CS222 Project Proposal
Data Compression on Wireless Sensor Networks

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1 Introduction

Wireless Sensor Networks present a unique computing environment due to their limited resources. Many traditionally accepted paradigms must be reexamined in this new context. One important contraint is energy, which often requires reengineering of old techniques to meet the new energy requirements. Compression is an example of such a technique. Most compression schemes were designed with performance and compression ratios as the primary metrics of success. Rarely was energy efficiency a metric in the design of such schemes. In Wireless Sensor Networks, energy efficiency is vital and any compression implementation must be tested for energy efficiency as well as performance and compression ratios.

We propose to implement several compression schemes on a wireless sensor mote. We will test the energy efficiency, as well as compression and performance, directly on the mote. These experiments will tell us how feasable it would be to use traditional compression schemes in Wireless Sensor Networks. We will determine which schemes are the most energy efficient, or if new compression schemes must be designed with energy efficiency in mind. Due to sensor motes' limied memory resources, we will also determine if it is possible to implement these compression schemes on such small memory devices.

2 Related Work

Many papers in the Wireless Sensor Network field deal with compression on the side rather than as the primary focus [2][3]. Xu et al. [3] mention compression and briefly describe a wavelet compression scheme, but never implement it on a mote. This scheme transmits wavelet compressed (lossy) data, but stores the raw uncompressed data in flash. They also propose quantization and thresholding as a simple way to achieve lossy compression. These techniques might be well suited for Wireless Sensor Networks, but this is not the primary focus of their paper.

Mainwaring et al. [2] also mention compression in their paper as a side note. They state that compression is a trade off between the cost of data processing and the cost of data transmission. We believe this is the right approach when examining compression schemes on motes. They present anecdotal evidence that was obtained using compression schemes run on Unix. They compare various resolutions of data, delta encoding, Huffman encoding, gzip, and bzip2. Although these results are a good first step, they never implement any of these algorithms on a mote and do not measure the energy cost of these algorithms.

Barr et al. [1] perform a thorough energy analysis of several compression schemes. This analysis would be applicable to Wireless Wensor Networks if they performed their experiments on mote class devices. Instead they use a StrongARM/Linux based platform with an 802.11 wireless interface. We intend to mimic the type of analyis that these authors performed, on a mote class device, with a TinyOS implementation of the compression schemes studied. In addition, these authors used data from the Calgary Corpus. This corpus contains many english texts and is not representative of the type of data encountered in Wireless Sensor Networks. We will use a more appropriate corpus for our experiments.

3 Proposed Approach

First we will implement the LZ77 [4] compression algorithm in TinyOS. This type of sliding window algorithm is well suited for the low memory constraints of a sensor mote. Implementing this algorithm on such a small memory will be an important challenge and one of the goals of this project. We will investigate the energy efficiency of LZ77 while changing the window size in order to find an optimal window size within the limited memory constraints.

Using sensor data obtained through previous experiments, we will run experiments to determine the cost of compressing away one bit of information. Due to the multi-hop nature of many wireless sensor networks, we believe that the cost of compressing one bit will be amortized over many hops. The one bit compression cost will help determine the optimal routing tree depth in terms of reducing compression cost.

Once we have finished implementing LZ77 we will investigate if other popular compression schemes are suitable for implementation on motes. If so, we will implement them as we did LZ77 and perform the same type of energy analysis.

4 Resources

We will need at least two tMote Sky devices and the TinyOS toolchain. We have these devices and tools available and the experience necessary to work with this platform. We might also want to run experiments on MoteLab, which is a 184 mote platform available to us. We will also need a tool to measure the energy expended by the motes, which we also have available.

References

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