

Cyclops: A Reconfigurable Low-power Platform for Distributed Image Sensing

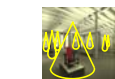
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Distributed Image Sensing and Interpretation

Why Vision

- Vision as Sensing
- Strong Modality to Disambiguate the Environment

Context, texture, Shape or change in shape, Presence or absence, Displacement, Interaction, Color



Why Distributed

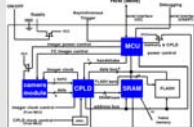
- A Difficult Problem Reduces to Many Simpler Problems
 - Multiple Views, Multiple Observations, Closer distances
 - Avoid distance and scaling problems
 - Stronger Association of Objects with Cameras
- CMOS technology is cheap and low power
 - Integration Imaging and Computation

Why It is Important

- Many Applications
 - Smart Environments, Traffic Monitoring, Activity Measurement, Security and Intrusion Detection, Precision Agriculture

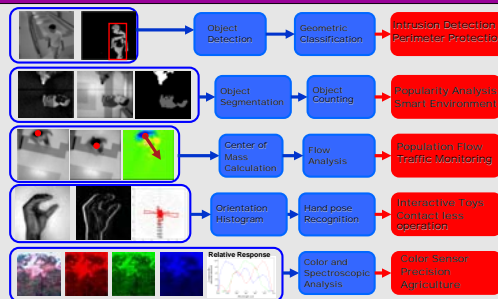


Cyclops: A Reconfigurable Low Power Image Sensor



Cyclops

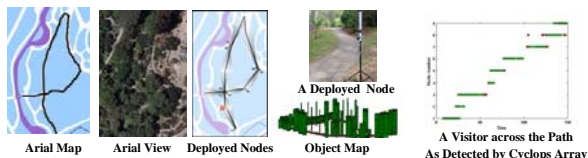
- Dedicated Computation, Low Power Frame Grabber, Memory and CMOS Imager
- Sensor Device for Conventional Sensor Network Nodes such as Mote
- Custom Sensing through Reconfigurable Computing
- Many Sensing Experiments have been Pursued



Research Direction

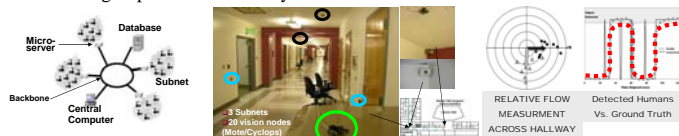
Coverage of a Network of Cyclops

- Given a bounded domain and partial knowledge of occlusions, find an optimal placement of camera nodes.
 - NP-complete - related to Art Gallery Problem
 - Need to find good approximate solutions



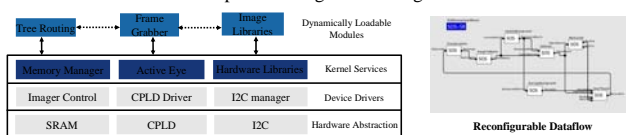
Tiered Image Sensing Network

- A Cyclops Network
 - Runs the Image Sensing Functionality through Declarative Query
 - Subnets of Cyclops at Different Frequencies
 - High Speed Back Bone System



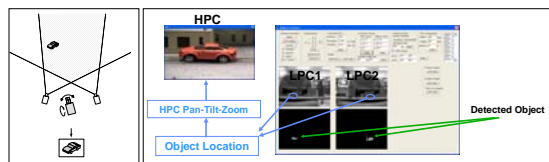
Dynamic Reconfiguration

- Update Image Processing After Deployment
 - Respond to Environmental Variation (i.e. Change in luminance), Time
 - Update the Computation by Learning from the Data
- Customize Computation by Configuring Image Processing Modules
 - SOS operating system
 - Loadable Modules Encapsulate Image Processing Libraries



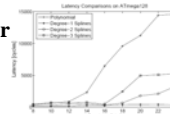
Actuated Network

- Actuated Cyclops Network
 - Self Calibration of Camera Models,
 - Self Configuration
- Tiered Actuated Vision System
 - Exploit Low Resolution Cameras to Locate Object in 3Dimensional Space Using Stereoscopy
 - High Precision Pan-Tilt Camera for Object Recognition and Recording



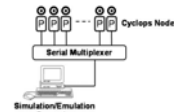
Energy Optimized Function Evaluation

- Optimize Evaluation Performance vs. Power Consumption
 - Depends on the Architecture of Processor



Simulation and Emulation Environment

- Easy Configuration of the Imagers
- Large Scale Data Collection
 - Simulation vs. Scenarios (Collected Data)



Vision Network Deployment

- James San Jacinto Mountains Reserve
- Micro-servers (4)
- Nest Boxes (15)
 - Occupancy, Territory, Egg Laying, Nest Building clutching or Hatching
- Pitfall Traps (12)
 - Reptile Size, Statistics, Activity vs. Environmental factors, Time

