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Title

Actuation–assisted Calibration of Distributed Camera Networks

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CENS

Center for Embedded Networked Sensing

Actuation-Assisted Calibration of Distributed Camera Networks

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Problem Description: Determine extrinsic parameters for actuated camera networks.

Context

- Calibrate camera poses in 3D space
  - location
  - orientation
- Actuated camera devices use pan and tilt capabilities to adapt FOV.
- Cameras equipped with optical beacons reconfigure their poses to intercept other nodes' optical signal and extract their identities.

Conclusion

- Actuated camera networks gain significant reduction in network density as opposed to static camera networks.
- Cameras can refine their pose estimates using additional observation that are potentially available in an actuated network.

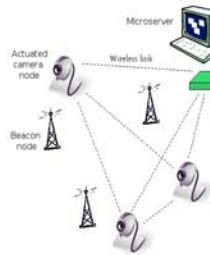## Methodology, Prototype Platform and System Architecture

Camera Network Geometry

Pair-wise triangulation

Network-wise fusion
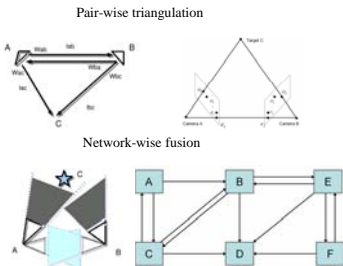
Actuation Platform

Servo Specs

| Operating Voltage	5 V
Current (idle)	8 mA
Current (operating)	160 mA
Operating Speed	315 degrees/second
Rotational Range	180 degrees

Localization Architecture

- **Actuation Strategies**
  - Raster scan: omni-directional beacons
  - Random scan: directional beacons
- **Termination Rule**
  - Local rules: exhaustive; neighborhood
  - Global: complete network fusion; negligible marginal change
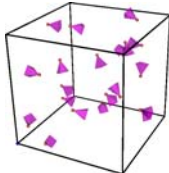
Simulation and Experimentation

Simulation

- Developed the simulation environment in Python
  - Generate camera networks
  - Acquire observation
  - Execute localization algorithms
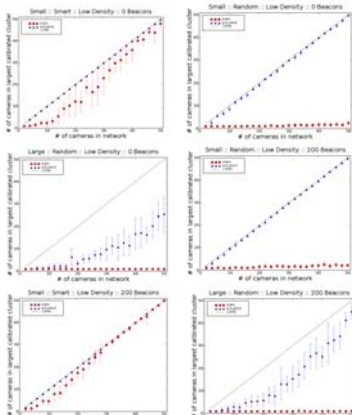 - Visualize results

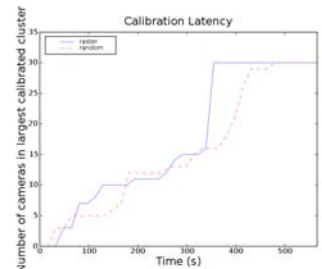**Random location and smart orientation**
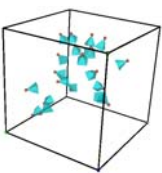
Random location and random orientation

Node Density

Calibration Latency

- **30 actuated cameras**
- **FOV: 45 degrees**
- **Pan/tilt range: 180 degrees**

Testbed environment

- **Crossbow MICAZ motes**
- **Cyclops image sensors**
  - Running SOS (an operating system for mote-class wireless sensor networks)

Accuracy

Testbed Position Estimation Error

Testbed Orientation Estimation Error