Sandia National Laboratories

Sensor Placement Optimization using Chama

Continuous or regularly scheduled monitoring has the potential to quickly identify changes in the environment. However, even with low-cost sensors, only a limited number of sensors can be deployed. The physical placement of these sensors, along with the sensor technology and operating conditions, can have a large impact on the performance of a monitoring strategy.

DETAILS

Chama is an open source Python package which includes optimization formulations to determine sensor locations and technologies that maximize the effectiveness of the sensor network.

The methods in Chama are general and can be applied to a wide range of applications, including:

- Fire and gas detection in chemical facilities, offshore platforms, and liquid natural gas terminals
- Contamination in water distribution systems
- Asset protection and surveillance

Given a set of site-specific simulations (e.g., fire scenarios, contamination incidents) and candidate sensor technologies (e.g., point or camera detectors), the impact of detecting each scenario is extracted and used in mixed integer linear programming formulations to determine optimal sensor layout under a specified budget.

Optimization can include the following objectives:

- Minimize time to detection
- Minimize damage metrics like population exposed or extent of contamination
- Maximize scenario coverage
- Maximize geographic coverage

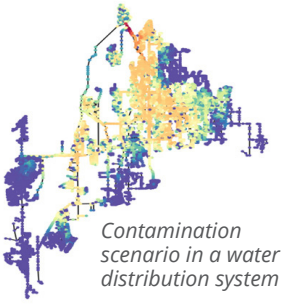
Download Chama from the Sandia National Laboratories GitHub site: https://github.com/sandialabs/chama

Documentation is available at http://chama.readthedocs.io.

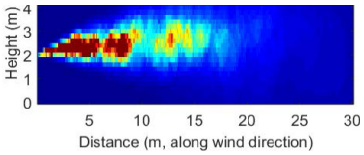
Chama

SENSOR PLACEMENT OPTIMIZATION

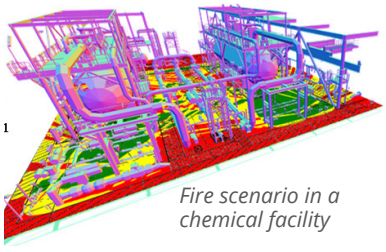
The flexible software framework integrates simulations or impact assessments from third party software.



Contamination scenario in a water distribution system

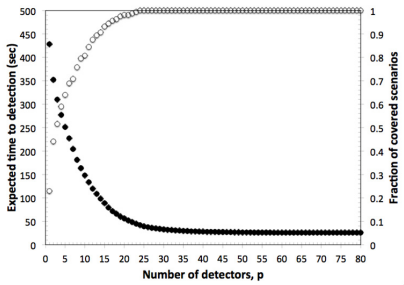


Gas leak from a production well pad



Fire scenario in a chemical facility

Cost benefit analysis showing detection time (black circles) and scenario coverage (open circles) for an increasing number of detectors.



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