


# Chapter 6


## Advanced AI-Based System for Precision Oil Spill Detection in Marine Environments

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### ABSTRACT

*Oil spills threaten marine ecosystems, demanding precise detection methods. This paper introduces an AI-based system for accurate and timely oil spill detection in marine environments. The system integrates satellite imaging, unmanned aerial vehicles (UAVs), marine sensors, and IoT devices. It employs multispectral and hyperspectral imaging, synthetic aperture radar (SAR), and high-resolution cameras to detect oil spills. Machine learning algorithms enhance accuracy by distinguishing oil slicks from natural phenomena. Autonomous UAVs and sensor-equipped buoys*

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*provide real-time data transmission and analysis, enabling swift response efforts. This comprehensive system offers a reliable solution for monitoring and mitigating the impact of oil spills on marine ecosystems.*

## **1. INTRODUCTION**

With the swift advancement of industry and transportation, oil has become essential to modern civilization. However, the surge in oil consumption has led to a growing number of oil spills each year. These spills cause significant and often irreversible harm to the biosphere, drawing considerable attention from scholars and researchers to oil spill response (OSR) efforts. Oil spills in marine environments are a looming threat that demands our attention due to their potentially catastrophic consequences. These spills, often resulting from accidents involving oil tankers, have the capacity to devastate ocean ecosystems, contaminate coastal regions, and endanger marine life. Detecting these spills swiftly and accurately is not just a matter of environmental concern; it is an urgent imperative for safeguarding our oceans, their biodiversity, and the livelihoods of coastal communities. Efficient oil spill detection systems play a pivotal role in ensuring timely responses to mitigate the environmental and economic damage that such incidents can cause. In response to this critical need, our project presents an innovative solution designed to enhance precision and efficiency in oil spill detection. Since 1967, there have been numerous catastrophic oil spills worldwide. The largest occurred in 1991 during the Persian Gulf War, where Iraqi forces intentionally released an estimated 380 to 520 million gallons of oil into the Persian Gulf to impede U.S. and coalition forces, resulting in oil slicks as thick as five inches in some areas. The most recent major oil spill took place on April 22, 2010, when an explosion on BP's Deepwater Horizon rig led to the release of approximately 206 million gallons of oil into the Gulf of Mexico, finally being sealed on July 15, 2010 as shown in Figure 1.

Our approach leverages the power of advanced machine learning techniques, particularly deep learning models. Central to our system is the utilization of satellite imagery for data collection, which spans diverse geographical locations associated with significant oil spill incidents. This expansive dataset forms the backbone of our system, facilitating the training and fine-tuning of various deep learning models.

To achieve a high level of accuracy in oil spill detection, we have customized and fine-tuned models like VGG19 for classification, PSPNet for semantic segmentation, and Mask R-CNN for instance segmentation. These models are the core components of our detection system, enabling us to precisely identify and delineate oil spills within images. In addition to oil spill detection, we have expanded the scope of our project to encompass the detection of vessels and oil rigs in maritime environments.

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