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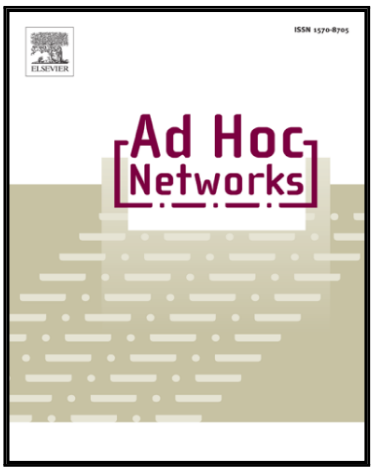

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A New Lossless Neighborhood Indexing Sequence (NIS) Algorithm for Data Compression in Wireless Sensor Networks

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Abstract

In the recent years, wireless sensor networks (WSN) has been deployed in different real time applications. Energy efficiency is the critical issue in the design and deployment of WSN since the sensor nodes are powered by batteries with limited capacity. As data transmission is the main power consuming process in WSN, several energy efficient techniques have been proposed. Data compression is a popular energy efficient technique which helps to reduce the amount of data to be transmitted in the network resulting in significant power saving. This paper proposes a new algorithm called Neighborhood Indexing Sequence (NIS) for data compression in WSN. The proposed NIS algorithm dynamically assigns shorter length codewords to each character in the input sequence by exploiting the occurrence of neighboring bits. Using the real world WSN dataset, it is shown that the compression performance of the NIS algorithm is superior to existing compression algorithms. Compared with existing methods, the proposed compression algorithm is not only efficient but also highly robust for different WSN dataset. The proposed algorithm attains a compression ratio of 89.13 with the bit rate of 1.74 per sample. Moreover, it achieved power savings up to 87.57% for the applied WSN dataset.

Keywords: Character encoding; Data compression; Energy efficiency; Wireless sensor networks; Robustness

1. Introduction

Recent advancements in the field of Micro Electro Mechanical System (MEMS) and information technology enabled the development of low cost, low power, compact and autonomous sensor nodes. Wireless Sensor Networks (WSN) is an integral part of IoT; it makes billions of devices to share data for improving the environmental user control [1]. It is a kind of adhoc network, consists of numerous sensor nodes and is deeply embedded into the real world to monitor the environmental conditions. It is highly suitable for tracking and data gathering applications like environmental monitoring, industrial automation, object tracking, precision agriculture, disaster management, smart cities, health monitoring, seismic and structural monitoring, and so on [2]. In real scenario, it is used to sense physical parameters like temperature, pressure, humidity, vibration, acoustic signals, etc. [3]. Every individual sensor node is equipped with battery, transceivers, sensors and microcontroller. After the random node deployment, the sensor node senses the physical parameters and transmits the sensed data to base station directly or via multihop communication [4]. The sensor nodes are constrained in energy, bandwidth, memory, computational capability, packet size and lack of fidelity. Due to limited inbuilt battery, one of the greatest challenges in the design of WSN is the energy consumption. The deployment of sensor nodes in harsh environment makes it difficult or impossible to recharge or replace inbuilt batteries [5]. Several researchers reported that large amount of energy is spent for data transmission when compared to sensing and processing operations [6]. So, an energy efficient data transmission strategy is essential to conserve the available energy efficiently.

Data compression is an effective technique to lessen the amount of data needs to be communicated before transmission. [7] reported that saving a byte of data using compression has been shown to worth spending between four thousand (using Chipcon CC2420 transceiver) to two million (using MaxStream XTend transceiver) cycles of computation. The reduction in data size being exchanged in the network will results in significant power saving. Thus, compressing data in prior to transmission is one of the important strategies for energy-efficient WSNs. The basic idea behind data compression is the process of eliminating redundant and irrelevant data. It represents the data in its compact form without negotiating the data quality to a certain extent. Since textual data is highly available in WSN dataset, the loss of information is not desirable and lossless compression technique is preferable. For instance, the numeral characters in the temperature and humidity measurements, alphabets in the seismic and real time data are highly sensitive to the loss of information. The need of efficient and robust lossless compression technique for WSN dataset motivated us to perform this study.

This paper aims to provide a simple and efficient lossless compression scheme called Neighborhood Indexing Sequence (NIS) algorithm for WSN. The proposed algorithm exploits the neighborhood information based on a new procedure called "traversing data based on 0's and 1's". Using this procedure, NIS algorithm produces a shorter length codewords for every individual character in the input sequence. Since the sensor nodes have

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