Fidelity Driven Sampling in Environmental Sensing

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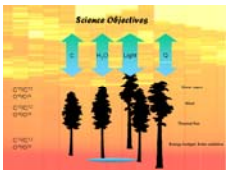
Exploiting Mobility to achieve High fidelity Environmental Sensing

Motivation

- *Networked Infomechanical Systems*
  - Mobility for application science
- Extended visibility using motion
- Interaction of static sensor network and mobile sensor network
- Sensing close to the phenomena

Why is it Important?

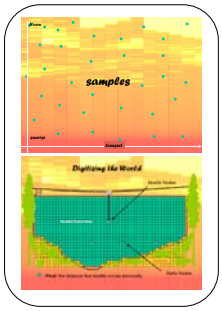
- Environmental Science
- Habitat monitoring
- Example
  - Aging in forests
  - CO_2 Respiration
  - Global warming at microclimate level
  - Comparison of different forests (ex. Oxygen generation)



Approach: Fidelity Driven Sampling to Create a Dynamic Model of the Environment

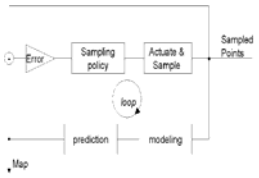
Goal

- Represent our knowledge in a mathematical model
- Actively build a model
- Optimize the trade-off
  - Spatial resolution,
  - temporal resolution
  - spatial coverage.



Approach

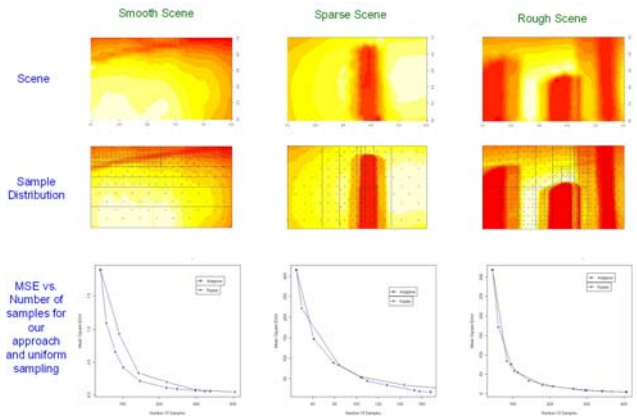
- Minimize the *integrated squared error*
  - sample the phenomenon in regions of high curvature
- Use prior knowledge of the phenomenon or a coarse estimate to identify regions that need higher resolution
  - Nearest-neighbor weights are used for the local polynomial fit; the
  - Bandwidth for our estimator decreases as we take more measurements in a region



System Prototype and Simulation Results

Simulation Results

Evaluated subjecting to representative cases

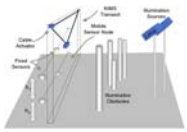


•For reduced curvature,

- Fidelity Driven Sampling *adaptively converge to a specified mean squared error*
- It is equal or superior to raster scanning in *efficiency with respect to numbers of sample points*

Experiments with light

- Generating light patterns in lab
  - •Close to reality
  - •Static
  - •Having Ground-truth



Software Architecture

- •Using *statistical tools in motion*
- •Moving from simulation to real time in statistical environment
- •Rapid *prototype algorithm*
- •Using the tools for environmental science

Future Work

- Temporal analysis of the scheme
- Utility of the motion
  - •Statistical error
  - •System delay
- Using Fidelity Driven Sampling in the field
- Use *Bayesian* approach to represent our previous knowledge