Drone Assisted Cavity Ringdown Sensor for Real-time Environmental Methane Gas Monitoring

Dr. Prabhakar Pradhan (PI)

Department of Physics, BioNanoPhotonics Laboratory, University of Memphis

A. Research Justification

Methane is an environmentally significant gas which plays important role in atmosphere. As highlighted by Environmental Protection Agency (EPA, USA), methane (11% share) is the second most prevalent greenhouse gas in the atmosphere after carbon dioxide (81% share) emitted in United States, and poses a very high global warming potential [1]. The impact of methane on climate change has been estimated to be 25% times higher than carbon dioxide over a time period of 100 years. As a result, monitoring and controlling the methane concentration in atmosphere is an important requirement. While the natural sources of methane are Wetlands, oceans, sediments, wildfires, etc., a major part (> 60 %) of the globally produced methane comes from human activities. Few of important sources of human activity led methane production are industrial emissions, agriculture, wastes from home, livestock, etc. It should be worth pointing out here is that recently (Oct 2015) there was huge leak of methane gas (largest in the history of US) at an oil & gas facility in California, whose massive damaging effects on climate is still being evaluated. In such a situation, it becomes important to conduct real time monitoring of accurate percentage of methane in the atmosphere, especially around its emission sources. For example, continuous or regular monitoring of methane at wide wetlands, in the air nearby the industrial emissions, emissions by vehicles, etc. Rarely, but events such as the Californian gas leak (pointed out above) also requires continuous monitoring of methane leak in the atmosphere. Continuous monitoring of methane gas is an important requirement not only to evaluate it potential impact on climate change, but at smaller level, it will help in keeping a check on local air quality. However, most of the methane sensors, such as catalytic bead sensors, infrared sensors, etc., are limited either by their sensitivity, or prone to get damaged upon chemical reaction with different molecules in the atmosphere. Additionally, except for only a few attempts at research level, there is no drone based sensing device for methane measurement or monitoring [2].

The present proposal aims to develop a drone based sensor for regular monitoring of methane gas in atmosphere using cavity ringdown spectroscopy (CRDS) detection technique. CRDS is a multipass laser scattering and absorption technique for gas molecules detection. The technique will allow a robust, high sensitivity and accuracy detection of the methane molecules, relative to the presently existing techniques. The use of drone based CDRS sensor will allow us to perform the monitoring process with greater ease, in terms of area coverage including areas with difficult human accessibility. This is mostly on the above atmosphere depending on the height of the drone. The Objectives of this project are the following:

***Objective 1*:** Development of methodology for high sensitivity methane detection and monitoring using cavity ringdown sensor (CRDS) technique, and develop mechanism to integrate the sensor with drone system.

***Objective 2*:** Develop a first drone assisted methane sensing prototype system, and perform trial measurements in UoM campus and elsewhere.