[***Smart-navigational-aid-monitoring***](https://github.com/ilyosbek97/Smart-navigational-aid-monitoring)

*AI & IoT-based Smart Navigation Aids Monitoring*

**1. Project Overview**

**Introduction**

Navigation aids, such as buoys and lighthouses, play a crucial role in ensuring maritime safety. However, these aids are often installed in remote areas and are susceptible to damage from collisions, harsh weather, and environmental factors. This project aims to develop an **AI & IoT-based Smart Navigation Aids Monitoring System** that can detect and report malfunctions or damage in real time.

**Objectives**

* Develop a real-time monitoring system for **navigation aids** using **AI and IoT technologies**.
* Detect **damage or malfunctions** in navigation aids (e.g., buoys, lighthouses) using **sensor-based monitoring**.
* Enable **remote tracking and maintenance** of maritime navigation aids to enhance operational efficiency.
* Expand functionality to **marine environmental monitoring** (temperature, seismic activity, tsunamis, etc.).

**2. Problem Statement**

**Current Issues**

1. **Difficulty in monitoring**: Navigation aids are installed in remote maritime locations, making it difficult to check for damage or malfunctions regularly.
2. **Frequent damage & costly repairs**: Collisions with ships and harsh marine conditions often cause damage, leading to high maintenance costs.
3. **Limited functionality**: Existing systems are primarily used for navigation only, without additional data collection capabilities.
4. **Lack of real-time monitoring**: No efficient system exists to immediately detect and report problems with navigation aids.

**Proposed Solution**

* Implement **AI-based damage detection** using **cameras and impact sensors**.
* Use **IoT connectivity (LTE-M, NB-IoT, LoRa, satellite, etc.)** for real-time data transmission.
* Monitor **marine environmental conditions** (temperature, seismic activity, tsunami detection).
* Develop a scalable and adaptable system for **future expansion and commercialization**.
* Fig 1.jpg

**3. System Architecture**

**Hardware Components**

* **Embedded System**: Raspberry Pi or similar microcontroller for processing.
* **Sensors**:
  + **Impact Sensors** – Detect collisions with ships.
  + **Cameras** – Capture and analyze visual data for AI-based detection.
  + **Environmental Sensors** – Monitor temperature, seismic activity, and water conditions.

**Software Components**

* **AI Model**: Image recognition and anomaly detection for damage identification.
* **IoT Communication**:
  + **LTE-M, NB-IoT, LoRa, VDES, AIS, Satellite** – Multi-hop communication for real-time data transmission.
* **Cloud-based Monitoring Dashboard**: Web-based interface for monitoring navigation aids.
* **4. Implementation Plan**
* **Project Phases & Timeline**

| **Phase** | **Tasks** | **Timeline (Months)** |
| --- | --- | --- |
| **Phase 1** | Research & Planning | 1-2 |
| **Phase 2** | AI-based Damage Detection Model Development | 3-4 |
| **Phase 3** | IoT Communication System Implementation | 5-6 |
| **Phase 4** | Marine Environmental Sensor Integration | 7-8 |
| **Phase 5** | System Testing & Optimization | 9-10 |
| **Phase 6** | Deployment & Commercialization | 11-12 |

**5. Expected Outcomes & Impact**

**Benefits**

**Fig 2.jpg**

* **Enhanced maritime safety**: Real-time damage detection reduces the risk of accidents caused by malfunctioning navigation aids.
* **Cost-effective maintenance**: Early detection of issues minimizes repair costs.
* **Multi-purpose functionality**: Additional environmental monitoring benefits marine research and disaster prevention.
* **Global scalability**: The system can be expanded for international maritime applications.

**Future Prospects**

* **Intellectual Property (IP) Generation**: Patentable AI & IoT technologies for maritime safety.
* **Commercialization Potential**: Collaboration with maritime authorities and navigation aid manufacturers.
* **Environmental Monitoring**: Integration with marine research and climate monitoring initiatives.

**6. Repository Structure**

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📂 Smart-Navigation-Aid-Monitoring

│── 📂 docs # Documentation files

│── 📂 hardware # Sensor & device configurations

│── 📂 software # AI model, IoT communication, and dashboard

│── 📂 tests # Testing scripts and datasets

│── README.md # Project overview

│── requirements.txt # Requirements