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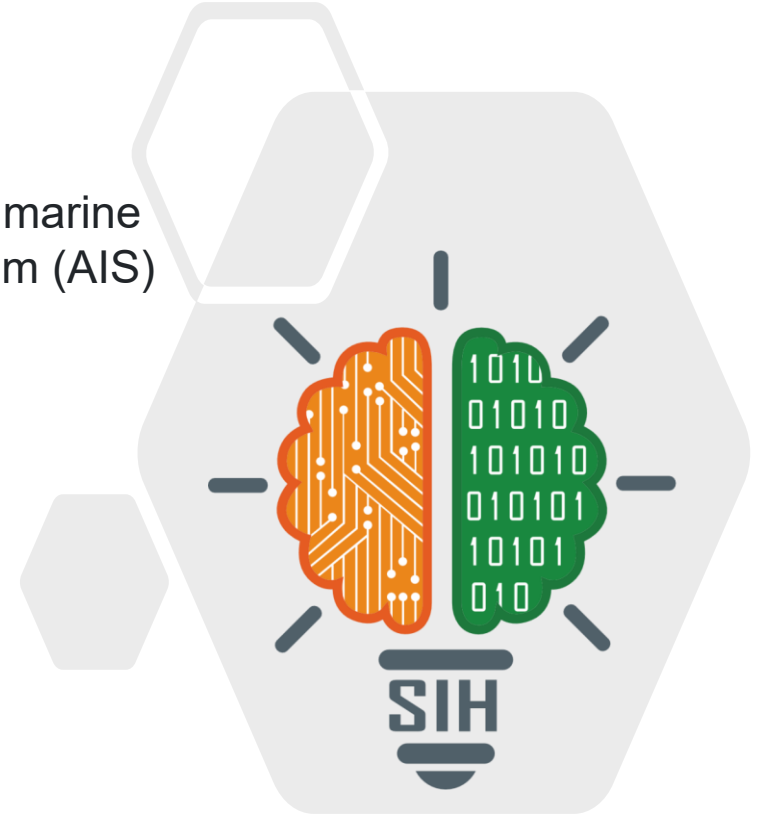
- **Problem Statement ID –** SIH1655
- **Problem Statement Title-** Detecting oil spills at marine environment using Automatic Identification System (AIS) and satellite datasets.
- **Theme-** Smart Automation
- **PS Category-** Software
- **Team ID-** 19570
- **Team Name -** FrostSpire



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Oil Spill Detection

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IDEA/ SOLUTION

Implementing real-time oil spill detection in the marine environment using **Automatic Identification System (AIS)** and **satellite** datasets with the help of **machine learning.**

- **Machine Learning for Anomaly Detection**: Utilize DBSCAN clustering algorithm on AIS data to detect anomalies in vessel speed, course, and deviations, indicating potential distress or illegal activities.
- **Customized CNN for Oil Spill Detection:** Train a Convolutional Neural Network (CNN) on Synthetic Aperture Radar (SAR) images to accurately identify oil spills.
- **Real-Time Detection System:** Implement a real-time oil spill detection system by integrating AIS data and satellite datasets.

PROBLEM RESOLUTION

- **Early Anomaly Detection**: Monitor AIS data to detect unusual vessel behaviors indicating potential distress or oil leaks.
- **Accurate Spill Identification**: Use satellite imagery to confirm oil spills at the locations identified by AIS anomalies.

UNIQUE VALUE PROPOSITIONS (UVP)

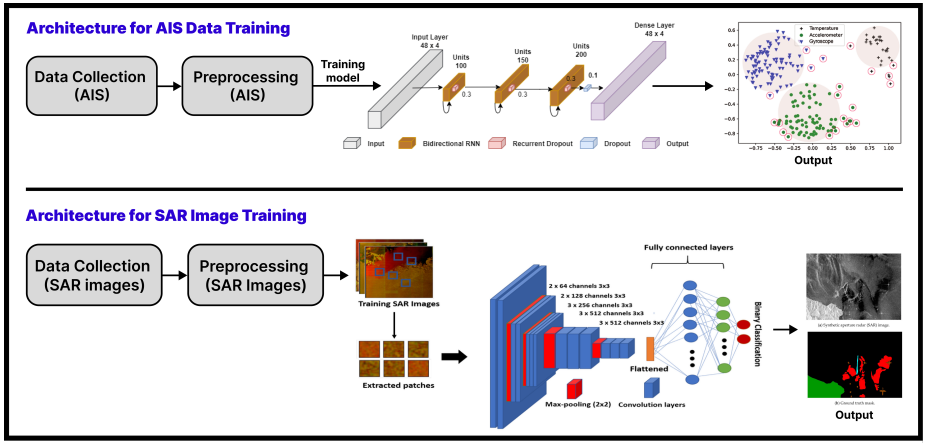
- **Comprehensive Detection Approach:** First-of-its-kind solution that fuses AIS data with satellite imagery using machine learning for oil spill detection.
- **Advanced Machine Learning Implementation:** Employs DBSCAN for anomaly detection in AIS data and a customized CNN for analyzing SAR images, enhancing detection precision.

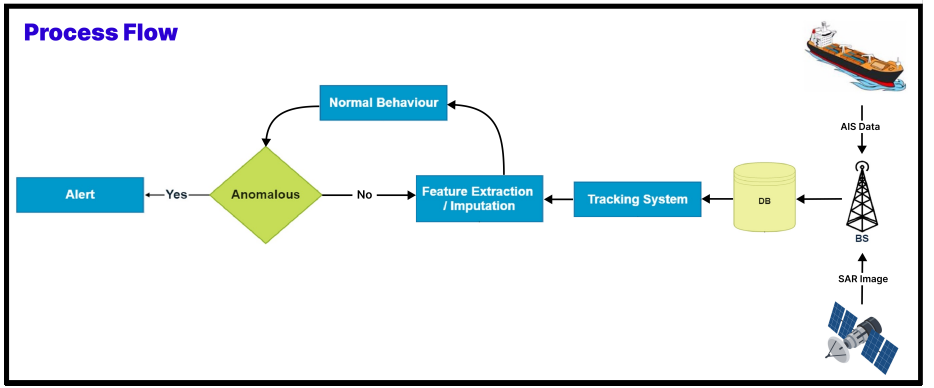
Technical Approach

TECHNOLOGIES USED

- **Programming Languages:** Python for data processing, machine learning, and image analysis.
- **Machine Learning Frameworks:** Scikit-learn for DBSCAN anomaly detection, TensorFlow/Keras for training the CNN model on SAR images.
- **Data Processing:** Pandas and NumPy for AIS data handling and preprocessing, OpenCV for image manipulation.
- **Frameworks & Tools:** Jupyter notebook, Google colab, SNAP tool for processing SAR datasets
- **Database:** MongoDB

OpenCV jupyter SNAP





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Feasibility And Viability

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CHALLENGES AND RISKS:

1. **Data Quality and Preprocessing:**
   - ***Challenge:*** AIS data may have missing, noisy, or incorrect values.
   - ***Risk:*** Inaccurate data can lead to poor anomaly detection and model performance.
2. **Model Accuracy and Generalization:**
   - ***Challenge:*** Risk of overfitting or underfitting, affecting anomaly detection in new data or different regions.
   - ***Risk:*** Potential to miss anomalies or incorrectly classify normal behaviors.
3. **Handling Complex Behaviors:**
   - ***Challenge:*** Vessel behavior is complex due to factors like weather, tides, and navigation rules.
   - ***Risk:*** Misclassification due to not accounting for these contextual factors.

ANALYSIS OF THE FEASIBILITY OF THE IDEA

- **Proven Technology:** Machine learning algorithms (DBSCAN and CNN) have shown success in anomaly detection and image classification, making this approach technically feasible.
- **Data Availability:** Real-time AIS data is globally accessible, and satellite SAR imagery is available through various platforms, ensuring continuous data flow.

STRATEGIES FOR OVERCOMING CHALLENGES:

1. **Efficient Data Handling:**
   - Use data streaming and real-time ingestion.
   - Perform batch processing to manage computation load.
2. **Model Optimization:**
   - Start with simpler models like Isolation Forest or DBSCAN.

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Impact And Benefits

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POTENTIAL IMPACT ON THE TARGET AUDIENCE:

1. **Maritime Authorities & Port Operators:**
   - **Impact:** Enhanced monitoring of vessel behaviors, improving safety and security. They can quickly identify deviations, suspicious speeds, or unusual patterns, allowing for faster interventions.
2. **Shipping Companies:**
   - **Impact:** Improved fleet management through real-time vessel monitoring, detecting issues like unauthorized route deviations leading to optimized fuel usage and efficiency.
3. **Environmental Agencies:**
   - **Impact:** Early detection of vessels in protected or restricted areas helps prevent environmental damage from illegal fishing , aiding the enforcement of environmental regulations.
4. **Insurance Companies:**
   - **Impact:** Enables more accurate risk assessment by identifying behavior patterns linked to accidents or illegal activities, reducing fraudulent claims and enhancing vessel safety.

BENEFITS OF THE SOLUTION:

1. **Social Benefits:**
   - Improves maritime security and public safety by detecting suspicious movements and preventing accidents.
2. **Economic Benefits:**
   - Reduces costs for shipping companies through optimized routes and helps prevent illegal activities, minimizing economic losses.
3. **Environmental Benefits:**
   - Protects marine ecosystems by preventing illegal activities and reducing pollution through adherence to approved routes.
4. **Operational Benefits:**
   - Enhances fleet management with real-time tracking and allows proactive resolution of operational risks.

Research And References

- Bui, N. A., Oh, Y., & Lee, I. (2024). Oil spill detection and classification through deep learning and tailored data augmentation. *International Journal of Applied Earth Observation and Geoinformation, 129*, 103845. https://doi.org/10.1016/j.jag.2024.103845

- Ribeiro, C.V., Paes, A. and de Oliveira, D., 2023. AIS-based maritime anomaly traffic detection: A review. Expert Systems with Applications, 231, p.120561.

- **Dataset Link**

AIS information: https://marinecadastre.gov/accessais/

(USA waters) https://www.vesselfinder.com/

(Indian Waters with subscription) https://www.marinetraffic.com/en/ais/home/centerx:73.8/centery:13.7/zoom:8
https://www.aishub.net/

Satellite datasets: https://dataspace.copernicus.eu/ SNAP tool for processing SAR datasets
https://step.esa.int/main