OIL SPILL DETECTION IN OCEAN

DOMAIN : DATA SCIENCE

20CS713 - PROJECT PHASE-1 - C3

TEAM DETAILS

TEAM MEMBERS:

1) RAMYA P - 111720102123
2) SUSHMITHA J J - 111720102156
3) SWARNASRI G - 111720102158

TEAM MENTOR:

Ms. S D LALITHA,
ASSISTANT PROFESSOR.,CSE

Abstract

Oil spills in marine environments pose a significant threat to ecosystems and coastal regions. This project presents an innovative system designed to address the critical issue of oil spill detection with a focus on precision and efficiency. The system incorporates advanced machine learning techniques, including deep learning models, to enhance detection accuracy.The major process here is the preprocessing of the images to detect accurate oil spills. By fine-tuning models such as VGG16 for classification, PSPNet for semantic segmentation, and Mask R-CNN for instance segmentation, the system accurately identifies and delineates oil spills within images. Moreover, it leverages the YOLOv3 model for vessel and oil rig detection in maritime environments. The project's comprehensive approach to image preprocessing and deep learning models significantly enhances the accuracy and Effectiveness of oil spill detection, even in challenging offshore conditions.

SCOPE

The increasing frequency of oil spills originating from accidents involving oil tankers is a matter of great environmental concern. These incidents have the potential to cause severe damage, such as polluting ocean waters, harming marine ecosystems, and contaminating coastal areas.The scope of the project is to address the above-mentioned issue by developing a system for offshore oil spill detection, including data collection, image preprocessing, and machine learning-based detection methods. The project focuses on various image sources and geographical locations.

LITERATURE SURVEY

"Scientific Bases Development for Oil Spill Accidents Automated Detection Using Drones" by Aleksey Vytovtov, Denis Corolev, et al. (2023)

This research focuses on the effective utilization of unmanned aerial systems (UAS) for oil pipeline monitoring. It establishes the scientific foundation for detecting oil spill incidents and outlines the key technical specifications of aircraft suitable for this purpose.

ADVANTAGE:

- scientific foundation for oil spill detection

DISADVANTAGE:

-It may not provide extensive real-world testing result or case studies to demonstrate its effectiveness in various environmental conditions.

"Multi-source knowledge graph reasoning for ocean oil spill detection from satellite SAR images" by Xiaojian Liu, Yongun Zhang, et al. (2023)

This paper provides a comprehensive survey of marine oil spill detection methods, emphasizing the use of synthetic aperture radar (SAR) imagery, deep learning, and feature based techniques.The introduction of multi-source knowledge graphs for integrating various data types is a key innovation

Advantage:

-Integration of multi- source knowledge graph

Disadvantage:

-Implementing such complex techniques may demand significant computational power and data storage,which could pose practical challenges,especially for organization with limited resource.

"Oil Spill Contextual and Boundary-Supervised Detection Network Based on Marine SAR Images" by Qiqi Zhu, Yanan Zhang, et al.

Advantage:

- Improved Oil Spill Detection Accuracy with CBD-Net and Deep-SAR Oil Spill (SOS) dataset.

Disadvantage:

- Limited exploration of the method's generalization to other domains and data types, potentially limiting its broader applicability.

- The computational resources or hardware requirements for implementing the CBD-Net, which could be crucial for organizations with limited computing capabilities.

"Realtime Oil Spill Detection By Image Processing of Synthetic Aperture Radar Data" by Subhrangshu Adhikary, Surya Prakash Tiwari, et al. (2022)

Advantage:

The paper introduces an image processing technique for real-time ship oil spill detection using SAR data, offering a cost-effective and automated solution with high accuracy and swift detection times.

Disadvantages:

The paper may not provide sufficient insight into the generalization of the proposed technique to different environmental conditions or the adaptability to varying SAR data sources. While the method is fast, there might be a marginal trade off in accuracy compared to deep learning techniques. The paper could benefit from discussing the circumstances in which this tradeoff is acceptable or not.

"Improved YOLOX-S Marine Oil Spill Detection Based on SAR Images" by Shuai Zhang Jun Xing, Xin Zhe Wong et al. 2022

The paper introduces IYOLOX-S, an enhanced YOLOX-S model for marine oil spill detection, addressing contrast issues in SAR images and achieving high accuracy. However, it lacks extensive discussion on generalization and real-world validation.

Advantages:

The model addresses the challenge of inconsistent contrast in SAR images, improving feature learning for more efficient marine oil spill detection.

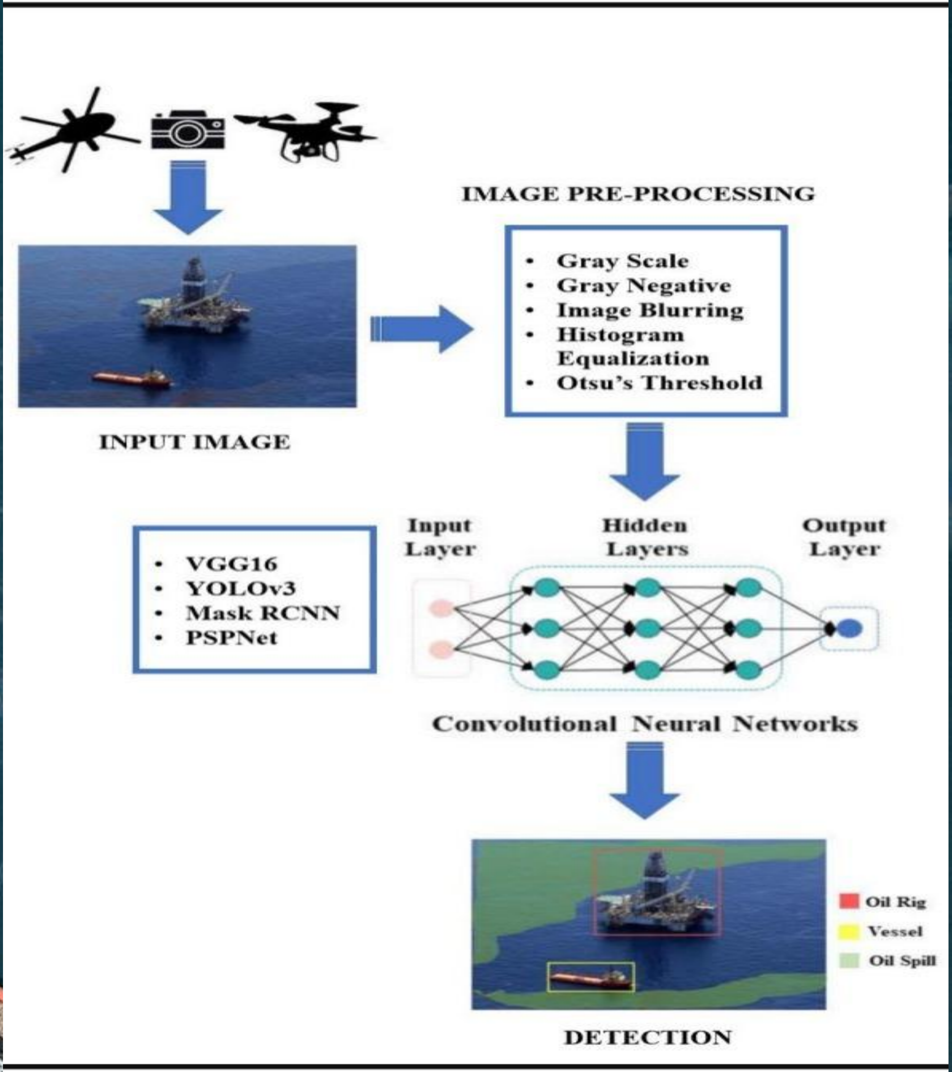
Disadvantages:

While the model performs well on the oil spill dataset, there might be a need for real-world testing and validation to assess its practical applicability.

Proposed System

The proposed system leverages advanced machine learning techniques and image preprocessing to create an automated and accurate oil spill detection system. It utilizes satellite and aerial imagery to collect data and applies a sequence of image enhancements, including grayscale conversion, negative conversion, smoothing, and thresholding. Additionally, deep learning models like VGG16, PSPNet, and Mask R-CNN are employed for classification, semantic segmentation, and instance segmentation of oil spills, respectively. This comprehensive system enhances detection precision and efficiency, making it well-suited for oil spill monitoring and mitigation in marine environments.

SYSTEM ARCHITECTURE



Module Description

(1) Data Collection: Acquiring relevant data sources, such as satellite and aerial imagery related to oil spills and maritime environments.

(2) Preprocessing: Cleaning and preparing the acquired data to ensure its quality and alignment for subsequent analysis, including noise reduction.

(3) Detection: Identifying and classifying oil spills within the images using deep learning models like VGG16, PSPNet, Mask R-CNN, and YOLOv3, or other suitable methods.

(4) Validation and Testing: Evaluating the models' performance on validation and test datasets to ensure their accuracy and readiness for practical deployment

IMAGE PROCESSING MODULES

- GRAY SCALE CONVERSION
- GRAY NEGATIVE
- IMAGE SMOOTHENING
- HISTOGRAM EQUALIZATION
- OTSU'S THRESHOLDING METHOD
- COLOUR SPACE AND CANNY EDGE

DETECTION MODULES

- VGG16 FOR IMAGE CLASSIFICATION
- PSPNET FOR SEMANTIC SEGMENTATION
- MASK RCNN FOR INSTANCE SEGMENTATION
- YOLO V3 FOR OIL RIG AND VESSEL DETECTION


THANK YOU