CSC714: Real Time Computer Systems
Project Proposal

Team Members:

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Title:

Study fault-tolerance RF communication in multi-hop routing environments, develop robust dynamic re-routing software architecture by combination of LEGO / RCX kits and Motes

This aim of this project is to do a fault tolerance analysis of a multi-hop routing environment and propose an algorithm for the same. Specifically, we aim at the following aspects of sensor networks:

Abstract:

Sensor networks are very common in areas like environment monitoring, system monitoring, etc. Lot of research work has been done in proposing routing algorithms in multi-hop sensor networks. The main disadvantage of multi-hop sensor networks is that the overall power consumption increases in the sparse network due to large distance transmission. Also there can be several retransmission due to increase in transmission errors. Data mule is an approach to reduce these issues in case of sparse sensor networks.

Data mule is a mobile agent which travels around the network along a fixed path and communicates with each sensor nodes, gathers data from these nodes and delivers to the gateway system (which can be a computer). In this case, the sensor nodes need not do long range transmission and save power considerably. The data mule approach itself has its own drawbacks such as increased latency in gathering data at the central gateway and estimating the optimal path to move around in the network.

We aim to combine the advantages of the two approaches. Instead of having an entirely multi-hop network or entire sparse / unconnected group of motes which convey data through data mule, we propose a clustered sparse network, comprising of islands of sensor networks. A cluster / island of sensors in themselves is a multi-hop sensor network. We aim to propose a fault-tolerant multi-hop routing algorithm that can be used within each cluster. At this level, the data mule moves around in the network and communicates only with the “group-leader” of each cluster. The data mule itself becomes a solution for fault tolerance when the fault-tolerant algorithm reaches its limits because of physical constraints. When network isolation is detected, data mule can be used to consider the isolated network as a new island of sensors and start moving to three networks instead of two island of network.

Our Approach:

- Design and implement a multi-hop sensor network
  - Each network consists of multiple motes
  - One mote acts as "group leader" for the clustered network
  - All motes forward their data to the group leader through multi-hopping
- Study and analyze existing fault tolerant algorithms for wireless sensor networks
  - In case one of the motes fails, the algorithm should dynamically re-route the packets and inform all other motes of the change
  - If the group-leader itself fails, the algorithm should elect a new group leader and inform all motes of this change
- Study existing work on data mules in the sensor network and design a data mule with RCX kit and sensor network using motes.
  - The data mule should be capable of moving around in the network as per instruction given by central coordinator / gateway
  - It communicates with the group leader of each island.
  - In case where the fault tolerant algorithm fails, the data mule bridges the isolated sensor(s).

Work Distribution:

Team member #1 and #2: Work on designing and building basic data mule for sensor network using RCX and Motes.

Team member #3: Analyze, design and build multi-hop sensor network using motes and perform evaluation of different OS like Contiki and MantisOS to build multi-hop sensor network. Also design fault tolerance algorithm to detect network isolation and to use data mule to treat isolated networks as separate multi-hop sensor network.

References:

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4. Contiki - a Lightweight and Flexible Operating System for Tiny Networked Sensors by Adam Dunkels, Bjorn Gronvall, Thiemo Voigt (http://www.sics.se/~adam/dunkels04contiki.pdf)
5. MANTIS OS: An Embedded Multithreaded Operating System for Wireless Micro Sensor Platforms by Shah Bhatti, James Carlson, Hui Dai, Jing Deng, Jeff Rose, Anmol Sheth, Brian Shucker, Charles Gruenwald, Adam Torgerson, Richard Han (http://www.cs.colorado.edu/~rhan/Papers/MANTIS-MONET.external.pdf)