Identifying Plumes through Semantic Segmentation of Satellite Imagery

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Abstract:

Providing effective and scalable techniques for monitoring and surveillance is relevant to the NNSA's nonproliferation mission. We propose a framework to identify plumes from satellite imagery, which could be adapted to many different types of atmospheric releases. We focus on identifying plumes due to unregulated burning of waste, which is problematic as it endangers all surrounding airborne, marine, and human life. The discovery of unregulated burns in landfills can be addressed using computer vision and satellite imagery of landfills, including one unique case occurring at the manmade landfill of Thilafushi in the Maldives. Utilizing satellite imagery of the Thilafushi island, we developed a machine learning approach to identify plumes originating from trash burning. We employ an image classification and semantic segmentation model based on a convolutional neural network to determine if a plume is visible within a given image, followed by segmenting the exact location of the plume within the image. The discovery and detection of plumes allows us to further understand what and where waste is being burned, to dive further into why populations burn their waste in the ways they do. We achieve an image classification accuracy of 96% and an Intersection-over-Union on the segmentation of 0.48. Our results promote expanding plume detection into a multilocation domain adaptation, where we use cycle-consistent generative adversarial networks to translate images of plumes between different locations and types of plumes. Plume detection tasks can be robustified with a multilocation domain adaptation approach to include different types of plumes from forest fires, smokestacks, volcanic eruptions, or nuclear emissions.