Coverage and Detection in Wireless Sensor Networks

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Alina Olteanu
Spiru Haret University

Outline

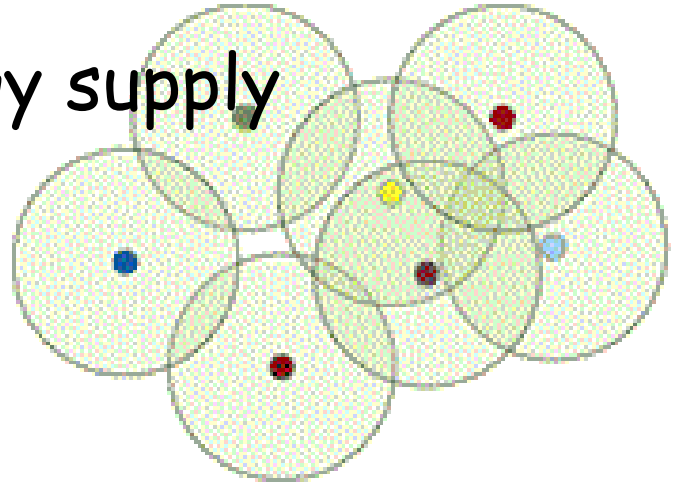
- Intrusion detection in WSN
  - Background & Motivation
  - Main Results
- Current and Future Work
  - Mobile Sensor Networks
  - Bio-inspired approaches
    - Coverage and intrusion detection

Intrusion detection in Wireless Sensor Networks

Retrieved from: http://www.defence-industries.com

Motivation

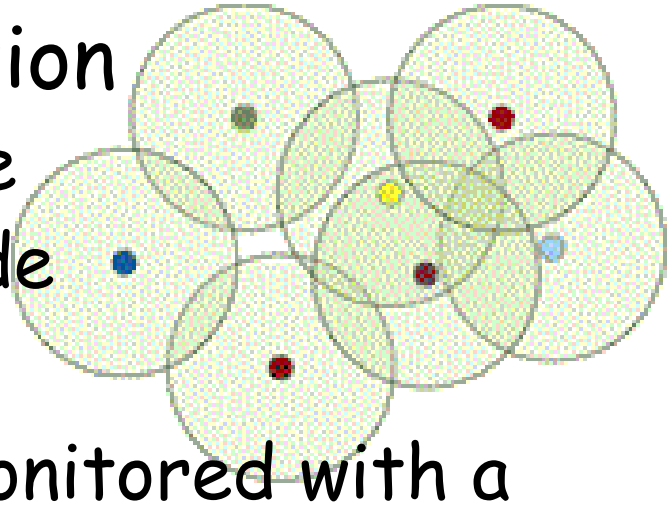
- WSN applications
  - efficient surveillance, civil, military fields
  - detection of intrusion events
- Sensor nodes
  - limited in terms of energy supply
  - high density
  - high redundancy



Retrieved from http://www.ams.org/news

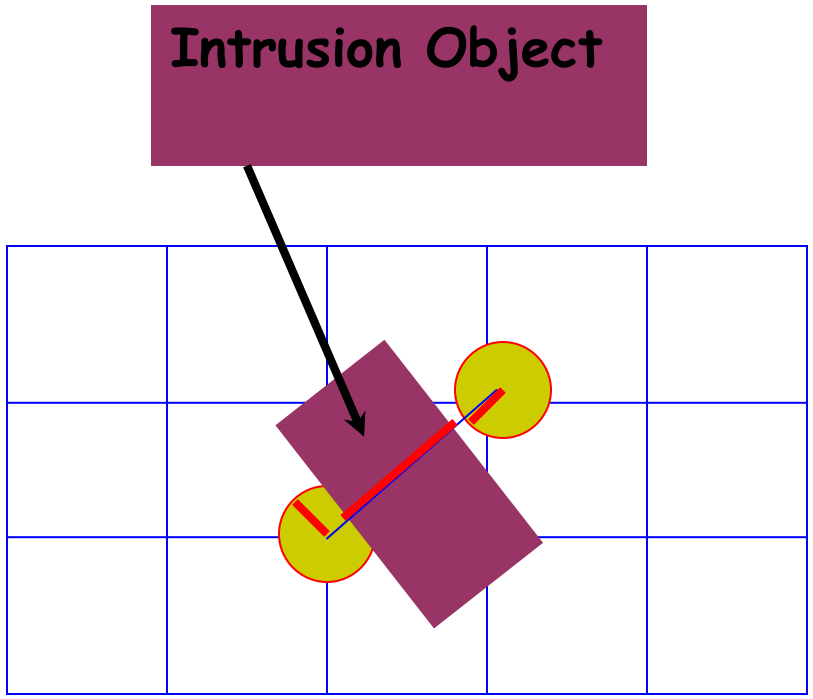
Optimization problems

- Minimize energy consumption
  - put sensors into sleep mode
  - other sensors in active mode
- State-of-the-art models
  - *each point* in the field is monitored with a certain probability at any time instance
  - size and shape of intrusion object
    - detection probability, # of sensors, area to be covered



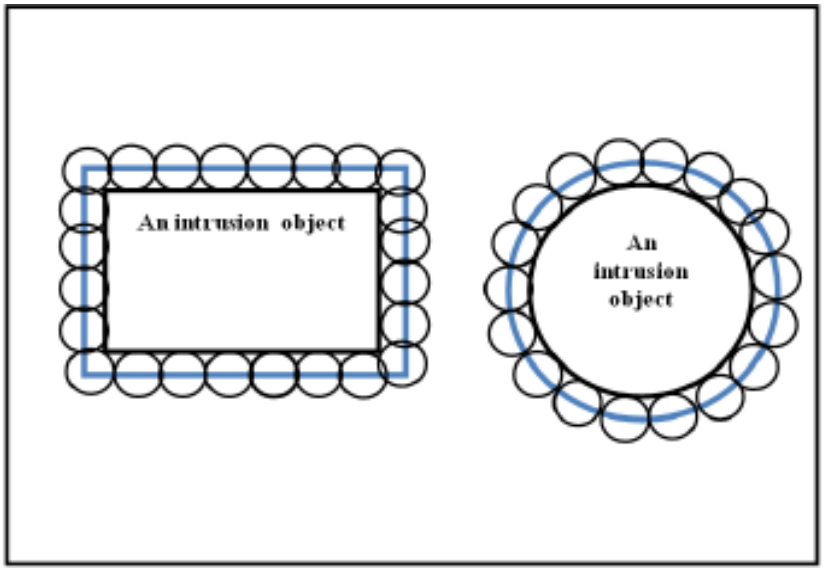
Rectangle Intrusion Object

- divide the area into squares
- diameter of each square "cell"
  - smaller than length of intrusion object + sensor radiuses



Probabilistic methods for detecting intrusion

- *p* – probability that a random sensor's area overlaps the area of an intrusion object
- *p = (area obj + "shadow") / total area to be covered*
- Detection probability



Maximizing Network Lifetime

- Maximize # of subsets of sensors
- QoS constaints
  - desired detection prob.
  - # of sensors
  - intruder size

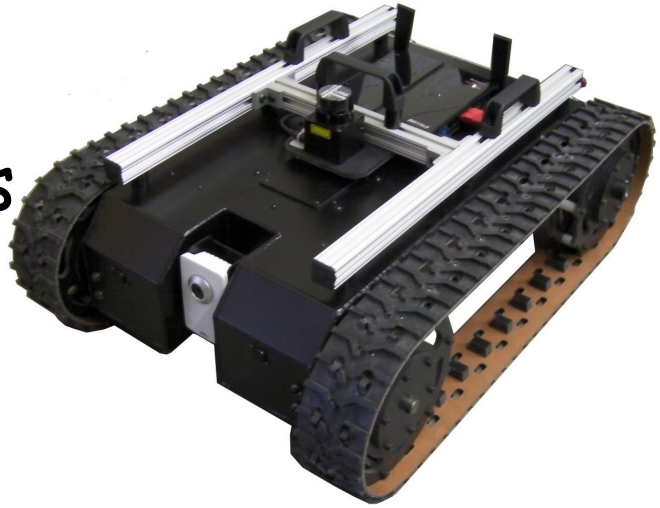
Retrieved from: http://blogs.princeton.edu/itsacademic/

Implications & Related Work

- How to build an effective sensor network
  - Detect large objects
  - Small number of active sensors
- Deterministic deployment strategies
  - # of sensors / detection probability
- Intrusion detection of 3D objects

Current & Future work

- Mobile and robotic sensors
  - Newer sensor nodes
  - Ability to relocate
- Efficient patrolling strategies
  - Wireless interference
  - Effective communication
  - Mobility



Retrieved from: www.superdroidrobots.com

Mobile sensors

- Monitoring large/complex areas
  - Group formation
  - Efficiency vs. interference
- Bio-inspired approaches
  - Primate behavior
  - Rhesus macaques
    - Large groups
  - Titi monkeys
    - Small groups

Mobile sensors

- Intuitively
  - Large groups
    - Efficient coverage
    - Detection time
  - Small groups
    - Successful transmission probability
- Analytical results
  - One or more intruders
  - Interference constraints

Conclusion

- Static sensor networks
  - Maximizing network lifetime
    - Detection of 2D intrusion objects
    - Nr. of sensor nodes
    - Detection probability
- Mobile sensor networks
  - Bio-inspired approaches
    - Primate behavior
    - Efficient patrolling and communication

Thank you!