

# SMART INDIA HACKATHON 2025

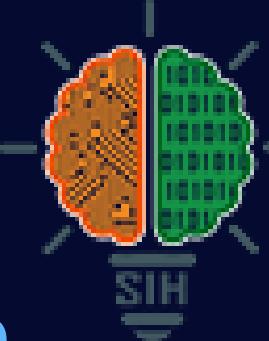
## SAMUDRA - SAND ANALYSIS & MAPPING USING DEEP RECOGNITION ALGORITHMS

- Problem Statement ID: 25037
- Problem Statement Title: Development of a low-cost camera-based automated beach sand grain size mapping system
- Theme: Miscellaneous
- PS Category: Hardware
- Team ID: 101905
- Team Name: Team Dope





# Development of a Low-Cost Automated Beach Sand Grain Size Mapping System



SMART INDIA  
HACKATHON  
2025

## SandScan: Geo-Tagged Grain Analysis System



### OUR SOLUTION

- Low cost portable and automated camera based device that brings sand analysis directly to the field.
- Built around a powerful microcontroller and a camera module.
- Eliminates the need for expensive lab equipment and manual labor, making coastal research accessible to everyone.

### HOW IT ADDRESSES THE PROBLEM?

- Replaces slow, expensive and non-scalable lab work with rapid on-site data collection.
- Is scalable thus allowing wide deployment using affordable tools.
- Provides an efficient and scalable alternative for large-scale environmental studies.

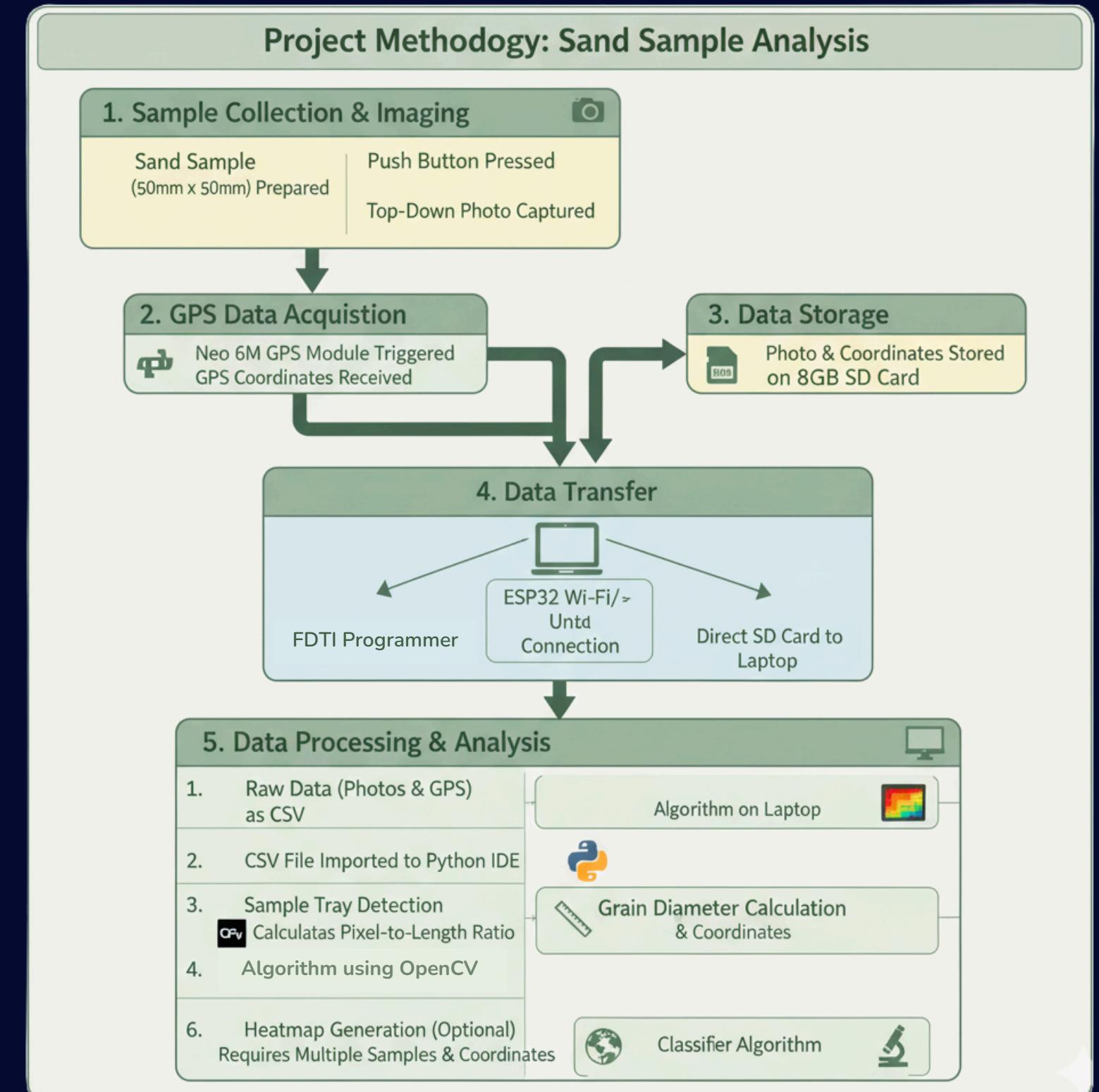
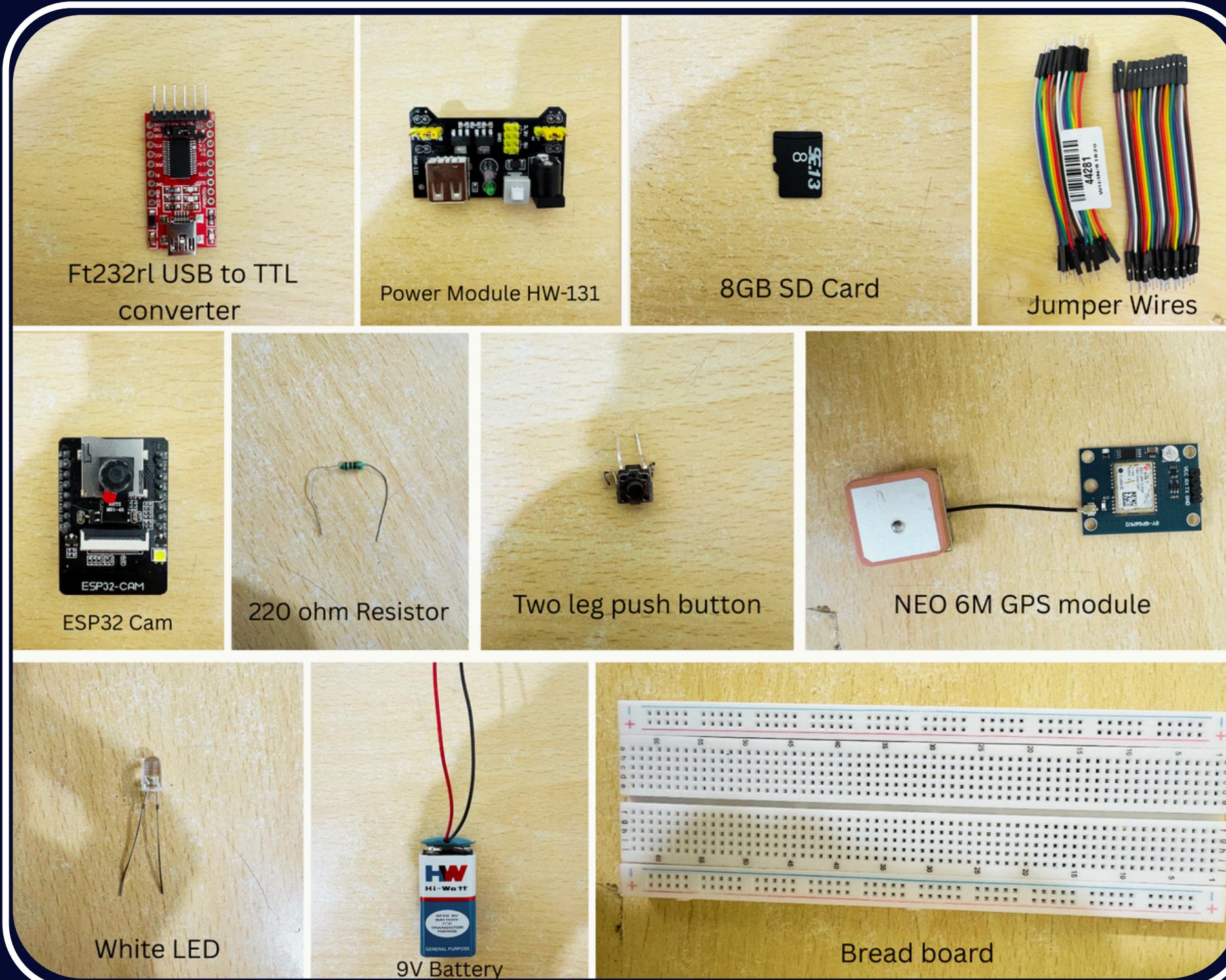
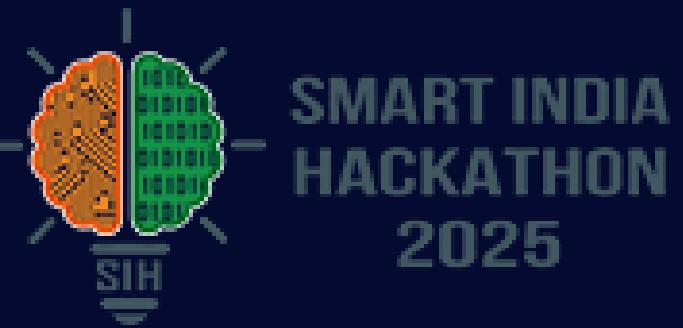
### INNOVATION AND UNIQUENESS

- Our system is unique as it automates the entire process from data collection to analysis.
- Complements lab methods by delivering broad real-time data at a fraction of the cost.
- Uses low-cost sensors and image processing to offer a portable grain-size analysis alternative.



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# TECHNICAL APPROACH



# FEASIBILITY AND VIABILITY

## Project Feasibility & Risk Mitigation

### FEASIBILITY

#### 1. Low-Cost Components:

The project utilises readily available and affordable hardware, such as the ESP32-CAM, Arduino Uno R4 Wifi and a Neo 6M GPS module, making it economically accessible.

#### 2. Simple Technical Approach:

The core function of capturing an image, using a reference object to calculate grain size, is a straightforward application of image processing and embedded systems.

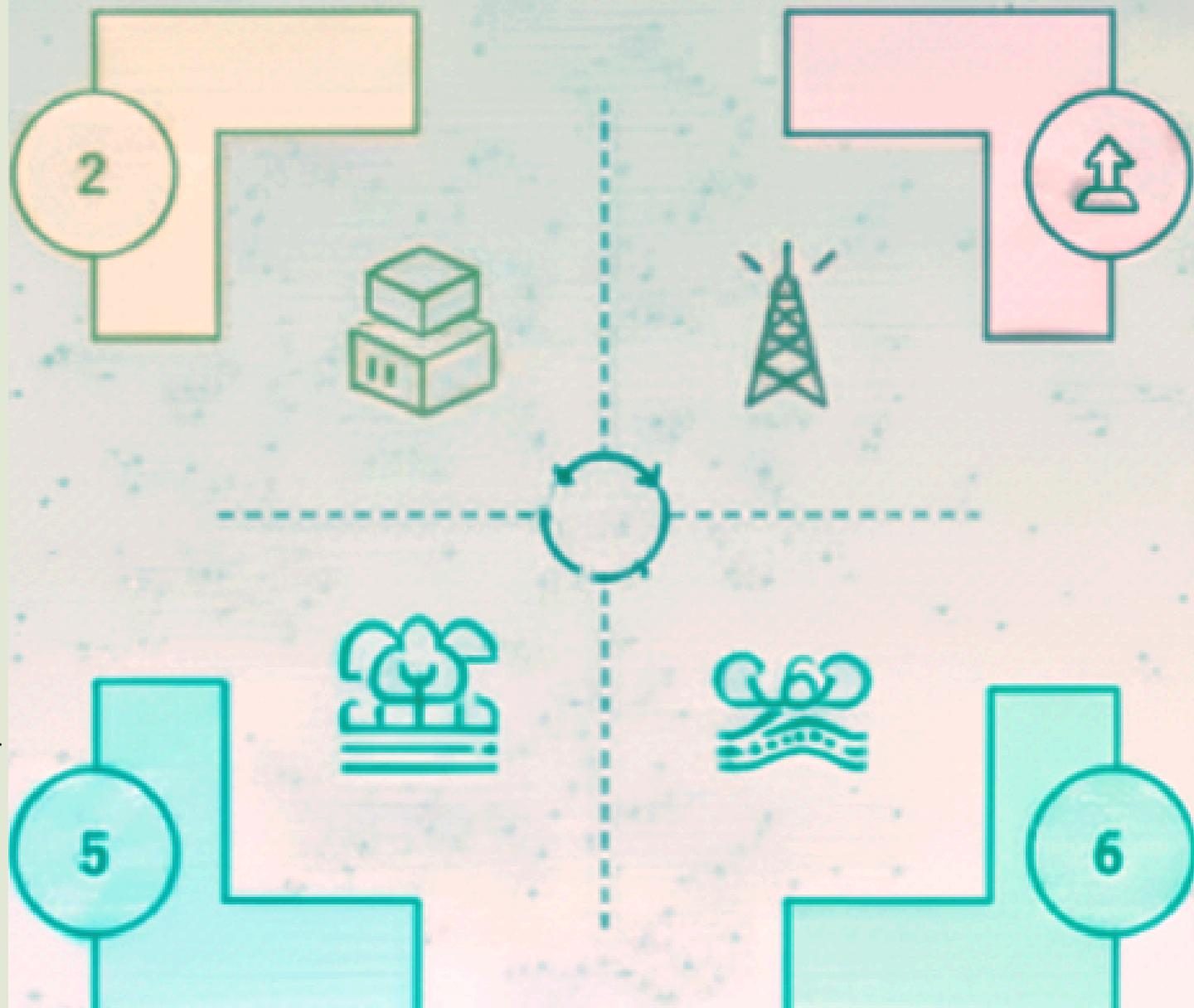
### LONG TERM VIABILITY

#### 1. Market Scalability:

The project's low cost and ease of use enable large-scale deployment, positioning it as the new standard for global coastal monitoring, especially in developing nations.

#### 2. Data Monetization:

The system can evolve from a hardware product into a data-service platform, generating long-term revenue by providing valuable coastal data and predictive models.



### POTENTIAL CHALLENGES

#### 1. Accuracy Limitations:

The primary risk is the trade-off between cost and absolute accuracy. The camera-based method will not match the precision of a controlled lab environment.

#### 2. Environmental Factors:

The device's performance could be affected by real-world conditions like lighting variations (sun glare, shadows), camera stability, and moisture.

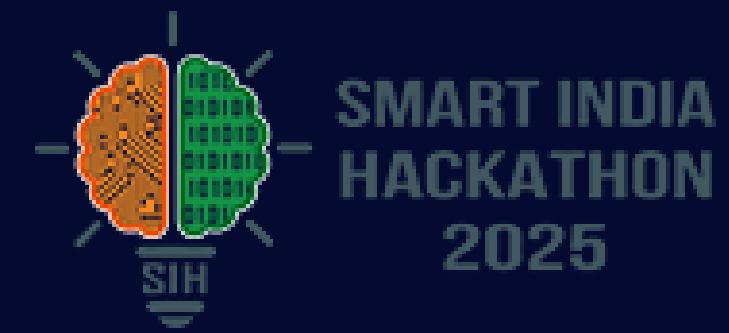
### STRATEGIES TO OVERCOME THESE CHALLENGES

1. **Develop a Robust Calibration Protocol:** Implement a simple, user-friendly calibration method using a standard reference object to ensure consistent measurements.

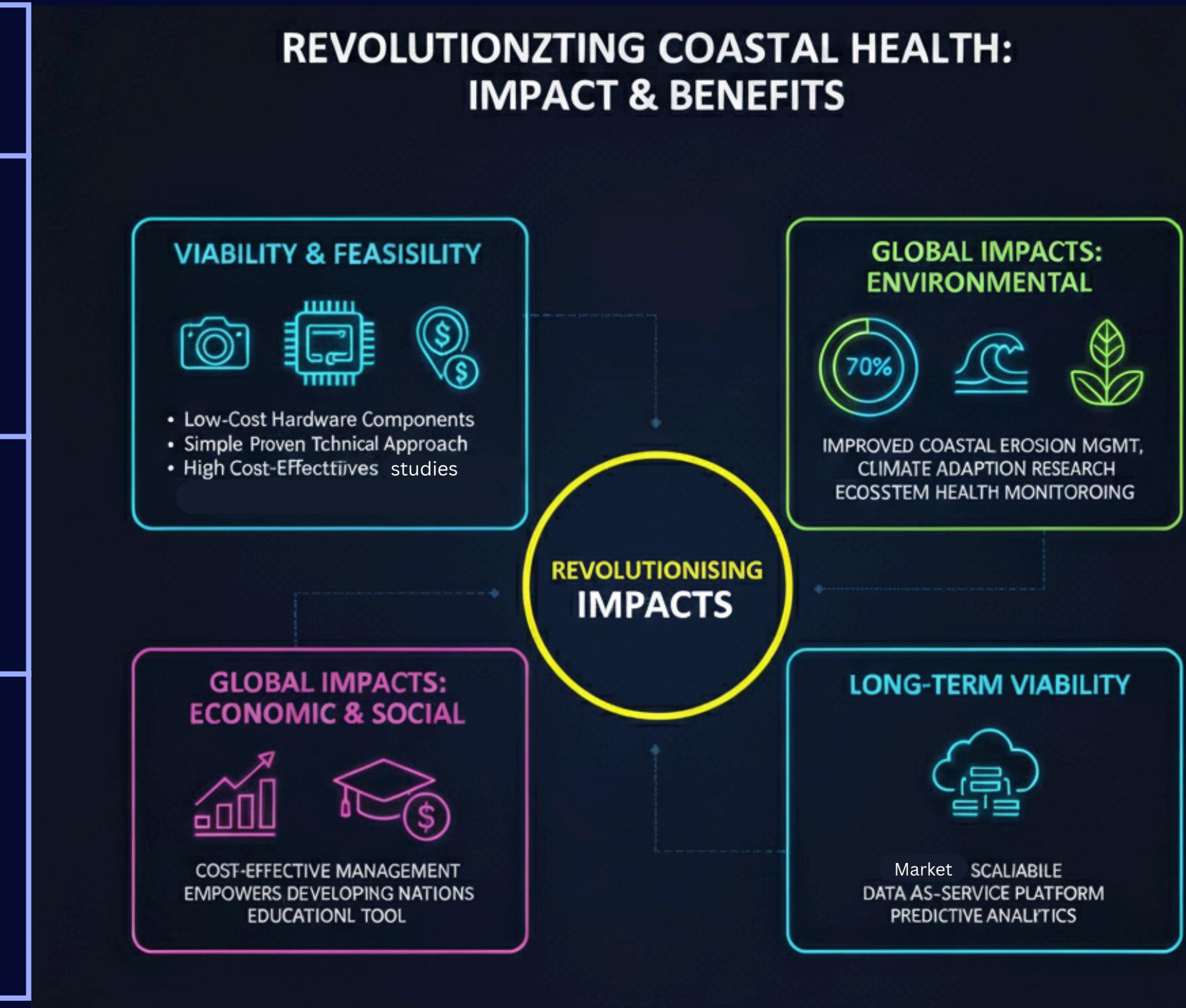
2. **Durable Enclosure:** Encasing the device in a waterproof and dust-proof housing is the first step to protecting it from moisture, sand, and other environmental elements.

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# IMPACT AND BENEFITS

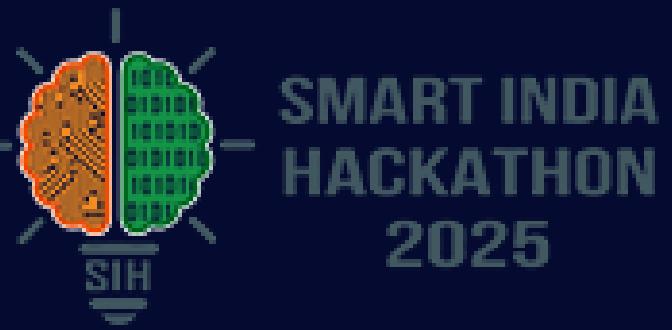


Solves Global Data Deficit	This keeps coastal management in a reactive state, unable to address problems until they become crises.
Democratization of Data	Its low cost allows for adoption by local communities, students and NGOs in developing nations. This fosters a bottom-up, citizen science movement, creating more comprehensive network for monitoring the world's coastlines.
Proactive Management	This data enables the development of hyper-accurate predictive models for erosion and storm damage, which allows for targeted, preventative measures rather than costly last-minute interventions.
Unified Coastal Health	This project has the potential to become a central node in a unified global network. Each device contributes to a real-time "health dashboard" for the planet's coasts, providing a cohesive, scalable solution to a worldwide challenge that no single entity can solve alone.



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# RESEARCH AND REFERENCES



Some of the references we used for research and analysis include:

- <https://youtu.be/JYchUapoqzc>
- [https://www.espressif.com/sites/default/files/documentation/esp32\\_datasheet\\_en.pdf](https://www.espressif.com/sites/default/files/documentation/esp32_datasheet_en.pdf)
- <https://randomnerdtutorials.com/esp32-neo-6m-gps-module-arduino/>

RANDOM NERD TUTORIALS     Menu     ≡

## ESP32 with NEO-6M GPS Module (Arduino IDE)

Learn how to interface the NEO-6M GPS module with the ESP32 to get GPS data. You'll learn how to get raw GPS data and interpret NMEA sentences. Finally, we'll show you how to easily get latitude, longitude, altitude, speed, and UTC time using the `TinyGPSPlus` library. The ESP32 will be programmed using Arduino IDE.

NEO-6M GPS MODULE