Lab-Scale Actuated Sensing Testbeds

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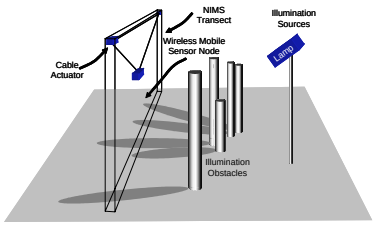
NIMS LS: Exploring Infrastructure-assisted Actuated Sensing of Enviromental Phenomena

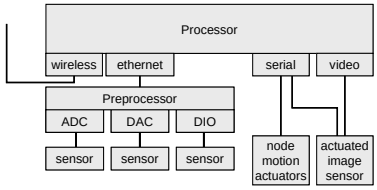
Emulation of Environmental Phenomenon

- **Static and dynamic phenomena, such as light distribution in ecosystems**
- **Algorithm verification via robotic hardware-in-loop emulation**
  - E.g. CENS research on adaptive sampling, sensor calibration

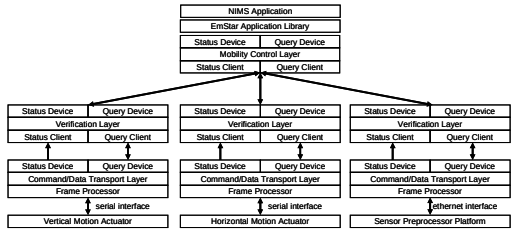


Flexible Actuated Sensing Node

- **Modular Emstar-based software organization with embedded R statistical computing environment**
  - Seamless migration to deployment using NIMS Field System



NIMS LS Actuated Sensor Node



RoboMote: Ultra-lowpower Mobile Mote for Research in Mobile Sensor Networks

Benefits of Mobility

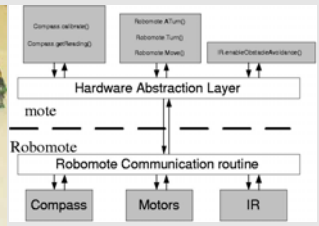
- **Adaptive deployment, network repair, active event detection, energy harvesting, …**
- **Application exploration using RoboMotes:**
  - **Detection of level sets: use control law that uses local sensing to drive mobile sensor node towards the gradient**
  - **Bacteria inspired light tracking: locate and track light sources using biased random walk analogous to bacteria tracking food sources**

Hardware Details

- **Mobile platform with 2 motors carries a Mica2 mote**
  - **Application and netwok processing: Mica2**
  - **Low-level Processing: AVR 8-bit microcontroller with 8K Flash, 512 byte RAM, and 512 byte EEPROM**
  - **Mobility: 2 motors, 15-20 cm/s speed, 36 pulses/cm odometer, 5 degree precision compass, 300 gm payload, software PI controller, IR object avoidance system**
  - **Energy: 345 mAh energy source, 15-20 minute wall recharge time**

RoboMote

Pack of RoboMotes



Software

COMPONENT	POWER CONSUMPTION (in mW)
Both Motors on	720
Compass	60
IR (Both RX/TX)	588
LEDs (both)	44
All external Services (MCU+MoteV_{dd})	36

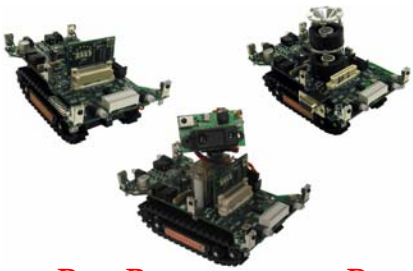
RagoBots and RagoWorld for Mobile Sensing Research, and Education in a Fun Setting

Design Goals

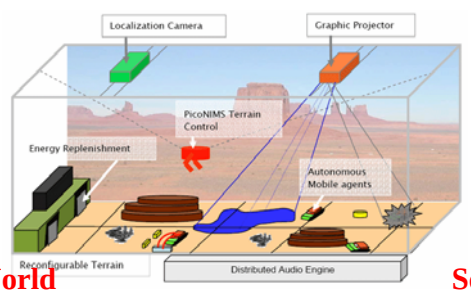
- **Research tool for mobile sensor networks with distributed control and coordination**
  - **Ecology of mobile sensors co-existing with static sensors**
  - **Controllable and realistic artificial terrain**
- **Fun education tool for sensor networks and embedded systems**
  - **Expose students to sensor networking problem and algorithms in a controllable and fun setting while emulating physical world realism**
  - **E.g. exploring sensor network resource allocation as a game**

System Components

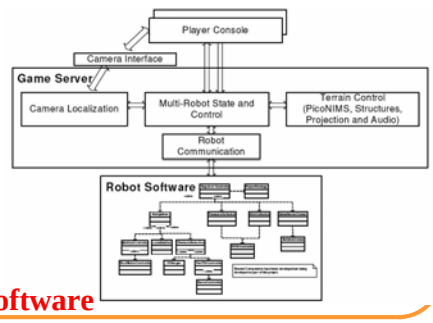
- **RagoBots**
  - **Small form-factor, low-power, reconfigurable architecture**
  - **Hierarchical modularity: “nerve”, “brain”, “head”, “neck”, ‘body”**
  - **Tracked mobility substrate for all-terrain operation**
  - **Multimodal sensor suite: imager, microphone, IR ranging and avoidance, RFID reader, ultrasound, light, temperature, humidity etc.**
  - **Software environment: dynamically downloadable modules, scripting**
- **RagoWorld: modular, reconfigurable artificial terrain**
  - **Electronically-controlled actuated structures using shape-memory alloys permit creation of new terrain environments**



RagoBots



RagoWorld



Software