COMPOSITE HYPOTHESIS TESTING ERROR EXPONENTS WITH APPLICATIONS TO CBRN RELEASE LOCALIZATION

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Detecting and responding to CBRN terrorism within urban areas has its own unique challenges. A typical city tends to be characterized by irregular geometry, many different types of surfaces, and highly dynamic population fluxes. All of these properties make analytic approaches to air flow modeling and agent particle transport difficult. In addition, as cities contain many centers for commerce and dense gatherings of people, accurate release localization and quick response times are of grand importance.

Existing CBRN source localization approaches [1], [2], [3] observe CBRN agent concentrations and solve the inverse problem of tracing dispersion backward in time and space to the source of the release. Limitations of this methodology stem from the irregular and dynamic phenomena typically found in urban areas. Lack of homogeneity makes modeling of dispersion, a critical component of the approach, difficult.

In this poster, we present a novel methodology to CBRN source localization. This problem is approached solely on discrete time sequences of observations made by CBRN sensors monitoring the environment through a process of hypothesis testing. The localization methodology builds upon the work presented in [4], wherein a wireless sensor is located within a wireless sensor network solely on independent and identically distributed (iid) sequences of Radio Frequency (RF) signals observed at *clusterheads*. The key difference between the existing work and the work presented in this poster, apart from locating a CBRN source in an urban area instead of a wireless sensor in an indoor sensor network, is that, conditional on a CBRN event, if a CBRN sensor observes a large (small) concentration of CBRN agent, the next observation in the sequence will reflect a similarly large (small) concentration. To accommodate this unique phenomenon, we model CBRN sensor observations as a first-order Markov chain. Accordingly, the techniques and theory presented in [4] are extended to the Markovian case.

Our methodology is model independent, robust to low fidelity modeling, and potentially more accurate then the approaches presented in [1], [2], and [3] in scenarios with highly variable weather conditions. We formulate CBRN localization as a composite hypothesis testing problem. We characterize the exponents of Type-I and Type-II error probabilities, from which we obtain the worst case probability of error exponent for each pair from a discrete set of potential CBRN release locations. We then leverage these quantities to formulate and solve the problem of optimally placing sensors so as to maximize the overall probability of error exponent.

*This work is sponsored by the United States Air Force under Air Force Contract #FA8721-05-C-0002. Opinions, interpretations, recommendations and conclusions are those of the authors and are not necessarily endorsed by the United States Government

†Research partially supported by the NSF under grand EFRI-0735974, by the DOE under grant DE-FG52-06NA27490, by the ARO under grand W911NF-11-1-0227, and by the ODDR&E MURI10 program under grant N00014-10-1-0952.

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