A Sensor-cyber Network Testbed for Plume Detection, Identification, and Tracking

Introduction

- Under a national SensorNet initiative, we have carried out prototype deployments of detection, identification, and tracking sensor-cyber networks (DITSCN) at diverse sites (including Washington D.C., Port of Memphis, etc) to detect chemical, biological, and nuclear (CBN) agents and cyber threats.
- DITSCN combines various modalities of sensors and cyber networks
  - Sensors network provides information about the physical space
  - Cyber network provides storage and computational resources to predict plume propagation based on realistic dispersion models
  - Decisions regarding future sensing and communications are made in cyber network and carried out in the physical space

DITSCN Architecture

- Sensor data communicated through RS-485 or 802.11x interfaces to the Sensor-Net Node
- Adapted IEEE 1451 interface to configure sensor at runtime

Research Tasks

1. Convergence between physical and cyber spaces
   - Effectively gather information about the physical space
   - Communicate most useful data to the cyber space
   - Enable the cyber space to task and activate sensors to collect high-quality data
2. Acknowledge the existence of uncertainty and enable decision making processes to deal with uncertainty in a robust fashion
   - Corporate physical environment: terrain elevation, land cover, and meteorological conditions
   - Adequate modeling of physical phenomena (e.g., plumes with respect to the absorption, propagation, and dispersion coefficients)
3. Support for deeply embedded operations
   - Ability to integrate system components in an open, plug-and-play manner, through the use of open data, control and communication interfaces

Cyber Space

- Realistic SCIPUFF plume dispersion model support for analysis and rendering of plume propagation in a real terrain
- Dynamically update plume propagation with variations in wind speed or direction
- Dynamically update the topology and routes in the multi-hop wireless sensor network

ER-1 Robots

- Supporting autonomous and programmable movement are guided by the cyber space, using commands sent over 802.11x wireless network.
- Tasking enables sensor mobility to increase the coverage of a high-risk location.
- Mobility affects the performance of wireless links

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