Project proposal template
Graduate School studentships
March 2015

Project title	Methane Leak Detection for Shale Gas Facilities Using Intelligent UAV systems
First Supervisor	Dr — Olga Duran
Second Supervisor	Yahya Zweiri
School	Mechanical and Automotive Engineering
Other member of supervisory team (no more than three KU supervisors in total)	
Specific requirements beyond 2:1 degree	

Project summary **(max 4,000 characters)**

i) Summary

Methane leaks are a reality in shale gas plants and are incompatible with current zero-methane emission industry initiatives. The nascent and particularly promising shale gas industry in the UK requires reliable and cost efficient methods for methane gas leak detection that are currently not available.

Leakage of methane in the context of shale gas facilities may occur at many different locations and through different gear including compressors, pipes, valves and flanges. Current technologies relate to solutions that are mainly positioned on the plant's perimeter and are unable to detect confined or localised leaks. Moreover, they are limited by fixed-camera strategies that are poorly integrated with additional information streams and require immediate proximity to the source of potential leakage.

Here we propose to use hyperspectral and infrared imaging instruments combined with artificial intelligence to detect gas leak signals. In particular, neural networks have been employed in the context of pipeline anomaly detection and spectral and infrared data analysis.

An un-manned aerial vehicle (UAV) system with full gas leak detection and intelligent communication abilities would form the basis of a reliable and cost effective solution. The proposed research solution would integrate information from UAV mounted-airborne sensors including spectral sensors, Inertial Navigation Unit (INU), GPS and trans-receivers in an efficient and robust way allowing detection and reporting of even very small leaks.

Machine learning abilities would allow intelligent recognition of leaks, efficient decision making and concomitant communication of events to the ground station.

A concrete, physical understanding of gas leak dynamics across a range of different industrial contexts and conditions would form the basis of the proposed solutions' detection reliability. To this end, controlled, laboratory-based gas leaks detection analyses will replicate and simulate leaks under a wide range of conditions. This breadth physical and virtual leak settings would then be used to train and refine the system's detection, evaluation and decision making abilities within a machine-learning, intelligent context.

The present shall offer a novel, highly cost-effective, adaptive, reliable and minimally supervised solution enabling autonomous gas leak detection within a user-friendly, industrially flexible, changing environment.

ii) PhD deliverables

Key PhD stages:

i) Simulating gas leaks and developing detection and quantification abilities
ii) Developing detection algorithms through gas leak modelling
iii) Integration with Neural Network for decision making and support of further training.
iv) Testing and Validation
v) Conclusions and Future steps

iii) Proposed study novelty

- Developing new algorithms to enhance gas leak detection ability.
- Developing machine learning strategy for intelligent decision making.

- Development of data transmission and communication protocols and GUI between UAV, UAV control station and plant operator room.