Experimental Study of Link Quality Distribution in Sensor Network Deployment for Building Environment

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ABSTRACT: Monitoring and automatic control of building environment is a crucial application of wireless sensor network (WSN) in which maximizing network lifetime is a key challenge. The link quality distribution in a single floor of an indoor building environment is investigated experimentally to obtain a full coverage map. The results indicate a broad transitional region between 15 to 30m from the hub, and confirm that the transitional region is of particular concern in wireless sensor network since it accommodates high variance unreliable links. The poor link quality in the transitional region may be attributed to the many obstacles within the radio path including concrete element, brick walls, plasterboard partitions, office furniture and other items that either absorbs or reflects these radio waves leading to signal loss or multi-path effects.

1 INTRODUCTION

Environmental monitoring is considered as one of the principle applications for sensor networks today (Schmid (2006)). One of the earliest known environmental applications of sensor networks is in ecological habitat monitoring. A team from University of California Berkeley (Mainwaring et.al (2002), Szewczyk et.al (2004a) Szewczyk et.al (2004b)), utilised a wireless sensor network to observe birds on an island, using a base station connected over the web via a satellite communication link. This kind of “unattended” monitoring minimizes disruption to the objects of study by an observer walking around the island to collect data.

A sensor network is a computer network of many, spatially distributed devices using sensors to monitor environmental parameters such as temperature, sound, vibration, pressure, motion or pollutants at different locations. These devices are usually small and inexpensive, so that they can be produced and deployed in large numbers, and their resources in terms of energy, memory, computational speed and bandwidth are severely constrained. Various research problems of sensor networks such as data aggregation or fusion (Boulis et.al (2003), Cayirci (2003)), packet size optimisation (Sankarasubramaniam et.al (2003)), cluster formation (Halgamuge et.al (2003), Halgamuge (2003)), target localisation (Zou and Chakrabarty (2003)), battery management (Halgamuge (2007)), network protocols (Heinzelman and Chandrakasan (2002), Intanagonwiwat et.al (2000), Ye et.al (2002)) are discussed in the literature with respect to crucial energy limitations.

Halgamuge (2007) investigated efficient battery management for sensor life and reported guidelines for efficient and reliable sensor network design (Halgamuge et.al (2009)). Commercial radio technology has advanced and commercial standards such as Bluetooth, developed by the Bluetooth (2009) consortium, have started to appear. Ad hoc networks have been gaining popularity for military, space, biomedical and manufacturing applications in recent years because their easy deployment and lack of infrastructure requirements. Unlike cellular wireless networks, ad hoc wireless networks do not need any fixed communication infrastructure. Three main networking protocols are known in wireless communications: direct communication, multi-hop communication and clustering. The routes can be single or multi-hop and the nodes which may be heterogeneous and communicate via packet radio.

The heterogeneity of the nodes would allow some nodes to be servers and others to be clients. The ability of an ad hoc node to act as a server or service provider will depend on its energy, memory and computational capacities. Each node should estimate its own battery life before committing to a task. Even relaying packets for others may result in deteriorating its own limited battery power, and the node may not accept the task when it is devoted to another important activity.

There is a fundamental, incompatible feature between computer simulation and experimental evalua-