Inter-glider Underwater Communication and Coordination for Ocean Monitoring and Coastal Tactical Surveillance

Prof. Dario Pompili
ECE Department, Rutgers University
Email: pompili@cac.rutgers.edu

Cyber-Physical Systems (CPS) Lab
http://nsfcac.rutgers.edu/CPS/
PhD students: Baozhi Chen, Hariharasudhan Viswanathan, Eun Kyung Lee, Parul Pandey
UG students: Mike, Kal, Jen, Seetha, Willy, Farboad, and many others…
Cyber-Physical Systems Laboratory
http://nsfcac.rutgers.edu/CPS/

- A Cross-disciplinary Research-Education Mission:
  - Propose novel sensing paradigms to transform raw heterogeneous data into valuable information (by giving semantic meaning to the data) and, finally, into knowledge through information fusion and integration

- Research Significance and Applications:
  - Leverage the acquired knowledge to broaden the potential of cyber-physical systems and to provide an effective and timely action
  - Examples include: (i) augmentation of human capabilities, (ii) understanding of human activities, (iii) coordination of heterogeneous (infrared) cameras, (iv) operation in dangerous or inaccessible environments, and (v) efficiency

- CPS is part of the NSF CAC:
  - A multi-site NSF research center funded by the I/UCRC program that combines resources from universities, private companies, and the federal government to conduct fundamental research on making computer systems and applications more reliable, secure, and efficient

Rutgers Robotics Workshop, Friday, Sept. 30, 2011
**CPS Lab Active Research Projects**

1. **Vital Signs Monitoring using Body Area Networks:**
   Designing an autonomic wireless sensor-based system that continuously and noninvasively monitors and tracks patients' vital signs and their activities.

2. **Communication Framework for Cognitive Ad Hoc Emergency Networking:**
   Implementing a communication framework for Cognitive Radios (CRs) to enable self-configuration and -regulation in the presence of primary users.

3. **Communication and Coordination among Autonomous Underwater Vehicles (AUVs):**
   Developing an acoustic communication substrate that supports QoS for underwater communications among AUVs.

4. **Thermal Awareness in Datacenters:**
   Validating information-fusion algorithms on a wireless sensing infrastructure for temperature and heat profiling in datacenters.

**DEMOS AVAILABLE AT:**
[http://nsfcac.rutgers.edu/CPS/demo.html](http://nsfcac.rutgers.edu/CPS/demo.html)
NSF CAREER: Investigating Fundamental Problems for Underwater Multimedia Communication with Application to Ocean Exploration
(Prof. D. Pompili, Rutgers/ECE)

Description of the project available at: http://nsfcac.rutgers.edu/CPS/
Rutgers Robotics Workshop, Friday, Sept. 30, 2011
A Sensor Network Increases the Visibility of a Team of Robots (Actors)

A team of actors with onboard sensors

A team of actors with a sensor network

WSANs

Framework for Wireless Sensor and Actor Networks (WSANs)

- Two interconnected coordination/communication problems:
  - **SENSOR-ACTOR COORDINATION**
    - Which sensors communicate with which actors?
    - How to optimally establish data paths
    - How to trade off energy consumption for increased **RELIABILITY**
      -> percentage of data packets received within a given latency bound
  - **ACTOR-ACTOR COORDINATION**
    - Which actor(s) should perform the action?
    - Optimal solution
    - Real-time localized auction


Rutgers Robotics Workshop, Friday, Sept. 30, 2011
Toy Example 1: Monitoring using coordinated cameras

1. Sensors detect movement or sound
2. Wireless, battery powered actor cameras are woken-up on demand
3. Actors coordinate to allocate tasks and scan the monitored area

Pan/tilt camera actors

1. Sensors detect movement or sound
Toy Example 2: Monitoring using multimedia actors

Scalar Sensors (MICAz)
Multimedia Sensors
Multimedia Actor with pan-tilt camera
Storage and Computation Hub
Central Sink

Room 1
Room 2

Streaming Video

Central Sink
Storage and Computation Hub