A Survey on an Optimal Data Compression Scheme & Enhanced Security techniques in Clustered Wireless Sensor Network

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Abstract: One of the main issues with the wireless sensor network is its data transmission rate. Latest technology of compressive sensing (CS) is a main research area under development. Compressive Sensing (CS) will reduce the rate of data transmissions and it can balance the traffic load along the whole networks. After all, while using the pure compressive sensing the total number of transmissions for data collection will be high. Inorder to cut short the rate of transmissions in sensor networks, hybrid method of Compressive Sensing (CS) is used. A light weight Enhanced Lossless Entropy Compression algorithm is used minimizing the amount data in sensor network. The major concern is security in WSN, So an advanced SET-IBS protocol is used to make the data efficient and more secure. This light weight algorithm will consumes less energy during the encryption and decryption of the data. This encryption takes less energy and therefore it is helpful to make the WSN efficient. In this survey, main focus is on optimization of energy in terms of lightweight security and compression techniques which reduces the complexity of Wireless Sensor network.

Keywords: Compressive Sensing, Lossless entropy Compression, Wireless Sensor Network ,Cluster Head, Base Station, SET-IBS protocol, Bit Error Rate

INTRODUCTION

Wireless Sensor Network mainly focus on monitoring the physical conditions with a number of sensor nodes. The sensors/actor nodes which are present have limited resources with respect to power, processing and computing, also the size must be small as possible so that the nodes can have enough number of applications. This sensors is basically used to observe many physical conditions like temperature, sound, pressure and motion, etc. The main activities of those sensors nodes can be summarize as follows: Sense the environment as well as collect the information of environment. The focus of the research is around the improved quality of communication through Wireless Sensor Networks. The major goal is to achieve the minimum consumption of energy and its optimal use. The WSN has got much attention from various applications, because, it can work on its own without any of the human interventions. The sensor nodes can communicate around a small distance via a wireless medium and collaborate to achieve a common task, for example, environment monitoring, military surveillance, industrial process control, warehouses, malls, tunnels etc.The sensor have different initial energy depending on the power levels. Wireless sensor networks present a series of serious issues that still need research effort. Challenges faced by WSNs are Network lifetime, Scalability, Interconnectivity, Reliability, Heterogeneity, Privacy and Security. To balance the traffic load and reduces the number of data transmissions throughout networks Compressive Sensing CS plays major role(1) (2). However, by using pure compressive sensing the total number of transmissions for data is large. To minimize the number of transmissions in sensor networks the hybrid method of using Compressive Sensing CS is used.

In the proposed research (1) a Hybrid Compressive Sensing which is a clustering method for sensor networks is intervend. The cluster is formed with the combination of sensor nodes, in each cluster, sensor nodes transmit sensed data to the cluster head CH.

A data collection is made as a tree structure and it sends data to CHs and will transmit the data to the sink by using the Compressive Sensing CS. To conclude how much the big cluster size should be is an important problem for the hybrid method. Suppose if the cluster size is too big then the number of transmissions required to collect data from sensor nodes in a cluster to the Cluster Head will be high.

Data compression (6) is a very important and useful technique in the wireless sensor network for conservation of energy. The Data compression technique was considere as a useful approach for reducing the power consumptions of WSN nodes. The advancement in Lossless temporal compression include compression algorithms that is Sequential-Lossless Entropy Compression S-LEC (6) which is used in compressing the sensed data which will improve the Efficient data transmission for WSNs. The Advance Secure and efficient data transmission (7) Advance SET-IBS is mainly focusing on the secured data transmission as well as efficiency in efficient in sensor network communication. By applying the ID-based cryptosystem and the orphan node problem is solved in the secure transmission protocols with the symmetric key management systems in the WSNs.

RELATED WORK

Ruitao Xie and Xiaohua Jia, “Transmission-Efficient Clustering Method for Wireless Sensor Networks Using Compressive Sensing” authors present the analysis on the optimal value of the edge length D of cluster-square and discussions on determining the parameter H in this paper distributed implementations. Finally, provided an additional performance evaluation. It includes the comparison between analytical results and simulation results, the simulations on the non-homogenous networks, and iteration times to converge of the iterative algorithm in our method.

In (2) the Compressive sensing (CS)-based in-network data processing is a promising approach to reduce packet transmission in wireless sensor networks. Existing CS-based data gathering methods require a large number of sensors involved in each CS measurement gathering, leading to the relatively high data transmission cost. In this paper, authors propose a sparsest random scheduling for compressive data gathering scheme, which decreases each measurement transmission cost from O(N) to O(log(N)) without increasing the number of CS measurements as well. In this papers scheme, authors present a sparsest measurement matrix, where each row has only one nonzero entry. To satisfy the restricted isometric property, authors propose a design method for representation basis, which is properly generated according to the sparsest measurement matrix and sensory data. With extensive experiments over real sensory data of CitySee, we demonstrate that our scheme can recover the real sensory data accurately. Surprisingly, our scheme outperforms the dense measurement matrix with a discrete cosine transformation basis over 5 dB on data recovery quality.

Ruobing Jiang, Yanmin Zhu, “Compressive Detection and Localization of Multiple Heterogeneous Events with Sensor Networks” considers the crucial problem of event detection and localization with sensor networks, which not only needs to detect occurrences but also to determine the locations of detected events and event source signals. It is highly challenging when taking several unique characteristics of real-world events into consideration, such as simultaneous emergence of multiple events, overlapping events, event heterogeneity and stringent requirement on energy efficiency. Most of existing studies either assume the oversimplified binary detection model or need to collect all sensor readings, incurring high transmission overhead. Inspired by spatially sparse event occurrences within the monitoring area, authors propose a compressive sensing based approach called CED, targeting at multiple heterogeneous events that may overlap with each other. With a fully distributed measurement construction process, authors approach enables the collection of a sufficient number of measurements for compressive sensing based data recovery. The distinguishing feature of this approach is that it requires no knowledge of, and is adaptive to, the number of occurred events which is changing over time.

In (4) it investigates and compares the performance of wireless sensor networks where sensors operate on the principles of cooperative communications. Authors consider a scenario where the source transmits signals to the destination with the help of L sensors. As the destination has the capacity of processing only U out of these L signals, the strongest U signals are selected, while the remaining (L - U) signals are suppressed. A preprocessing block similar to channel shortening (CS) is proposed in this paper. However, this preprocessing block employs a rank-reduction technique instead of CS. By employing this preprocessing, we are able to decrease the computational complexity of the system without affecting the bit-error-rate (BER) performance. From Authors simulations, it can be shown that these schemes outperform the CS schemes in terms of computational complexity. In addition, the proposed schemes have a superior BER performance as compared with CS schemes when sensors employ fixed-gain amplification. However, for sensors that employ variable-gain amplification, a tradeoff exists in terms of BER performance between the CS scheme and these schemes. These schemes outperform the CS scheme for a lower signal-to-noise ratio.

Megumi Kaneko and Khaldoun Al Agha, "Compressed Sensing Based Protocol for Interfering Data Recovery in Multi-Hop Sensor Networks"consider a multi-hop wireless sensor network that measures sparse events and propose a novel protocol based on Compressed Sensing (CS) as an alternative to traditional Media Access Control (MAC) scheduling and routing protocol. Instead of avoiding collisions, our CS-based protocol exploits interferences by superimposing the data measurements "over-the-air", simultaneously received at any node. Thanks to Author's protocol design, each node is able to recover and forward only new data towards the sink. Author's protocol achieves near zero reconstruction errors at the sink, while greatly reducing overhead and delays compared to conventional methods. These results reveal a new and promising approach to protocol design through CS.

In (7) Secure data transmission is a critical issue for wireless sensor networks (WSNs). Clustering is an effective and practical way to enhance the system performance of WSNs. In this paper, authors study a secure data transmission for cluster-based WSNs (CWSNs), where the clusters are formed dynamically and periodically. Authors propose two Secure and Efficient data Transmission (SET) protocols for CWSNs, called SET-IBS and SET-IBOOS, by using the Identity-Based digital Signature (IBS) scheme and the Identity-Based Online/Offline digital Signature (IBOOS) scheme, respectively. In SET-IBS, security relies on the hardness of the Diffie-Hellman problem in the pairing domain. SET-IBOOS further reduces the computation overhead for protocol security, which is crucial for WSNs, while its security relies on the hardness of the discrete logarithm problem. Authors show the feasibility of the SET-IBS and SET-IBOOS protocols with respect to the security requirements and security analysis against various attacks.

METHODOLOGY

For reducing the number of data transmission,a hybrid compressive sensing CS is used.In this approach the sensors are divided into clusters, each and every cluster is having a cluster head CH which is elected according to the maximum energy present in the batteries of sensor nodes and also the second maximum node is ready for further Cluster Head Selection. The sensed data is retrieved via the sensor nodes, every sensor sends will send the sensed data to the cluster head in the form of tree topology and gather all the data to the cluster Head.

A.Cluster Head Election:

The central point of a cluster area is determined and the sensor node comes closest to this central area will be made as the cluster head. Here the major issue is that the sensor nodes do not know who is the closest to the central point of a cluster area, and do not know if there is a sensor node falling into the close range of the central point, so all the nodes within the range of from the center is considered to be the CH candidates of the cluster where R is the transmission range of sensors. The value of H is determined such that there is at least one node within H hops from the central point of a cluster. To elect the CH, each node broadcasts a CH election message that possess

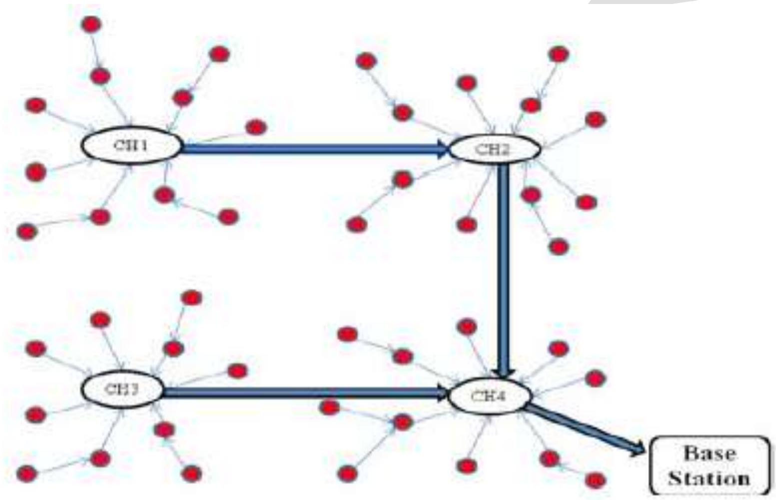

Figure 1: Hybrid Compressive Sensing

its identifier, its location and the identifier of its cluster. Later on the CH election message is propagated not more than 2H hops. After a timeout, the node that has the smallest distance to the centre of the cluster among the other nodes will becomes the CH of the cluster. In the particular case that no sensor node falls within H hops from the central point so that there is no CH for this cluster-area, the nodes in this cluster-area accepts the invitation from neighbouring CHs and will the become members of other clusters. Thus no node will be left out of the network.

B. Sensor Node Clustering

Once the CH is elected, CH will broadcasts an advertisement message to all the other sensor nodes in the sensor field, inorder to invite the sensor nodes to join the cluster. This particular advertisement message consists of the information such as: the identifier and location of the CH, and the number of hop that the message has travelled. The hop count is first set as 0. When a sensor node receives an advertisement message, if the hop count of message is smaller than that recorded from the same CH, it updates the information in its record including the node of previous hop and the number of hop to the CH, and then will broadcasts the message to its neighbouring nodes; otherwise, the message will be discarded. The routing from a sensor node to its CH follows the reverse path in forwarding the advertisement message. The data of sensor nodes within a cluster is collected by this routing tree.

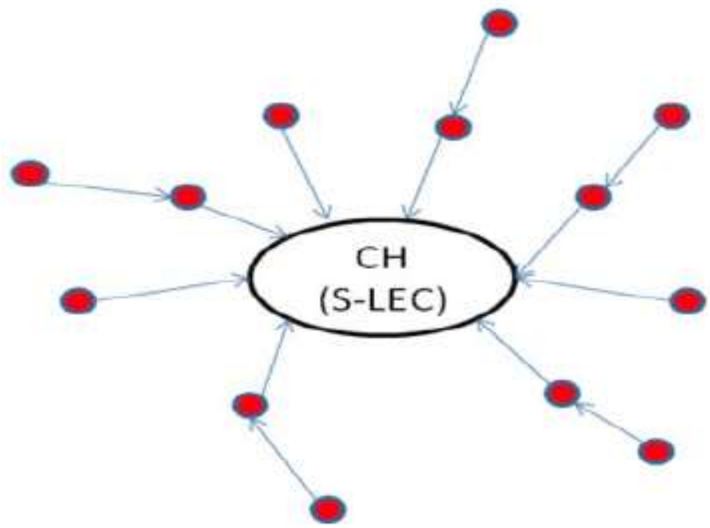

Figure 2:Sequential Lossless Compression

THEORITICAL ANALYSIS

In research (1) the simulations shows that this method can reduce the number of transmissions. When the number of measurements is 10th of the number of nodes in the network, the simulation results show that Hybrid CS method can reduce the number of transmissions by about 60 percent compared with clustering method without using CS. Even for the non-homogenous networks in the irregular sensor field, the Hybrid Compressive Sensing method can significantly reduce the data transmissions compared with the other data collection methods.

In (2) Experiment results shows that the CS based data gathering scheme can recover the sensory data without any errors. The Simulation results also shown this scheme can significantly save energy consumption while comparing with the existing compressive sensing data collection methods.

In research paper (3) presented a compressive sensing based approach inorder for the detection as well as localization of heterogeneous events with the sensor networks. And the distributed measurement construction process has been developed to produce a sufficient number of measurements.

In (4) the performance and complexity of the proposed reduced-rank techniques are superior to the CS technique when deploying the fixed gain amplification factor. However, a trade off can be observed between the complexity and BER performance when the sensors utilize the variable-gain amplification factor.

In (5) to techniques to exploit ”over-the-air” data aggregation which is a routing based on a simple flooding procedure is considered whereby upon packet reception every node broadcasts this packet locally until it reaches the sink. Unlike the single-hop case, there are major issues to be resolved in this multi-hop setting. If each node simply forwards all received packets, the number of superimposed measurements will drastically improve to the poor CS recovery due to loss of sparsity in each packet.

In (6) this comparison results on two different WSN data sets it is interesting fact to know that LEC can perform extremely different depending on the characteristics of WSN data sets. In other case LEC could perform well on Sensor scope WSN relative humidity and temperature measurements that are quite smooth and it performs rather poorly on WSN volcanic data that are very dynamic in nature. Smooth WSN data at Sensor Scope largely satisfy this assumption that LEC can lead to good compression performance. In contrast proposed S-LEC can perform good both in smooth WSN data and dynamic WSN data because of its capability of a high degree of robustness.

In (7) presents the SET protocols are designed for CWSNs with higher efficiency. The SET-IBOOS operates similarly to the previous SET-IBS that operates in rounds during communication and protocol initialization prior to the network deployment.

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