Monitoring Fugitive Methane Emissions Utilizing Advanced Small Unmanned Aerial Sensor Technology

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Methane, the primary component of natural gas, is a potent greenhouse gas (GHG) when vented to the atmosphere. Unburned emissions of natural gas from infrastructure can undermine the environmental benefits of using this low carbon fuel for power generation. Detecting and quantifying these emissions where and when they occur is essential for mitigating them.

To provide an affordable sensing system enabling more effective methane mitigation programs, we have adapted the backscatter-TDLAS technology embedded in the Remote Methane Leak Detector (RMLD) for mounting on PSI's two-foot-wide quadrotor Unmanned Aerial Vehicle (UAV) featuring highly advanced autonomy. We developed a smaller version of the laser sensor and adapted it to the high-performance all-weather sUAV depicted in Figure 1. This technology projects the laser beam towards the ground below and receives light backscattered from the ground surface. It measures the column-integrated methane between the vehicle and the ground. By flying self-directed patterns around a methane leak and using a mass-balance calculation [1], we deduce the leak rate and centralize on the leak location.

This RMLD-UAV is a platform for a system that can continuously monitor a site to detect leakage and provide automated leak localization and quantification. It can be deployed for aerial leak survey and quantification, and is intended for widespread cost-effective deployment at wellheads and other gas infrastructure sites.[2]

Figure 1: (left) RMLD-UAV, (center) flight at simulated experimental gas wellpad, and (right) flight pattern for surveying a wellpad and data visualization produced.

Low-altitude flights conducting raster pattern surveys of wellhead infrastructure located, visualized, and estimated flux from leaks smaller than 5 scfh. At a simulated experimental gas wellpad (Figure 1), the RMLD-UAV estimated leaks in 18 similar flight scenarios with leak rates ranging from 0 to 30 scfh. The RMLD-UAV system deduced the flow rate within 20% accuracy for 28% of tests, within 50% accuracy 50% for 56% of tests, and within 70% accuracy for 83% of tests.

References:

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2. Frish, M.B., Presentation to ARPAe Energy Innovation Summit, National Harbor, MD, PSI-VG-2016-017, March 2016