



Algal bloom in Lake Erie

MOTIVATIONS

Developing prediction and sampling algorithms for mobile robots, for:

- Monitoring water quality in lakes
- Environmental monitoring
- Harmful algal bloom tracing
- Chemical plume tracing

OBJECTIVES

- Develop *efficient prediction algorithms* to cope with uncertainty in model's hyperparameters and sampling positions
- Develop *optimal sampling strategy* for sensor networks to minimize prediction error and energy consumption
- Develop *autonomous robotic sensors* for experimental validation



SPATIO-TEMPORAL FIELD MODELS

Our approach relies on phenomenological and statistical modeling techniques—such as Gaussian processes, Gaussian Markov random fields, and kernel regression—to represent fields undergoing transport phenomena.



HARDWARE

Testing the mobile robot in an outdoor swimming pool

POTENTIAL IMPACT
ENVIRONMENTAL MONITORING
 water quality & harmful algal blooms in lakes
SECURITY
 monitoring of ports, rivers, & drinking water reservoirs
ROBOTICS
 simultaneous localization & mapping (SLAM)

K-12 OUTREACH & EDUCATION

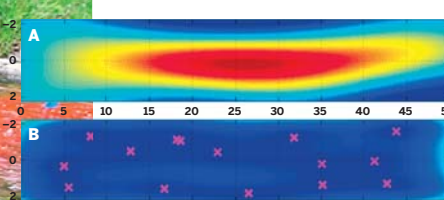
- Students design solar charging system regulated by onboard microcontroller
- Created lab to study energy collection and storage, expanding STEM curriculum
- Work in robotics lab helps teacher apply practical, real-world examples of robotics while coaching robotics team

- 2009**
- WIMS (Wireless Integrated MicroSystems) for TEENS
 - Women in Engineering
- 2008**
- Detroit Area Pre-College Engineering Program (DAPCEP)
 - WIMS for TEENS
 - Women in Engineering



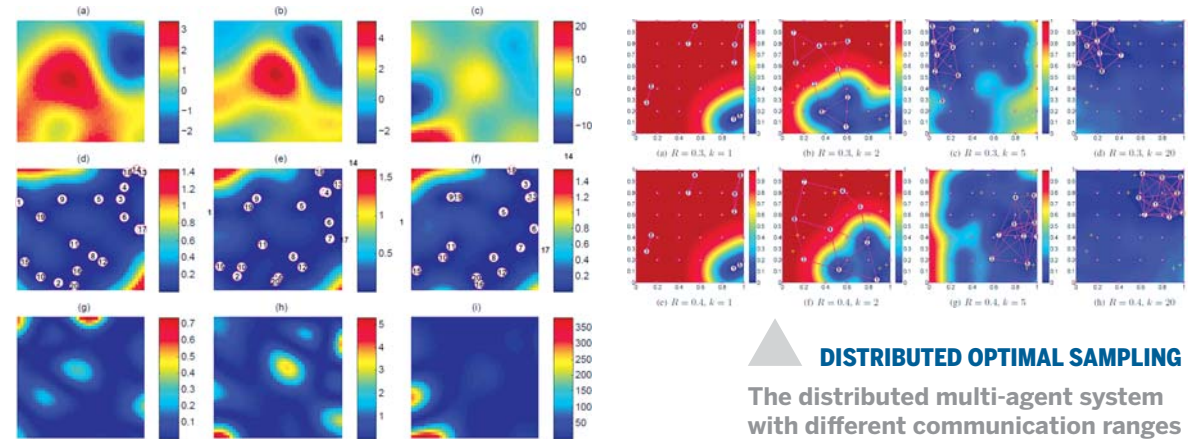
A highly visible dye plume near the source location

Predicted concentration of dye plume pulse in a river



EFFECT OF UNCERTAIN LOCALIZATION

Prediction results of applying Gaussian process regression on the true and noisy sampling position



DISTRIBUTED OPTIMAL SAMPLING
 The distributed multi-agent system with different communication ranges

TRAINING OF STUDENTS

- 3 graduate students
- 4 undergraduate students

SCHOLARLY PAPERS

- 8 journal papers published/in press
- 10 conference papers published
- "Best Student Paper" award finalist, Dynamic System & Control Conference, 2011



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