Wireless Sensor Networks (2023)

Mini-Project Proposals

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Mini-project 1: Sensor data collection and aggregation

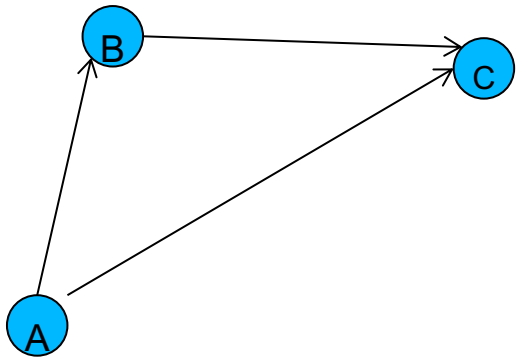
- Collect the sensor data, e.g., temperature and light, through a multi-hop network
- Create sensor data following certain distribution.
- Send periodic sensor data report or send detected event, e.g., temperature exceeding a threshold
- The intermediate nodes can perform data aggregation whenever possible
  - Compare with and without data aggregation
- Data visualization at the sink
  - Real-time data visualization at the sink [Optional]
- Evaluate the performance of the designed system, e.g., event detection probability, energy efficiency, etc.

Mini-project 2: Performance Study of ContikiMAC protocol in WSNs

- Study ContikiMAC
  - Adam Dunkels, “The ContikiMAC Radio Duty Cycling Protocol”, http://www.dunkels.com/adam/dunkels11contikimac.pdf
  - Understand the differences between ContikiMAC and the basic CSMA MAC.
- Verify the key functionalities of ContikiMAC, e.g.,
  - Fast Sleep
- Measure energy consumption of different operations in ContikiMAC and basic CSMA
  - Wake up, fast sleep, transmission and reception
- Evaluate the performance of ContikiMAC (e.g., energy consumption, access latency, throughput) through experimental results.

Mini-project 3:
Design a relay protocol: To hop or not to hop

- Node A needs to transmit packets to node C, varying node C's position in different scenarios. Node C is occasionally at a location where it could suffer deep fading and is not able receive the packets from A.
- Therefore, there is a motivation to get assistant from a relay node B.
- The advantage with a relay node is that it can increase the successful reception rate at node C but on the expense of extra energy at node B.



Mini-project 3(cont.)

- The project is to design a relaying protocol by yourself, i.e.
  - The protocol should decide when the relay node should relay the packets
  - How the ARQ should work
- Evaluate the designed relaying protocol in terms of total energy consumption and packet reception rate

- Set packet size 128 Bytes, Ptx=-25 dBm, node A sends the packets.
- Let node B at position in the middle between node A and node C. Let node C be at different positions to create different packet reception rate at node C.
  - Or you could deliberately let node C discard certain percentage packets to emulate packet loss at node C

Mini-project 4: Study Encrypted Sensor Data Communication

- Study AES (Advanced Encryption Standard)
- Encrypt sensor data using Contiki built-in AES and transmit the data from the source to the sink.
- Evaluate the cost of encryption in terms of processing time, memory footprint and energy, compare with the cost just transmitting plaintext sensor data

- Due to interference or channel fading, bit errors could occur in the received packets. To successfully decrypt the data, retransmission or forward error control is needed.
- Evaluate the cost of encrypted data communication vs. plaintext data communication under bit errors

- Note: You can focus on the cost of encryption, as the decryption can be done by PC or more powerful server

Mini-project 5:
Time-series data compression in WSNs

- Download a time-series sensor dataset from Internet, e.g., a small ECG dataset from https://physionet.org/.
- Load the dataset in the TelosB mote

- Basic requirement:
  - Apply a lossy or lossless compression algorithm
  - Transmit the block-wise compressed data to the sink
  - The sink reconstructs the time-series data (the sink can be a laptop)
  - Analyze the energy consumption with w/o compression.

- Advanced study:
  - Design and implement a compression solution that is appropriate for WSNs applications
  - Compare different compression design choices in terms of computational cost and recovered sensor data quality

Mini-project 5:
Time-series data compression in WSNs

- Ref.
  1. ECG signal compression algorithm (Lossy): “Lightweight electrocardiogram signal compression”, Biomedical Signal Processing and Control, Vol 85, 2023, https://www.sciencedirect.com/science/article/pii/S1746809423004457
  2. Sprintz: Time Series Compression for the Internet of Things (Lossless) https://arxiv.org/abs/1808.02515

Mini-project 6: Open proposal

- Welcome to propose your own project
- Send the proposal to qz@ece.au.dk , including
  - Project motivation and objectives
  - Brief project plan
- If the proposal gets approval, you can start!

Group registration & Project selection:

- 3-5 students per group
- Register group info at the link here by **13/9** including
  - Choosing group name, e.g., SenCom…
  - Student **full names**, **Student IDs**
  - Selected project with preference