2023

Development of a Cost-Effective Vertical Remote Sensing System for Detecting Emissions from Diesel Medium Good Vehicles

Yaohui Liu

Proceedings of the 8th World Congress on Civil, Structural, and Environmental Engineering (CSEE'23)
Lisbon, Portugal – March 29 – 31, 2023
Paper No. ICEPTP XXX (The number assigned by the OpenConf System)
DOI: TBA

Development of a Cost-Effective Vertical Remote Sensing System for Detecting Emissions from Diesel Medium Good Vehicles

Yao-Hui LIU[1], Yu-Han HUANG[2], Ming-Wai, MAK[1], Bei WANG[1], Yat-Shing YAM[3], Wai-Chuen MOK[4], Chun-Ho LIU[5], John Jun-Liang ZHOU[2], Edward Fuk-Cheung CHAN[6]

[1] Technological and Higher Education Institute of Hong Kong, (Author 1) yhliu@thei.edu.hk ;
[2] University of Technology, Sydney, (Author 2)yuhan.huang@uts.edu.au ;
[3] Environmental Protection Department of Hong Kong, y_s_yam@epd.gov.hk ;
[4] Environmental Protection Department of Hong Kong, wcmok888@hotmail.com ;
[5] The University of Hong Kong, chliu@hku.hk ;
[6] The Hong Kong Bio- and Eco- Energy Industry Association, edchan968@gmail.com

Extended Abstract

Remote sensing (RS) have been adopted by more and more environmental agencies across the world to establish profiles of vehicular emissions or to identify high emitters for inspection and maintenance programmes since the technology emerged as a cost-effective means for road-side air quality monitoring few decades ago. Remote sensing systems are commonly setup horizontally, where the light source and detector unit and the retroreflector are placed on the opposite sides of a road with the path of the light beam oriented parallel to the road surface. Since RS technology measures the difference in the intensity of the light beam before and after traversing the exhaust plume of a passing vehicle, the horizontal remote sensing (HRS) systems are limited to single-lane applications. Vertical remote sensing (VRS) system, where one of the main units is mounted over and the other unit underneath the traffic with the path of the light beam oriented perpendicular to the road surface, has been developed in recent years as a potential solution for multi-lane applications. However, limited studies were carried out on VRS programmes and the known VRS products are not available in Hong Kong. There is a need to develop a VRS system that can be trailed on Hong Kong's road to control the air pollution. As the RS programme of Hong Kong has been operated for more than 2 decades and the HRS devices in used are well-developed, converting the existing devices to suit VRS applications seems to be a cost-effective way to meet the need.

The study aims to investigate the performance of a newly developed VRS system with portable emissions measurement system (PEMS) in terms of consistency and reliability of the data, and to determine if the VRS system is a feasible alternative to the existing HRS system. The VRS system was tested against the PEMS in a single-lane situation with a diesel vehicle operating over a range of loading and driving conditions (i.e., 0 – 50% load and 10 – 30 km/h). Results of statistical analyses suggested that the VRS system was able to generate consistent measurements. One set of RS data contained the NO_x/CO_2, CO/CO_2, and HC/CO_2 measurements of 10 test runs conducted under a specific loading and driving condition. The reliability of the VRS data was found to be comparable to that of the HRS data. The linear regression analyses considering the HRS-PEMS pair the VRS-PEMS pair revealed that the r-square value of the VRS system is similar to that of the HRS system. It indicates that the performance of the VRS system is comparable to that of the HRS [1,2]. The findings confirmed that the VRS will be able to broaden the application of remote sensing in emission monitoring for air pollution control.

The work described in this study was fully supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. UGC/IDS(c)25/E02/19).

Keywords: *Vertical Remote Sensing, Vehicular Emissions, Horizontal Remote Sensing, Medium Good Vehicles, Air Pollution Control*