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Title

MAS 3: Coordinated Actuation for Environment Observation

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Coordinated Actuation for Environment Observation

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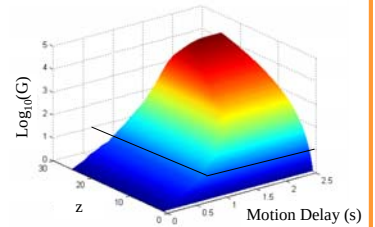
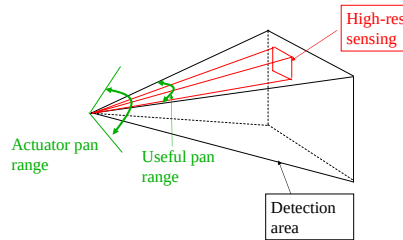
Introduction: Constrained Motion is Advantageous

Motion Advantage

- Adapt to obstacles in sensing medium
- Allocate sensing resources to phenomenon of interest
- Patrol larger area than covered by static sensors

Constrained Motion

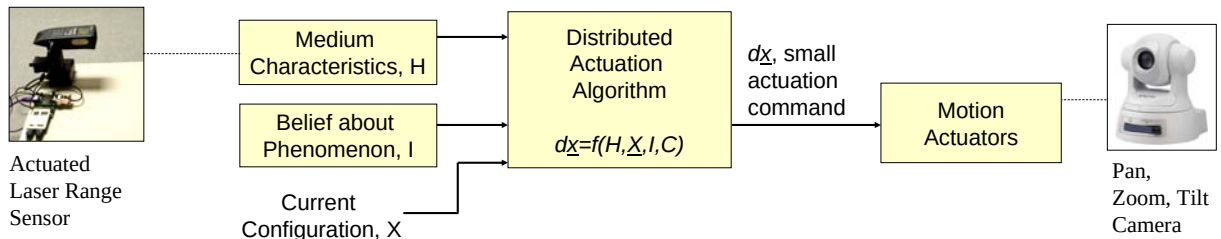
- Minimal navigation and localization resource overhead
- Low energy: Bulkier parts static, no complex terrain
- Feasible in tethered nodes.
- Low intrusion into environment.



Problem Description: Maximize field of view and maximize spatial resolution simultaneously

Configure network to take advantage of actuation with minimum actuation delay – have detection capability over large area and when an event occurs, actuate to it to provide high resolution coverage.

Proposed Solution: Optimize actuation delay for all points in covered space



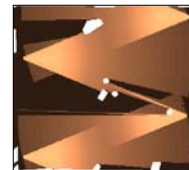
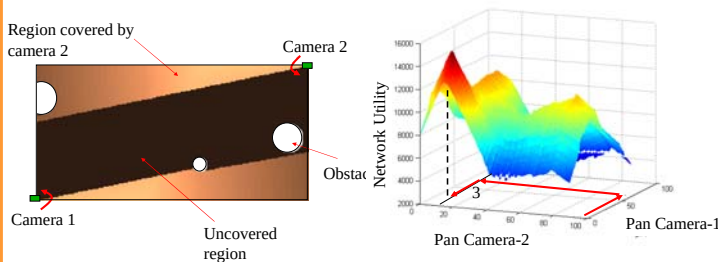
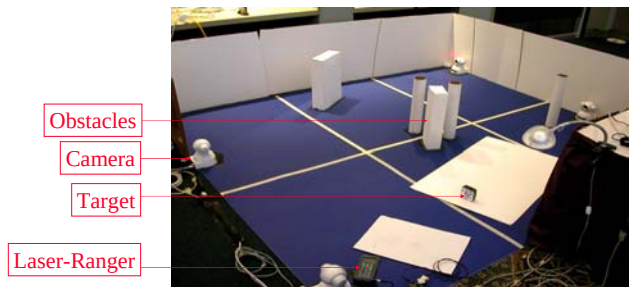
Distributed Actuation Algorithm

- Quantify network coverage metric of interest
- Coverage consists of
 - Detection quality: actuation time to reach a point, weight by phenomenon density
 - Actuation delay: modeled using information theoretic measure

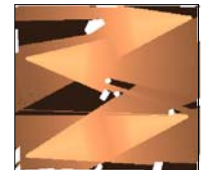
$$\tau(p) = \max\{\delta\theta_p * \omega_p, t_p(\delta_z)\}$$

- Distributed optimization:
 - Objective function is a summation of locally computable terms
 - Finding global optima: NP hard, requires central coordination
 - Incremental Line Search (ILS): Distributed optimization through communication limited to local neighborhoods

Experiments on Lab Test-bed



Regular Tessellation: suffers from obstacles and suboptimal resolution



Optimized using ILS: more area covered, better detection, lower delay

Experiment with Real World Data

Example Application

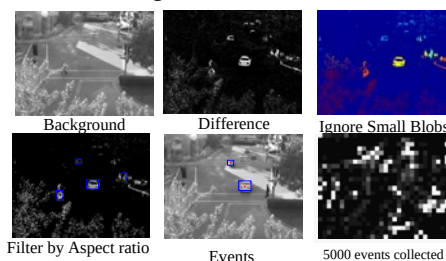


Low-res view for motion detection



High-res view for sensing application (784x resolution)

Event Trace Using motion Detection



ILS vs. a tessellation or random config.

