Optimisation of sensor locations for observation of air flows/pollutions

Supervisors: Drs. Fangxin Fang, Christopher. Pain, Earth Science and Engineering

Background: Our key goals are to minimize exposure of the population to air pollution and reduce carbon footprint. These goals will be achieved through the optimal placement of sensors and their types, as well as optimized urban controls. The proposed project aims to provide cost-effective measurements from optimal sensors that monitor main facets of a city's dynamics (air pollution, wind, traffic and the built environment itself). These measurements will allow policy makers and industry to test the effect of both strategic and real-time decisions to help create a safe, healthy and sustainable city environment.
The complex CFD models will be helpful in identifying cost-effective measures aimed at the improvement of air quality in urban regions. These measures correspond to policies of reducing emissions by various pollution sources (e.g., industrial plants, transport or energy combustion) combined with optimized urban design. For each type of emission a cost function is defined, which relates the emission level to the corresponding costs of reducing to this level a sum of various types of emissions. Thus cost-effective measures can be calculated through minimization of the total sum of costs related to all types of considered emissions.

Sensor optimisation: Identifying where best to acquire data to best improve a particular prediction, that is how to optimally instrument an experiment or neighbourhood or city. This enables us to form better data assimilation into models which can lead to improved prediction and therefore control. Sensor optimization/control is based on manipulating a goal - typically exposure of the urban population to pollution. These optimize the use of expensive data collecting devices (whether fixed or mobile (wireless) sensors in air quality networks) with the objective of optimally determining a functional indicator of the impact on people's health.

The project will leverage >120 person years of previous research and code development at ICL, allowing such a challenging project to be realistically achieved. **Deliverables** of the PhD research include: (i) develop a goal-based approach for optimising sensor locations in combination with reduced order modelling; (ii) develop the adjoint sensitivity analysis technique to quantify the effect of uncertainties in models and identify the areas where the errors are rapidly growing as candidate locations for additional monitoring; (iii) set up an optimal observation network at the selected sites; and (vi) demonstrate benefits of the proposed approach.
Novelty: A unique predictive air quality modelling capability using adaptive observation techniques and reduced order modelling (data assimilation, optimization of sensors and experiments, uncertainty analysis, control).

The Candidate The successful candidate should have a good mathematical background and a good degree/diploma in an appropriate field such as earth science, physics, mathematics, computer science or engineering. Good written and spoken communication skills are essential.

For more information please contact Fangxin Fang (f.fang@imperial.ac.uk).

For application details please contact Samantha Symmonds (sam.symmonds@imperial.ac.uk).

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