Adaptive Sampling for Marine Microorganism Monitoring

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Introduction: Aquatic Microorganisms Detection and Location

- Microorganisms can be exceedingly small (2~3μm) and they have patchy distribution in the water on various scales.
- It is not efficient to sample everywhere to detect microorganisms.
- The conditions under which aquatic microorganisms develop are not understood.
- Methods for detecting microorganisms are too slow and complex for timely intervention.

Problem Description: Understanding Ecology of Aquatic Microorganisms

Goals

- Correlation of of temperature, salinity and other environmental parameters with the growth of microorganisms.
- Location of microorganism concentrations according to sensor readings and environmental parameters.
- Navigation of the sampling system to take water samples.

Requirements

- Continuous (sensing) presence in the environment.
- Real-time data acquisition and analysis.
- Chemical, physical, biological measurements.
- Spatial and temporal scales relevant to the organisms.

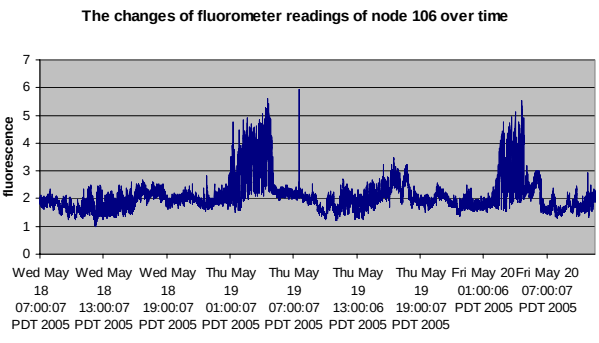
Proposed Solution: Real-time Monitoring and Sampling System

Field instrumentation and network design and construction

- Design and prototype development of a robot boat for surface operations in the field
  - Equipped with a GPS and a compass for navigation
  - Equipped with a thermistor and a fluorometer for environment paramters
  - Equipped with a sampler to take water samples when necessary
- Design and prototype development of a wireless sensor network for small-scale sensing in aquatic ecosystems
  - Equipped with a thermistor array for temperature profile v.s. depth
  - Equipped with a fluorometer for Chlorophyll at certain depth
  - 10 static nodes are constructed and 5 have been deployed in Lake Fulmor in James Reserve
  - Within-network data synthesis and decision making for directing a mobile sampler (boat)
  - Transmission of data to shore-based station

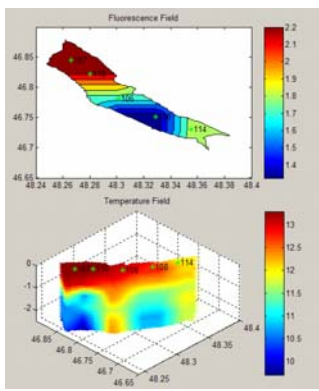
Field experiment results

- Fluorometric characterization of algal abundance in Lake Fulmor
  - Fluorescence of chlorophyll provides useful proxy for algal abundance
  - Fluorescence changes temporally and spatially
- Thermal stratification of Lake Fulmor
  - Temperature changes both on the surface and alone the depth
  - Changes in temperature with depth and over time affect the distribution of aquatic microorganisms

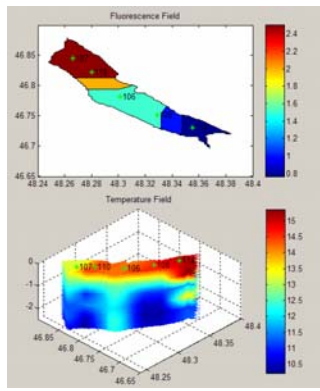


(a) The robotic boat and the static nodes

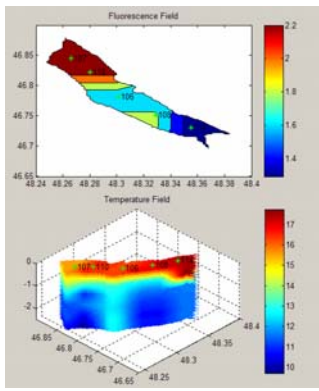
(b) All 5 static nodes in Fulmor Lake



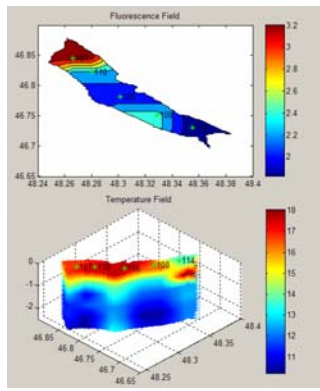
(a) 9 AM



(b) 12PM



(c) 3PM



(d) 6PM

Chlorophyll field (surface) and Temperature field at different time in the Lake Fulmor in James Reserve