

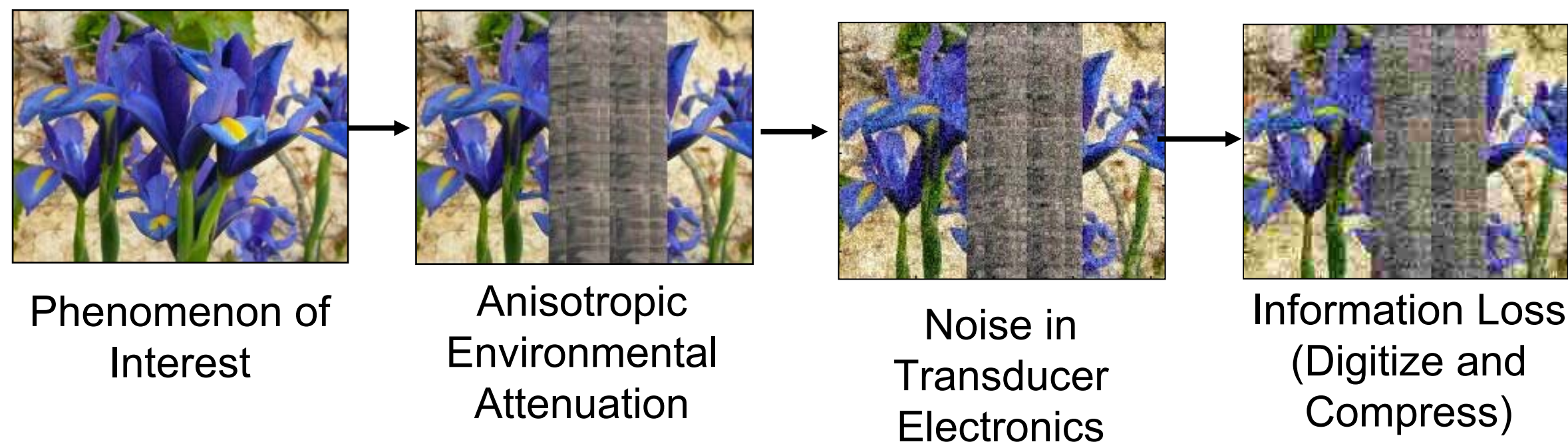
Actuation Methods for Enhanced Coverage

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NESL: <http://nesl.ee.ucla.edu/>

Introduction: Sensing Performance is Critical to All Sensor Network Applications

1. Sensing uncertainty due to multiple factors



2. Media and Phenomena are Dynamic

Medium anisotropies change in time

Eg: Growth of foliage in outdoor environments, Movement of people and other objects in indoor environments

Phenomenon is not stationary

Need high resolution coverage where phenomenon are present

Therefore, system must adapt to change

Problem Description: One line explanation of the problem to be solved

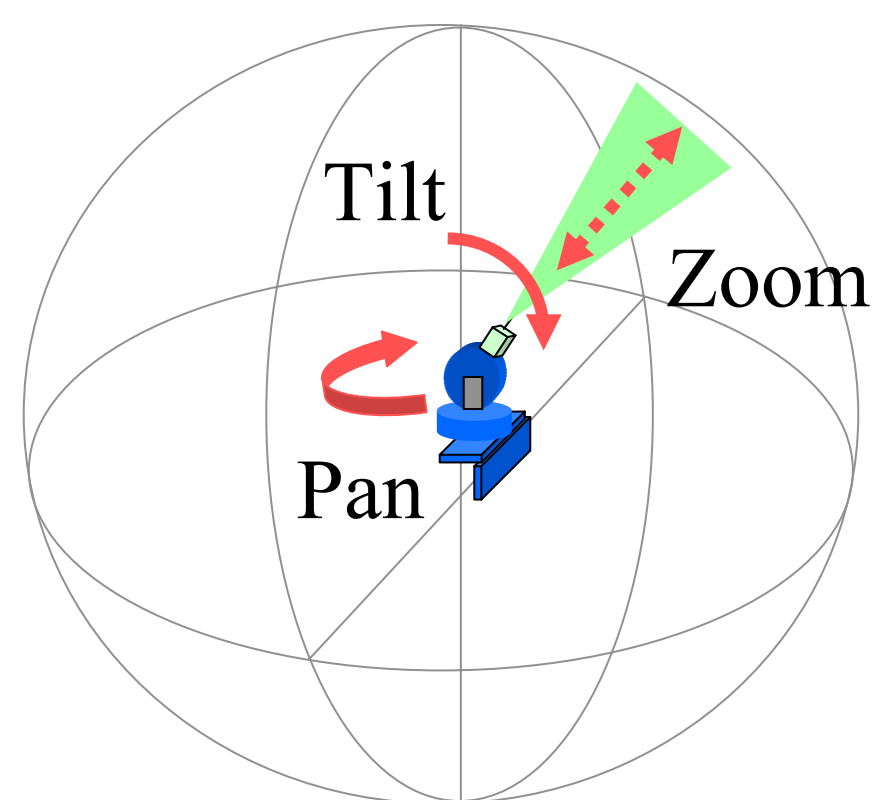
- Full-featured robotic capabilities have high resource and energy overhead: navigation and terrain sensing, locomotion over complex physical terrain, intrusion into user environment, high energy expense
- We propose reduced complexity actuation primitives to autonomously improve sensing coverage

Proposed Solution: One line with the main idea of the proposed solution

1. Reduced Complexity Actuation Primitives

- Actuated Appendages: Pan/Tilt/Zoom
- Small motion on assisted tracks
- Virtual Mobility: changing active and inactive nodes
- Feasible in sensor networks
 - Does not need navigational support, Energy expense is small

2. Advantage from Actuated Appendages



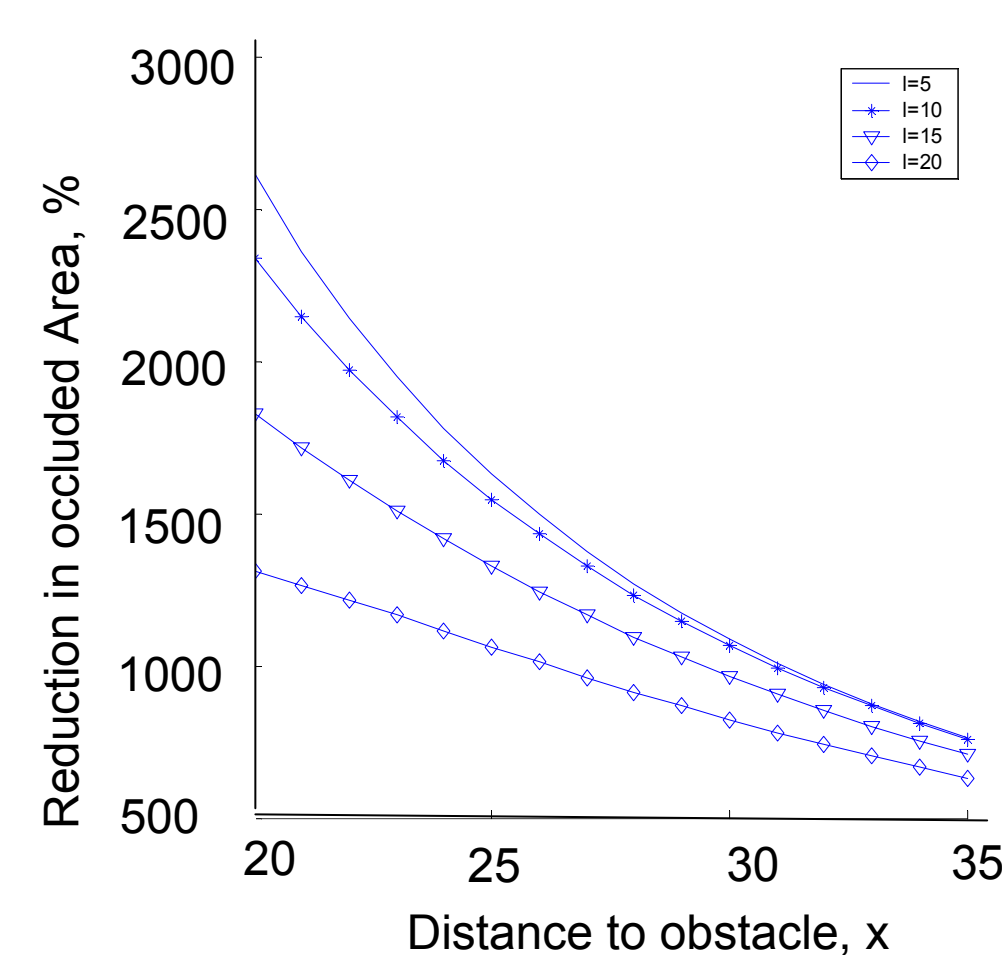
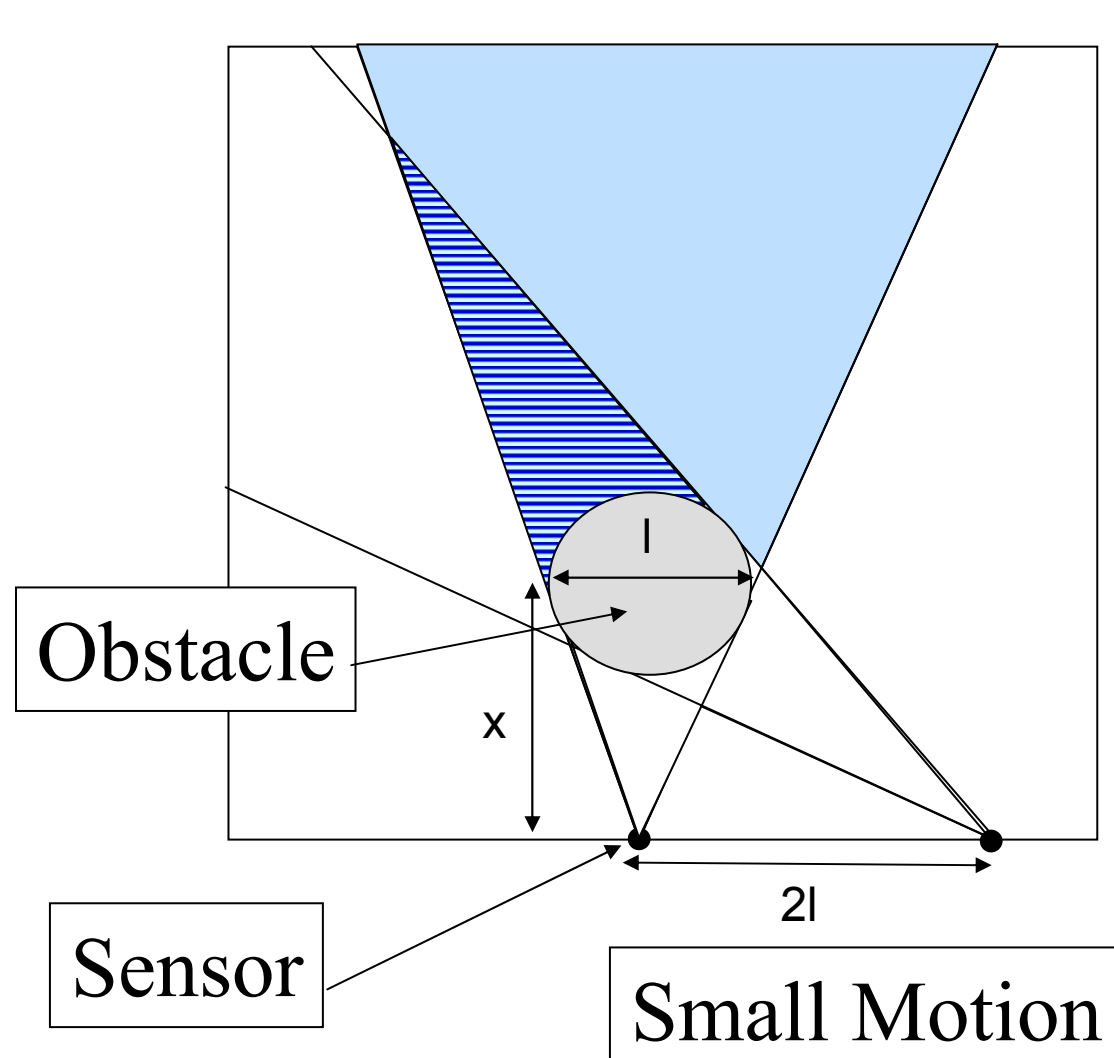
Example Camera (Sony): Pan: 340°, Tilt: 115°, Zoom: 25X

Increase in Covered Volume

Pan	7.74
Tilt	4.04
Zoom	73
Pan and Tilt	28
Pan and Zoom	6361
Pan, Tilt and Zoom	226940

3. Advantage from Small Linear Motion

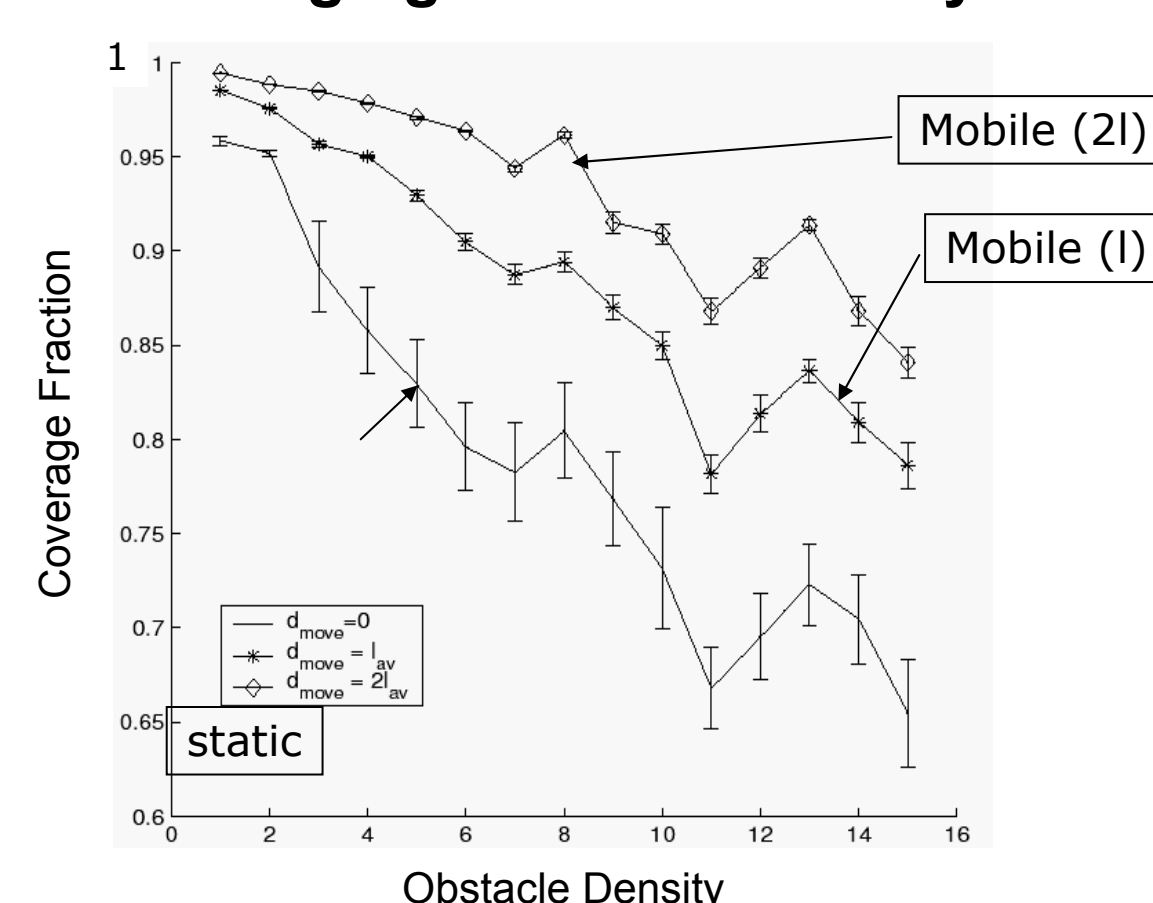
Analyzing Gain due to small motion



Multi-obstacle scenario

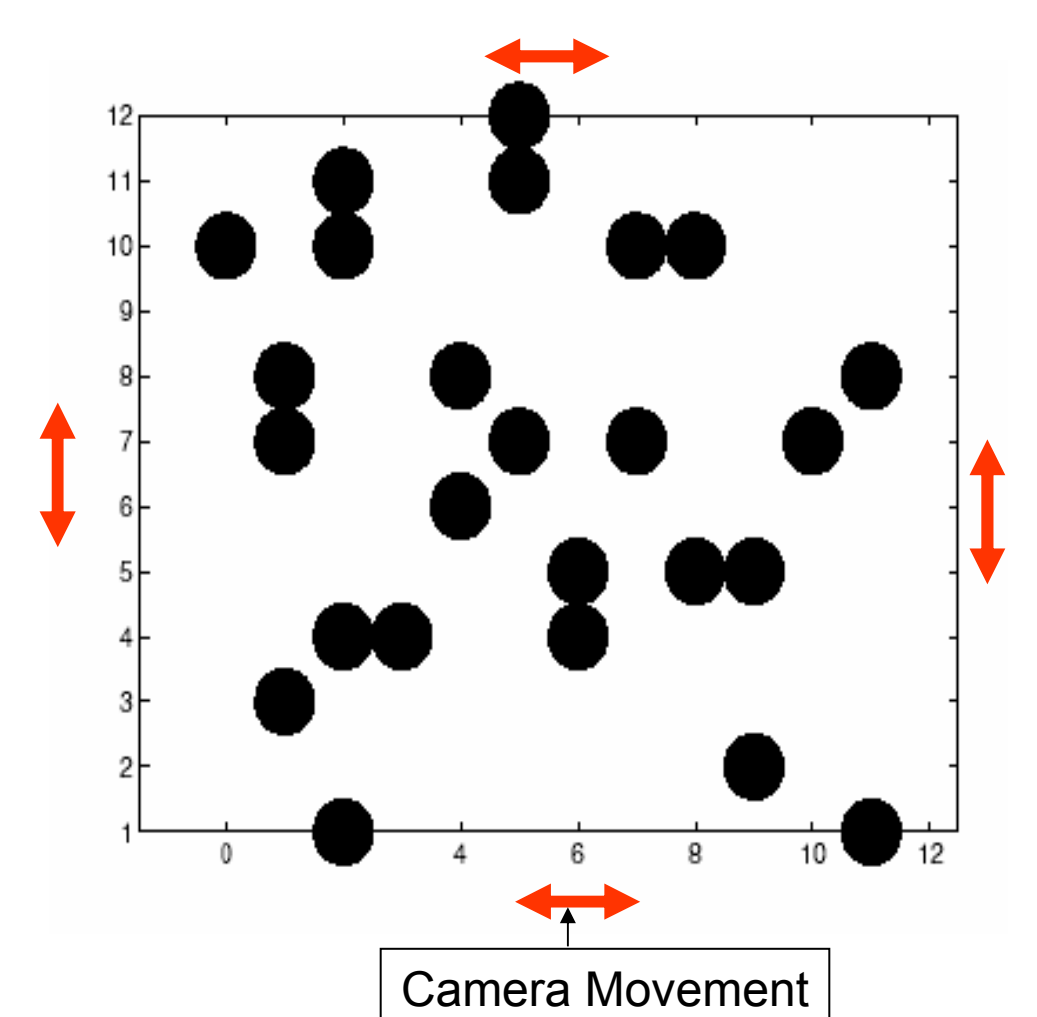
- Multiple obstacles with random sizes
- Sensor moves small multiple of mean obstacle size, l
- Obstacles distributed uniformly randomly
- 20 topologies averaged

Changing Obstacle Density

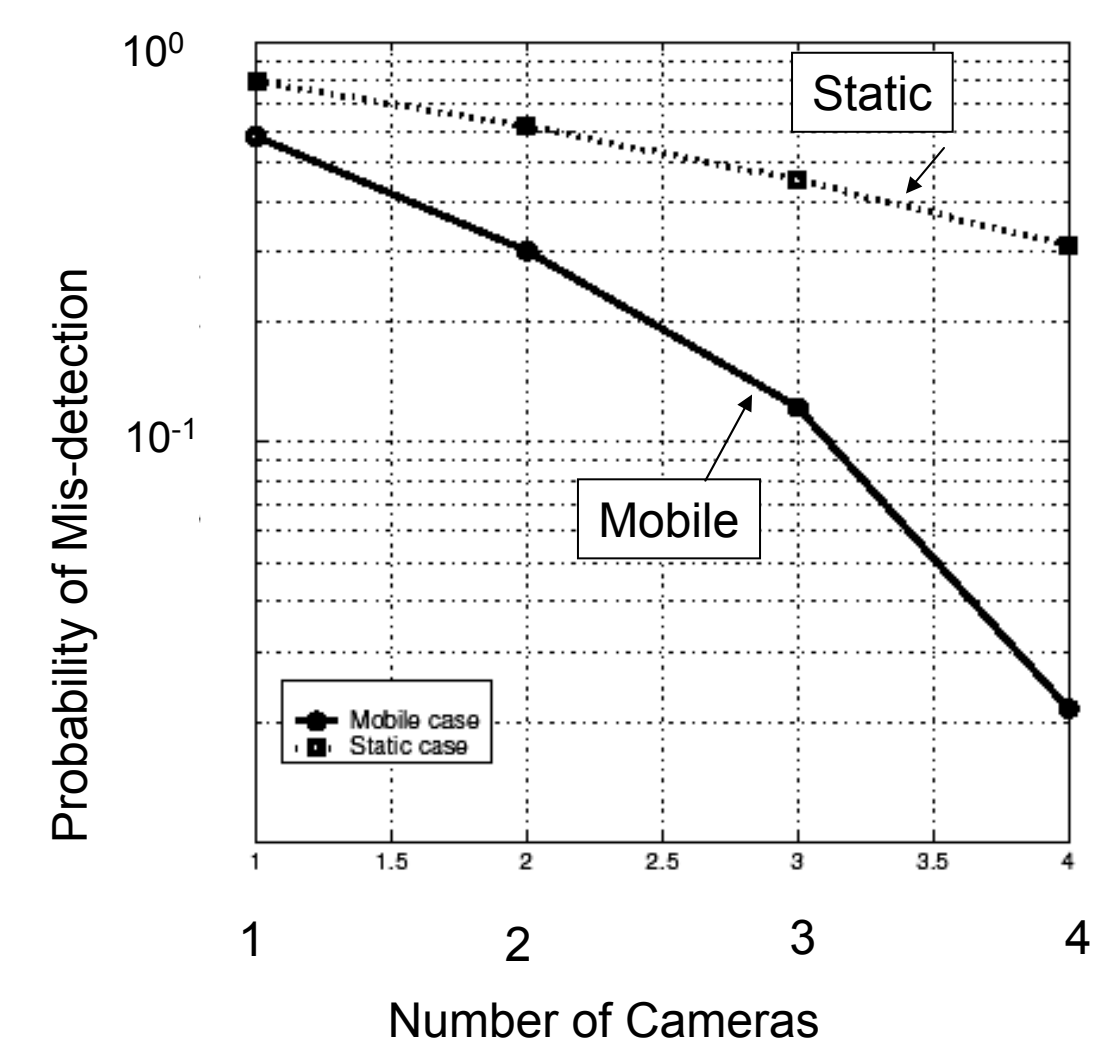


Experiments with real sensors

- Not based on circular disk coverage models
- Realistic sensor effects considered
- System of four cameras and a square field with obstacles
- Image processing on noisy camera output to detect target
- Measured detection probability by moving a target around the field
- Obstacle placement: Wind River Canopy Research Facility tree map

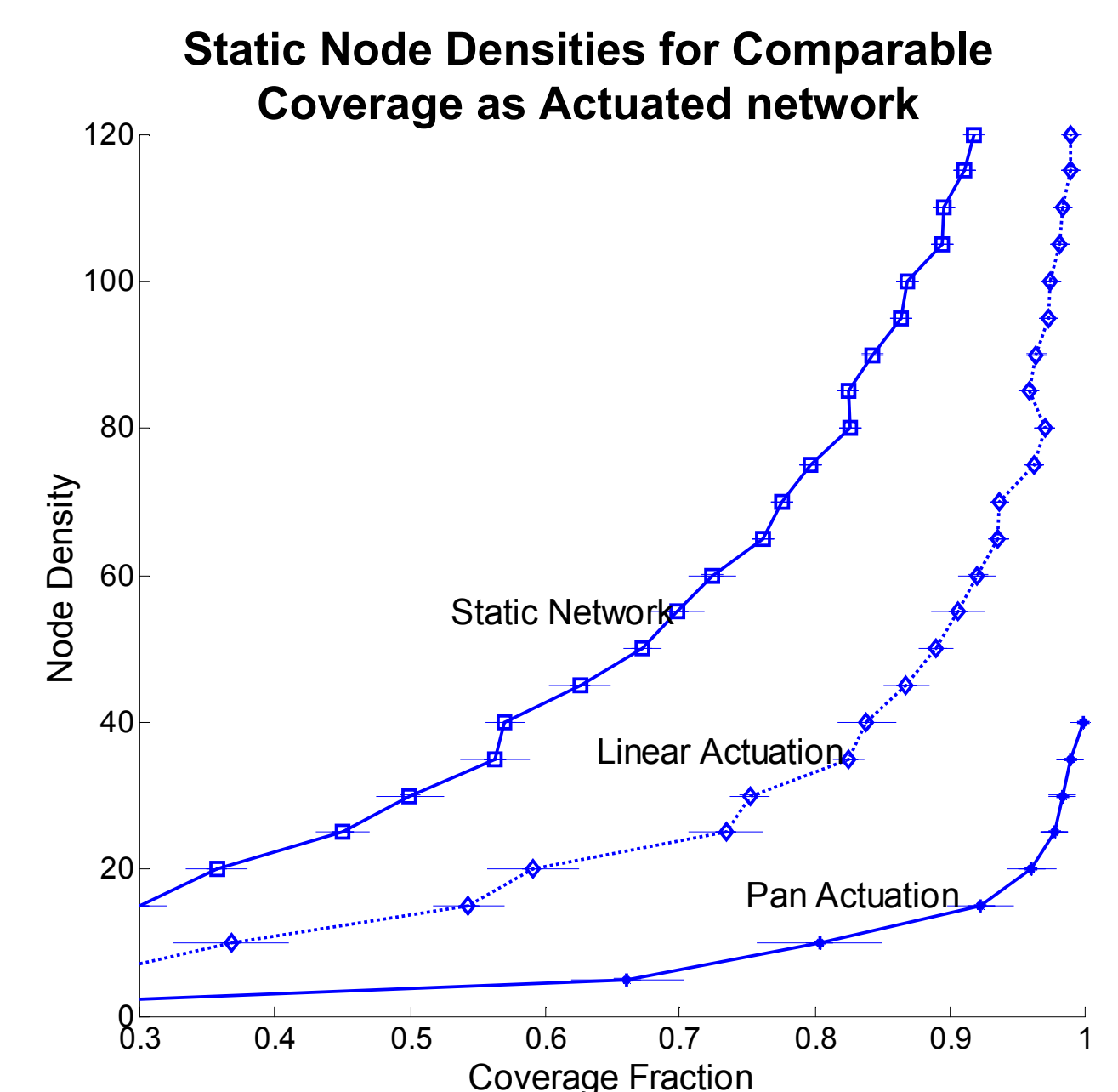


View from one of the test-bed sensors



4. Virtual Mobility

- Node ID insignificant: deactivating one node and activating another is same as relocation of a sensor
- Higher node deployment density required to enable migration to sufficient locations for coverage
- Motion delay can be made very small
- Multiple simultaneous nodes can be activated for special events



Ongoing Work

- Methods to determine achieved sensing coverage and desired coverage profile
- Distributed actuation algorithms to coordinate the motion of multiple sensors to achieve desired coverage profile
 - Avoid overlap among sensors
 - Orient so as to avoid obstacles