An Efficient and Robust Lossless Compression Scheme for Wireless Sensor Networks

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Abstract

In wireless sensor networks (WSNs), a large number of tiny, inexpensive and computable sensor nodes are usually deployed randomly to monitor one or more physical phenomena. The sensor nodes collect and process the sensed data and send the data to the sink wirelessly. However, WSNs have limitations such as tight energy budgets, limited radio bandwidth, limited memory, limited computational capability, limited packet size and high packet loss rates. These constrains are important issues when designing compression schemes for WSNs. Data compression is one important tool that can maximize data return over unreliable and low rate radio links. Thus, due to the unreliable nature of the radio links in WSNs that result in packet losses, it is therefore very critical to propose a data compression scheme that is very robust to packet losses. In this paper, we propose a block based approach which allows each block of source data to be encoded independently to ensure unique decodability at the sink, thus leading to an efficient and robust lossless compression scheme for WSNs. Simulation results using various real-world sensor datasets show that a maximum percentage energy saving of 29.29% was achieved by our proposed scheme. In addition, although the compression performance of our proposed scheme is comparable with those of LEC, it is however 200% as efficient as S-LZW.

Keywords: Energy Efficiency, Huffman Coding, Lossless Compression, Signal Processing, Wireless Sensor Networks.

1. Introduction

Wireless sensor networks (WSNs) is a cooperative network of small sized, inexpensive, computable and battery-operated wireless sensor nodes which are usually deployed randomly in large numbers to monitor one or more phenomena (Liao & Yang, 2012 Villas et al, 2012).

The nodes monitor their surroundings for local data and forward the gathered data to the sink node using direct or multi-hop communication. The sink node then processes all the received data from several source nodes and reports them to a monitoring facility. This network architecture allows a number of applications in areas such as industrial, environmental, military and medical (Kolo, Shanmugam, Lim, Ang, & Seng, 2013; Villas et al., 2012).

WSNs are highly energy-constrained because the sensor nodes are battery-operated. Other limitations of WSNs include limited memory, limited radio bandwidth, limited computational capability, high packet loss rates and limited packet size. Data communication among sensor