often positioned further offshore, missing nearshore wave details.

Radar and ultrasonic sensors struggle with resolution near the shore due to wave reflection and interference.

Satellite-based observations lack the precision needed for localized coastal monitoring.

Seabed pressure sensors exist but can be costly and often lack long-term durability in high-energy coastal environments.

✓ Environmental & Scientific Challenges

Researchers studying climate change, sea-level rise, and coastal ecosystems rely on detailed wave data to improve models and predictions.

The lack of accessible, high-resolution data limits our understanding of coastal wave dynamics and their long-term effects on the environment.

Who Benefits from This Technology?



Coastal Engineers & Urban Planners

- Better coastal protection strategies
- Improved infrastructure planning



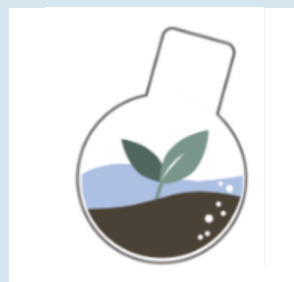
Local Communities & Authorities

- Early warning systems
- Sustainable tourism & recreation



Maritime & Shipping Industry

- Safer navigation
- Port management optimization



Environmental Scientists and Climate Researchers

- Better climate impact studies
- Enhanced coastal ecosystem monitoring

Technological Solution

The sensor will be a sealed, waterproof unit placed underwater at sand level, using pressure sensors to measure wave height. Instead of transmitting data wirelessly, it will store readings on an SD card, allowing users to retrieve the data periodically for analysis.

Components

- Pressure Sensors
- Microcontroller (e.g., ESP32, STM32)
- SD Card Storage
- Power System (Battery-Powered)
- Protective Enclosure

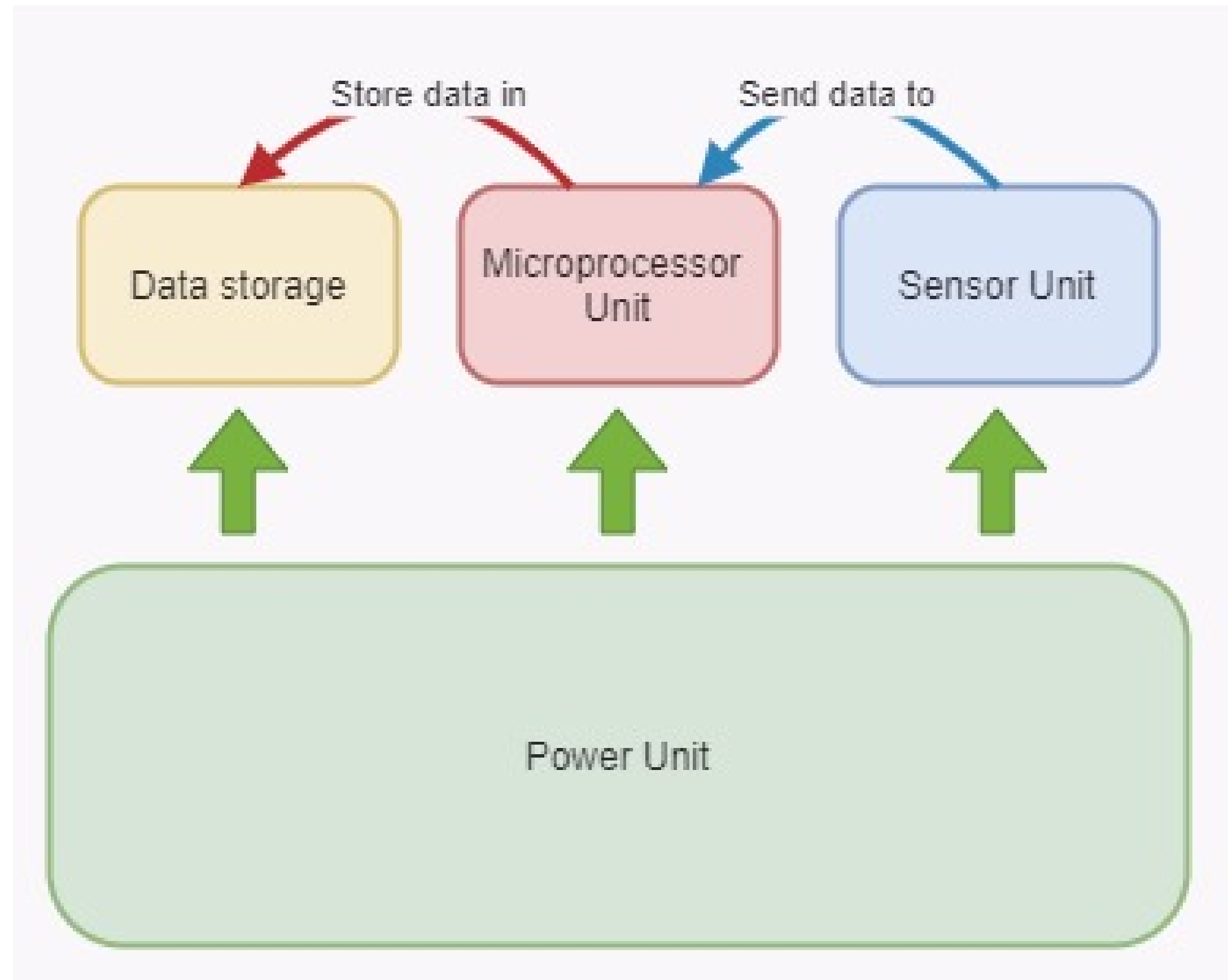
Affordable & Simple: Eliminates costly wireless communication modules.

Durable & Long-Lasting: Designed for long-term deployment.

Accurate & Practical: Provides precise nearshore wave height data.



Technological Solution: System Diagram





Environmental Durability >

Saltwater corrosion, pressure variations, and sediment buildup.



Power Management >

Low-power components and efficient data logging strategies.



Data Storage & Retrieval >

Must log data efficiently and have a user-friendly retrieval process.



Calibration & Accuracy >

Pressure readings must be converted into precise wave height values.



Deployment & Maintenance >

Needs to be easy to install and remove for occasional maintenance.



Challenges

Partners



Haedes

HAEDES is a consultancy and engineering firm specializing in challenges related to coasts, estuaries, rivers, and oceans. With hubs in Belgium and Portugal, they offer sustainable engineering solutions grounded in nature-enhanced frameworks and system thinking. Their services cater to governments, contractors, developers, and partners worldwide.

We are interested in learning from their expertise and exploring potential insights from their projects and team members.

Validation metrics

To ensure the sensor provides precise and reliable wave measurements, we will evaluate its performance using key validation metrics:

☒ Accuracy of Wave Height Measurement

- Compare pressure-based wave height calculations with reference instruments (e.g., traditional buoys or tide gauges).
- Use known water depth conditions to verify sensor readings.
- Conduct laboratory tests in controlled wave tanks before field deployment.

☒ Long-Term Reliability

- Test the sensor's durability under prolonged exposure to saltwater, sand, and biofouling.
- Monitor sensor drift over time, ensuring stable and consistent readings.
- Assess the waterproof enclosure's resilience against leaks and pressure variations.

☒ Data Integrity & Storage Efficiency

- Ensure no data loss occurs due to power failures, storage corruption, or environmental interference.
- Optimize SD card write cycles to balance storage longevity and frequent logging.
- Implement timestamped data logging to ensure accurate wave event tracking.

☒ Power Efficiency

- Measure battery life under real operating conditions.
- Assess power consumption per logging cycle and optimize sleep modes if necessary.

Division of labor

Manuel Silva

- Data Processing & Validation

Carlos Brito

- Deployment & Field Testing

João Custódio

- Mechanical & Environmental Integration

Pedro Tavares

- Hardware & Sensor

Matilde Augusto

- Embedded Systems & Firmware Developer

Diogo Carvalho

- Power & Energy Systems



Schedule

