A Real-Time CBR Sensor Fusion and Source Term Estimation Capability

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Riskaware, working with the Defence Science and Technology Laboratory (Dstl) under Dstl and DTRA funded projects, have developed an advanced Source Term Estimation (STE) capability, that performs real-time fusion of CBR sensor data, together with other available data, to provide source term estimation, situational awareness and probabilistic forecasting of the likely hazard area caused by a CBR release. The system is designed to provide CBR information superiority to warfighters and civil emergency response coordinators. The algorithms at the heart of the system have been developed by Dstl over a number of years. The new STE system hosts these algorithms within a flexible framework that allows different algorithm options to be integrated and deployed in a plug-and-play fashion. The main fusion algorithm is a sequentially updated Differential Evolution Markov Chain Monte Carlo (DE-MCMC) algorithm, which uses a sequential Bayesian inference approach to map out the Probability Density Function (PDF) for the source term parameters, such as the location, size and timing of the release, based on the incoming data. The incoming data is primarily sensor data, but the inputs can be any information of relevance, including observations and threat intelligence data. The algorithm will also provide estimates of the probability that a release has actually occurred, based on all the data available, meaning it has the potential to reduce the false alarm rate from a set of networked sensors by providing a robust estimate of the probability that a true incident is occurring. The software system Riskaware has developed adopts a distributed real-time architecture designed to continuously ingest live sensor data and provide live situational awareness to warfighters and responders. It includes an advanced graphical user interface that provides full visibility of the algorithm's status and the source-term PDF in both spatial and non-spatial dimensions. A map view is provided that displays both the likely location of the incident source and a probabilistic forecast of the hazard through time. The probabilistic forecast is generated by the Hazard Calculator component of the STE system, which creates an ensemble of transport and dispersion predictions, derived from samples from the source term PDF generated by the core DE-MCMC algorithm. This means that it calculates the level of uncertainty in the situation, given the information content of the sensor feeds and other information sources, providing users with a forecast that factors in situational uncertainty, as well as the uncertainty in the dispersion behaviour. Recent work on the system has involved developing and integrating new variants of the main algorithm selected and designed by Dstl, such as the Differential Evolution Adaptive Metropolis (DREAM) algorithm and a "delayed rejection" option. This has demonstrated the flexibility of the framework in integrating new algorithms and capabilities. Verification and validation of the algorithm has been undertaken by Dstl and Riskaware, and has provided promising results. Riskaware now has a licence agreement with Dstl to develop and distribute.