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AN INVERSE MODELLING TECHNIQUE FOR EMERGENCY RESPONSE APPLICATION

Prof. Stephen Belcher, Prof. Alan Robins

Following a malicious or accidental release in an outdoor environment (industrial/urban) it is essential for first responders to ensure safety by cordoning off and/or evacuating areas where human life may be in danger. For this to happen quickly they need information on the source (strength and location) and the type of chemical agent released. We present an inverse modelling technique that can estimate the source strength and location of such a release using measurements of concentration from a network of chemical sensors. The technique relies on the rapid deployment of chemical sensors to effectively gather data on chemical agents. As part of the DYCE (DYnamic deployment planning for monitoring of ChEmical leaks using an ad-hoc sensor network) project a demonstration (tracer trial) will be carried out in which sensors will be deployed into an area to gather information on the concentration and type of chemical released. These measurements will then be used with the inverse algorithm to find the "best" estimate of the source strength and location. Other tests make use of existing data from the DAPPLE research programme.

The inverse algorithm requires a forward model to predict the concentrations at each of the sensor locations. At the moment we implement the Gaussian plume model, but we are currently extending the method to include a simple urban network model approach. Within the inverse framework we evaluate a cost function, which quantifies the discrepancy between the measured concentrations and those predicted using the forward model. In an iterative fashion a Gauss-Newton minimisation algorithm refines a first guess of the source strength and location, taking into account the measured concentration data, and the uncertainty estimates in the measurements. If the algorithm converges we output a "best" estimate of the source parameters, together with associated uncertainty estimates, that can then be used in the forward model to forecast the plume's dispersion. Rapid provision of this information is invaluable for the first responders who take charge of the situation and coordinate potential evacuations. The source and uncertainty estimates are updated as more data becomes available.