COLLEGE OF ENGINEERING, UC BERKELEY

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TEAM FOR RESEARCH IN UBIQUITOUS SECURE TECHNOLOGY

SUPERB-IT 2006

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Empirical Robustness Analysis of Wireless Connectivity in Sensor Network Deployments

Tonmoy Bhattacharjee, Electrical Engineering, SUNY at Stony Brook
Graduate Mentor: Phoebus Chen, ***Supervisor***: Dr. J. Mikael Eklund
Faculty Advisor: Prof. Shankar Sastry

Abstract

Health care is a prospective area for using low power, wireless sensors. Elderly people can ask for remote assistance with the help of wireless sensor networks and stay at home with comfort and added security. The purpose of my project is to empirically analyze the wireless connectivity in sensor network deployments. Besides the connectivity issue, I also provide some general guidelines for deploying sensors in a typical household setting. To analyze the wireless connectivity, I observe the variation in connectivity of the nodes with the change of the radio frequency power level in the nodes (sensor motes), the link quality of the nodes, the packet reception rate and the yield for each node. Along the way, I choose different deployment patterns such as triangular, rectangular, square, random and perform experiments to see variations in the parameters.

Motivation

- Sensors need to track down the activities of the elderly people properly
- Too many sensors can cause traffic congestion in the network but too few sensors may not provide full coverage of the sensing region
- Optimal number of sensors are needed to collect data, process them and send alerts whenever needed
- Reduce cost and minimize power consumption
- Provide technicians with some guidelines about deploying sensors in a household setting

Fig 1: tmote sky wireless sensor module

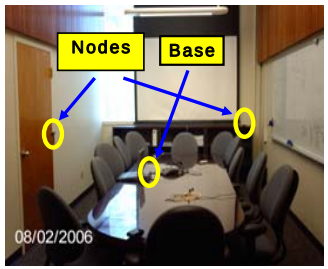

Fig 2: View of the experimentation room

Method

- Worked with the TinyOS platform and modified Surge program
- Deployed sensors in **Triangular, Rectangular, Square** and some other random patterns in a 7.087m X 3.29m room [Fig. 3]
- Recorded Link Quality Indication (LQI), yield, sequence number and node ID for each node for 100-120 messages
- Calculated packet reception rate of each node from corresponding sequence numbers
- Set radio frequency power level to 3 for each node and performed the experiments

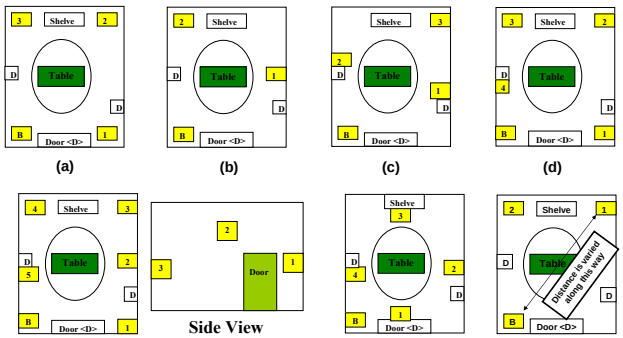

Fig 3: Top View of sensor deployment patterns: (a) Rectangular (b) Triangular (c) Parallelogram (d) and (e) Rectangular (f) Random (g) Right triangle

**(B – Base Station) , (1, 2, 3, 4, 5 – Node IDs)

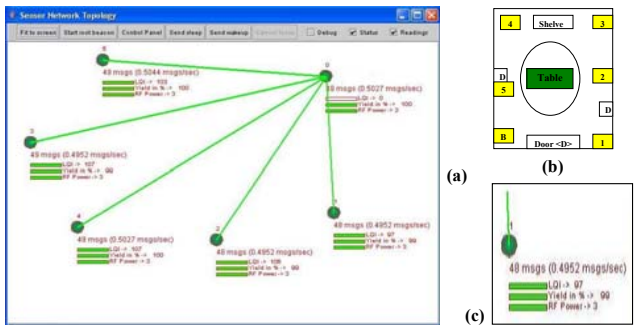

Fig 4: (a) Surge GUI and corresponding (b) Rectangular deployment pattern (Top View) (c) Large view of node 1 from Surge GUI

Results

- In a hall way, a node has a maximum transmission range of ≈11m (RF = 3)
  - The current consumption at RF power level 3 is almost half the current consumption at the full power level (31)
- In fig. 3(g) at the middle of the room node 1 had a good yield (>95%) and acceptable avg. LQI (90-99) [Fig. 5(a)]. At the far end, 1 had avg. LQI of ≈85 with a yield of ≈85-90%
- In fig. 3(b) node 2 had ≈80% avg. yield but good LQI (100-110) with the presence of a person walking around the room [Fig. 5(b)]
- In fig. 3(c) when two foam boards were placed in front of node 2 and 3, all 3 nodes had good yield while node 3 had a lower LQI compared to the other 2 nodes

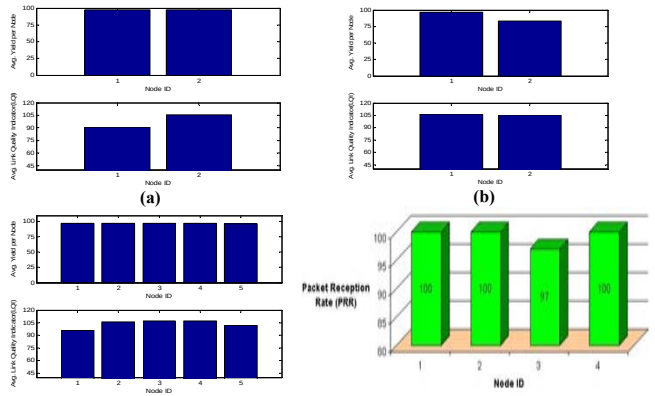

Fig 5: (a), (b) and (c) Avg. LQI and yield (d) Packet reception rate with node IDs for deployment pattern in Fig. 3 (f)

Conclusion and Future Work

From my experiments, it seems that in a typical room the wireless connectivity of sensor nodes does not vary significantly with respect to different deployment patterns.

Future Work :

- Include Received Signal Strength Indicator (RSSI) in the experiments to test the connectivity
- Evaluate sensor deployment patterns proposed by other researchers
- Perform experiments in larger rooms and in residential houses to better understand wireless connectivity and optimal sensor deployments

Acknowledgements

Phoebus Chen, Arsalan Tavakoli, Dr. J. Mikael Eklund, Prof. Shankar Sastry, Prof. Ruzena Bajcsy, Sonny Hernandez, Kaseima Frye, Jamie Lauren Webb, Jocelyn Adams, Jessica Jimenez, all other TRUST mentors, all other SUPERB students, all SUPERB staff, family, friends and www.moteiv.com

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