Cyber Physical Systems: Theory and Systems

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Research Interest Overview

- **Wireless Sensor Networks**, Cognitive Networks, Ad Hoc Networks

- **Topics studied:**
  - Wireless sensor systems for environment monitoring, industrial application --- “GreenXXX”
  - Theoretical performance studies of
    - Wireless networks
    - Social networks
  - Hardware/system design and manufacturing

- Supported by NSF, NSF China, RGC HongKong
Cyber Physical System

Opportunities and Challenges from Computing, Networking

1946
Computer
Auto computing

1965
Super Computer
High performance

1980
PC
User centered

1995
Internet
New networking service, cyberword

2010
CPS
Pervasive & sensor computing

Computing model involution.
Wireless Sensor Networks

Bridging the digital world and physical world
Representative Projects

- Environment monitoring
- Tracking objects: iLight
APPLICATIONS
OceanSense (2007-)

Joint work with Prof. Liu from HKUST, and Prof. Guo from China Ocean Univ.
GreenObs (2008-)

About 1000 sensors deployed
World largest WSN

Joint work with Prof. Liu from HKUST, and Prof. Dai from HDU, Prof. Zhou from ZFU, Prof. Zhao from Xi’an JTU, Prof. Gu from Tsinghua, Prof. Ma from BUPT, and several others
Applications

Canopy Measurement
Demo
In the process of deploying 20000 sensors in city environment a project that needs wide range of experts
Professors, and students
Collaborators
Students and Collaborators
System examples (iLight)
System examples (iLight)
Track Objects

Blue line: real trace
Red line: computed trace
Estimating heights

Testing environment and estimated height
Estimation error at most 2 cm w.h.p
Chicago Waterway System (NSF)

Joint work with Prof. Ren, Prof. Anderson and Prof. Teymour

Stickney WRP (world largest)

Ammonia sensor  Dissolved Oxygen sensor
Objectives and Challenges

• Objectives:
  – Protect the health and safety of the public, protect the quality of the water supply source (Lake Michigan), improve the quality of water in water-courses, protect businesses and homes from flood damages;

• Challenges:
  – Complex system (CWS, WRP, CSO, lake, dame, ….)
  – Systems built many years ago (from 1930’s to 60’s)
  – Difficult to meet new regulations and standards (e.g., ammonia, water effluent)

• What we can contribute
  – Real time sensor system, decision optimization
Other Projects

- BlueSense
- BlueSky
- WiFace
HARDWARES
Theoretical Studies

• Algorithm Design and Analysis of Practical Questions
  – Wireless ad hoc networks
  – Wireless sensor networks
  – RFID
  – Cognitive networks
  – **Online optimization (little regret)**
  – Computational geometry
  – Game theory and its applications
  – Information theory (such asymptotical behavior of large scale networks)
Where do we publish?

• Journals
  – IEEE/ACM Transactions on Networking, TPDS, Computers, JSAC, and so on
  – ACM Transactions, and so on

• Conferences
  – ACM MobiCom, ACM Mobihoc, ACM STOC, ACM SODA, ACM EC
  – IEEE INFOCOM, ICNP, ICDCS, and so on

• Well recognized and accepted in the community
Where do our students go?

• Graduated students (7 PhDs)
  – (4) Faculty at North Carolina Charlotte, Washington State University, Minnesota State University, BUPT (China)
  – Researcher at Google,
  – Game designer and truck industry
  – Financial industry
What kind of students needed?

• Students:
  – Programming on sensors, cognitive radio networks (CS), or
  – Theoretical performance studies (math), or
  – Hardware design and integration (EE)

  – Need hardworking and dedicated

  – Background in CS, or math, or EE, or some other engineering area
Contact

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