Advances in Oil Detection and Monitoring using a Smart Boom Monitoring System

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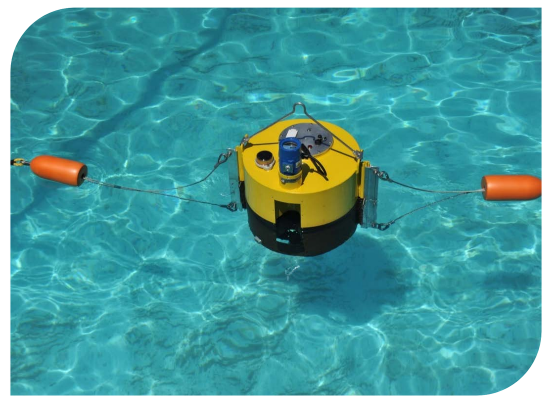

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Abstract

Boom can be used to corral and thicken oil for mechanical recovery and in situ burning, to deflect oil from sensitive areas, or to protect shorelines. For a large spill, hundreds of kilometers of boom could be deployed in these efforts. Currently, aerial or vessel-based observers are sent to determine if oil has been collected by the boom and to monitor the integrity of the boom. The level of effort required to carry out a thorough inspection is considerable and can be a challenge due to weather or logistical constraints. Further, the time interval between inspections can vary from a few hours to several days. In efforts to both minimize personnel requirements and provide real-time information, an advanced boom monitoring system has been developed.

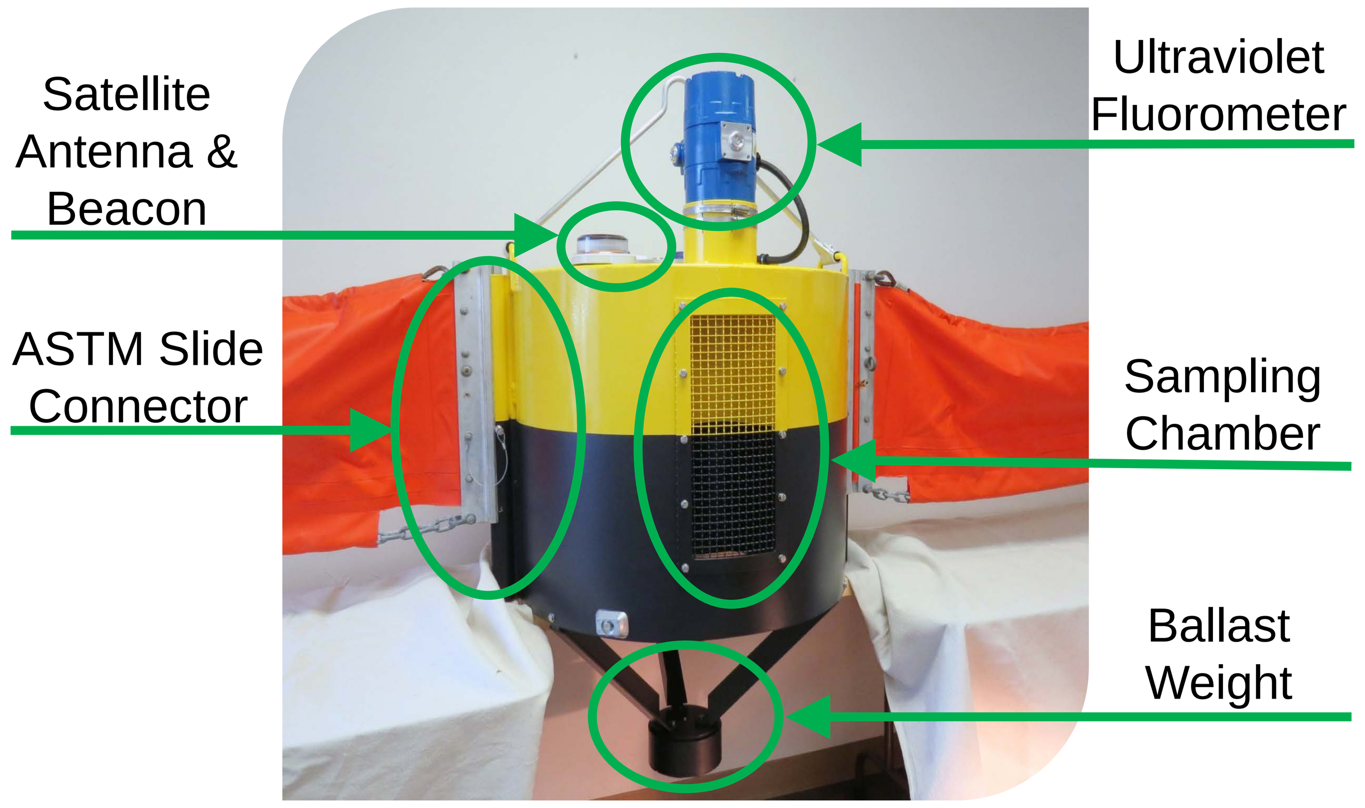

Figure 1. Exterior system components

Description of Technology

The system monitors boom integrity and the presence of oil using a number of sensors. The elements of the system include a non-contact ultraviolet fluorometer, a computer processing unit (CPU), a global positioning module, and a satellite modem for communication (Figure 1). This equipment is housed within a 24" marine aluminum buoy. The CPU can be interfaced to adjust parameters for data collection and reporting. Key parameters that can be adjusted include oil thickness on water (e.g., notification versus actionable oil), reporting time (e.g., sampling time of the fluorometer), system location and system status including battery life. The boom monitor has two standard boom connections to allow it to connect between two lengths of boom or it can be anchored separately as a buoy.

Research Objectives

The three primary objectives for system development and design are to:

1) distinguish between actionable and non-actionable surface oil;

2) provide real-time data to responders when oil comes into contact with boom or if the boom has moved away from the intended anchoring position; and

3) construct a robust yet deployable system that would integrate with existing oil spill response equipment stockpiles.

Bench-scale Testing

The key component of the system is the non-contact ultraviolet fluorometer. This sensor is deployed worldwide and proven to meet the design specifications to detect the presence of oil on water. In the first experiment, our researchers looked to further refine the information being provided by the sensor and to test the ability to distinguish between actionable (>2mm (0.08") slick) and non-actionable surface oil (sheen). A Gulf of Mexico (GoM) crude oil and an Alaskan North Slope (ANS) crude oil was tested (Figures 2 & 3). This initial screening demonstrated that a measured difference can be detected between a sheen and a slick for the GoM oil. However, the fluorescence of ANS appeared to mask the thickness differences and currently the system is unable to differentiate between the two thicknesses. Looking forward, a plan has been developed to test a wide range of crude oils to further our understanding and methods to augment the resolution of the sensor.

The second experiment was an evaluation of migrating oil detection and the subsequent alerts utilizing the satellite uplink. The system was placed in a 264-gallon tank filled with saltwater and crude oil was added to the tank to simulate a spill migrating toward the system.

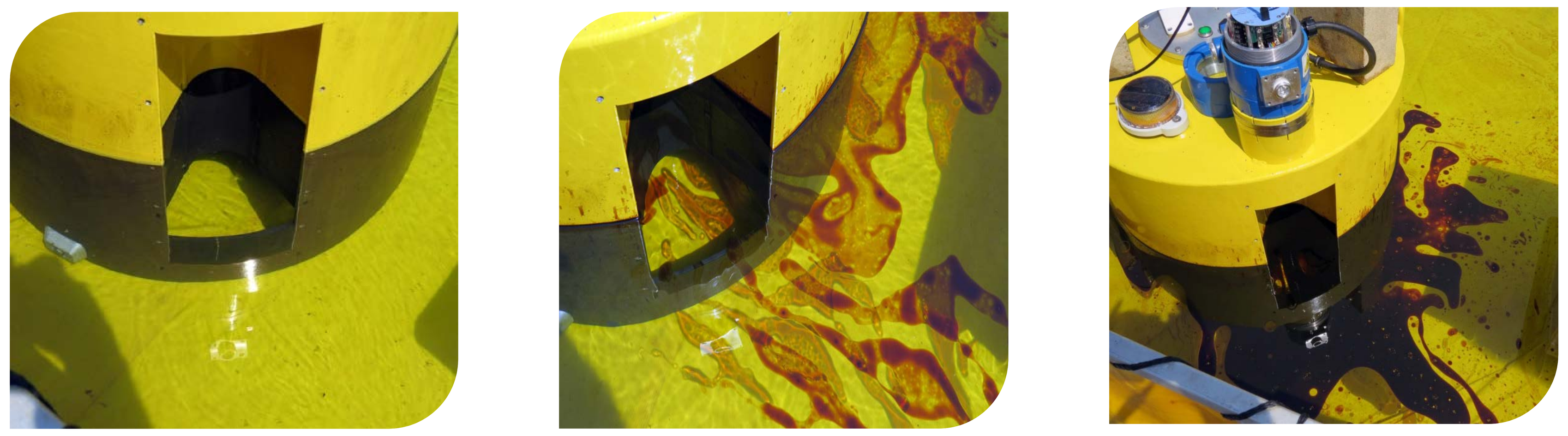

Figure 2. Gulf of Mexico Crude Oil: No oil (left); Sheen (center); Slick (right)

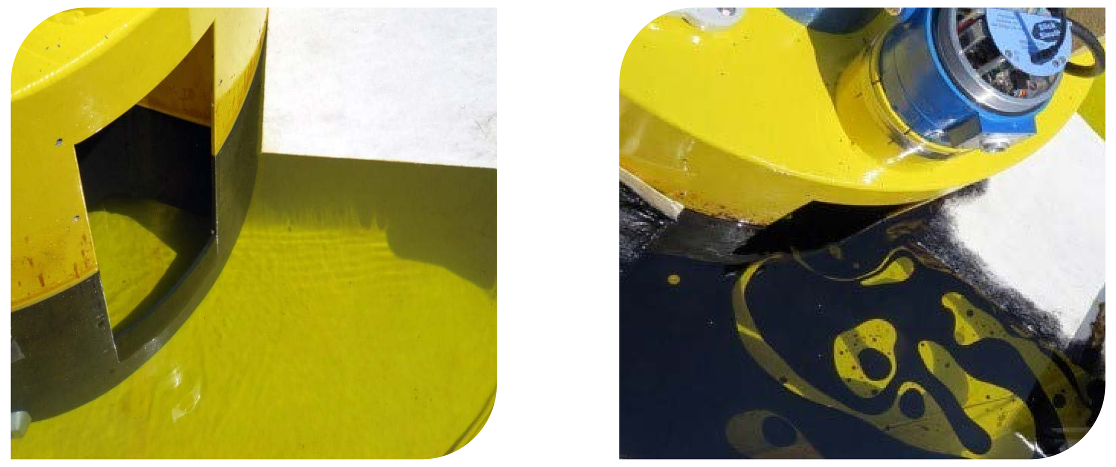

Figure 3. Alaska North Slope Crude Oil: No oil (left); Slick (right)

Meso-scale Testing

Following the bench-scale testing, the system was deployed into large outdoor saltwater tank that can produce waves of varying frequencies and height. The system was tested using a matrix of multiple permutations of wave height and frequency (Figure 4). The performance of the system in these conditions allowed the researchers to further enhance the stability of the system by the addition of a ballast suspended below the buoy. The results of the testing provided data to identify the operating limits of the system as designed and postulate on modifications that would broaden its capabilities.

Figure 4. System deployed with 6-ft sections of 18" solid flotation containment boom in moderate breaking waves

Discussion

The motivation for this work was to develop a system to enhance the industry's ability to respond to oil spills. The protection of sensitive areas including environmental (e.g., wetlands, marshes, mangroves), socioeconomic (e.g., beaches, marinas), and infrastructure (e.g. drinking water intakes, power plants) make it important to ensure that deployed containment boom remains properly in place. This system can provide information that will alert responders where resources are needed to collect oil or repair failing boom protection deployments.

Additional Information

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