Autonomous Oil Sheen Detection Using Machine Learning and Transfer Learning Approaches

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Oil sheen on the water surface can indicate a source of hydrocarbon in underlying subaquatic sediments. Here, we describe an approach for the autonomous detection of a transient oil sheen on water, including the development and testing of the accuracy of an algorithm for automated real-time visual monitoring of the water surface for detecting oil sheen. This detection system is part of an automated oil sheen screening system (OS-SS) that disturbs subaquatic sediments and monitors for the formation of sheen. We first created a new near-surface oil sheen image dataset. We then used this dataset to develop an image-based Oil Sheen Prediction Neural Network (OS-Net), a classification machine learning model based on a convolutional neural network (CNN), to predict the existence of oil sheen on the water surface from images. We explored the effectiveness of different strategies of transfer learning to improve the model accuracy. The performance of OS-Net and the oil detection accuracy reached up to 99% on a test dataset. Because the OS-SS uses video to monitor for sheen, we also created a real-time video-based oil sheen prediction algorithm (VOS-Net) to deploy in the OS-SS to autonomously map the spatial distribution of sheening potential of hydrocarbon-impacted subaquatic sediments. This work describes two important elements of the robot design process, namely the creation of detection system and automation of that detection.