Methodology / Implementation

Step-by-Step Implementation:

Data Collection:

Acquire satellite, drone, or surveillance camera imagery showing water surfaces.
Use open-source datasets or real-time imagery from sources like Sentinel-2.
Optionally gather environmental sensor data (for enhanced validation).

Preprocessing:

Convert images to grayscale or normalize RGB/HSV channels.
Resize and denoise images using filters (Gaussian Blur, Median Filter).
Apply thresholding or edge detection (Canny, Sobel) for initial segmentation.
Extract pixel-wise features such as intensity, texture, color histograms, etc.

Feature Vector Creation:

For each image region or pixel group:
Extract features like brightness, contrast, color values, spatial location (x, y), NDOSI (if using satellite data), etc.
Create a structured dataset where each sample represents a region or patch of the image.

Anomaly Detection using Isolation Forest:

Apply Isolation Forest to identify anomalous regions (likely oil spill areas) based on their statistical deviation from normal water regions.
This model isolates oil spill pixels due to differences in intensity, texture, or spectral signature.
Output: Binary classification (Normal vs Anomalous pixel/region).

Clustering using DBSCAN:

Apply DBSCAN to group spatially connected anomalous points into clusters.
DBSCAN helps remove noise and ensures only dense, connected spill areas are detected.
Each cluster is considered a potential oil spill zone, while noise is discarded.
Fine-tune eps (distance) and min_samples for optimal grouping.

Post-processing:

Apply morphological operations (dilation, erosion) to smooth detected areas.
Draw contours or bounding boxes around detected spills.
Calculate cluster metrics: spill size (area), location (centroid), spread.

Visualization & Reporting:

Visualize detected oil spills overlaid on original images.
Generate reports/logs with date, location, spill area size.
Export visual results (images with detected spills), optionally mapped with coordinates.