Wireless Sensor Networks in the Area of Medical Informatics

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Overview

Wireless Sensor Networks (WSN) consist of wireless sensors nodes and one or more base stations, known as data-sinks, which gather the data collected by the nodes. WSNs are currently at the center of many research projects in a range of application areas including industrial and environmental monitoring, agriculture, medicine and defense.
While most of the current research in WSNs is concerned with the challenges posed by the scalability of very large networks, this research will focus on small networks to be used in the medical field where performance & reliability assurances are required.

Wireless Sensor Networks

- Overview
  - Networks of autonomous miniature devices with computational, sensing and wireless communication capabilities known as **Nodes** or **Motes**
- Characteristics
  - Low cost, low maintenance
  - Energy-efficient
  - Small form factor, unobtrusive
- Applications
  - Industrial and environmental monitoring, agriculture, medicine...

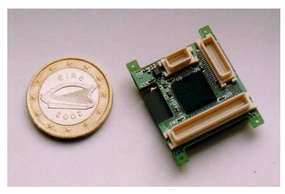

Fig 1: A UCC DSYS25 node

Fig 2: A UC Berkeley MICAz node

- Research Challenges
  - Coordinate small number of sensors to detect medical emergencies in a low latency manner
  - Use actuators to mitigate the effects of the emergency condition
  - Safety, security and energy-efficiency

Goals

- Perform a survey of related literature
- Devise suitable models for Data Delivery in WSNs
- Develop hypotheses and protocols to improve WSN reliability and performance
- Test theories and models using WSN
- Reduce unpredictability of communication in WSNs

State of the Art

- CodeBlue[1] system from Harvard University
  - Development of sensors including Wireless pulse oximeter and Wireless two-lead EKG.
  - Scalable software infrastructure for wireless medical devices

Fig 3: CodeBlue used in emergency response

Work in Progress

Existing Work

- Transmitter-Receiver Rendezvous
  - Radio has 4 states: Listening, Receiving, Transmitting & Sleeping
  - Sleep state has lowest power consumption ⇒ Increase sleep time to increase energy-efficiency
  - Communication cannot occur between two radios if either is in sleep state ⇒ Synchronisation method required
- Framelets[2]
  - Energy-efficient technique for Transmitter-Receiver Rendezvous used by DSYS25 platform
  - Receiver uses **Duty-Cycle**, switching regularly between sleep & listen
  - Sender uses precisely timed repeated transmissions of small fixed length "Framelets" to ensure receiver is listening for at least one framelet

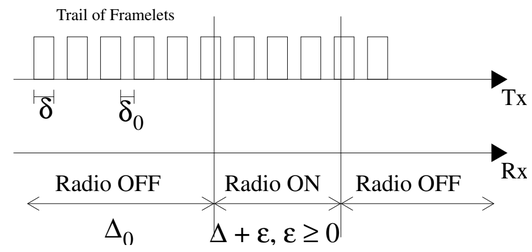

Fig 4: Framelet Approach

Current Work

- Modify Framelet Approach to be more reliable & robust
  - Determine reliability of channel and connection between nodes
  - Take measures to compensate for poor or unreliable connection
  - Possible measures include extending duty cycle or resending messages

Sponsors & References

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1. CodeBlue: Wireless Sensor Networks for Medical Care, http://www.eecs.harvard.edu/ mdw/proj/codeblue/
2. Andre Barroso, Utz Roedig, and Cormac J. Sreenan. Use of Framelets for Efficient Transmitter-Receiver Rendezvous in Wireless Sensor Networks. In Fifth International IEEE Workshop on Wireless Local Networks (WLN2005), Sydney, Australia, IEEE Computer Society Press, November 2005