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CLUSTER RESTRUCTURING FOR TRANSMISSION EFFICIENT WSN

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ABSTRACT

Wireless sensor network (WSN) comprises of low cost, large number of small sized resource constrained sensor nodes collecting and transmitting data through multi-hop transmission. In WSN we can view data gathering as a partial realization of spatial process. We observe the data at finite number of locations and the goal is to infer properties of the spatial process which generated the data and to predict the process at unobserved sites. If spatial correlation is present resources are wasted. Due to dense deployment nodes are spatially correlated. If application is long term monitoring then temporal correlation arises. Due to temporal correlation data collected at regular interval vary in a similar way. Both the correlated situations should be avoided. Correlated information lends itself to some form of compression that removes or reduces redundancy. Spatial correlation manifests itself in overall less transmission and temporal correlation manifests less data in each transmission. Limited capability of sensing, processing, communicating and battery operated nature of sensor nodes call for advanced hardware and software solution implementation of the correlated scenario.

KEYWORDS: Wireless Sensor Network (WSN), Compressive Sensing (CS)

INTRODUCTION

Existing approach adopts in-network data compression such as entropy coding or transforms coding to reduce global traffic. But these have significant computation and control overhead is present. Compressive Sensing (CS) provides a new perspective for data gathering problem in a more efficient manner by attempting to reduce sensor data traffic through collecting fewer measurements than the original sensor data. The essential idea of CS is to be able to recover an inherently sparse signal using far fewer samples than what is typically needed for a signal which is not sparse.

Simply applying CS to data gathering without consideration of the structure of WSN leads to more number of packets to be transmitted. Hybrid CS combines routing and can greatly reduce data transmission. Clustering is a well established technique for reducing data collection cost in WSN. Integrating CS with clustering is a well worked upon problem, but clustering along with compression to leverage spatio-temporal correlation in WSN is an open problem

In this work we are working on spatial and temporal correlation in WSN along with compressive sensing. In CS each sensor node measures the data but only random sensors are picked up for measurement according to the theory of CS. Since all are measuring the data resources are being wasted .putting some sensor to sleep as in clustering can help. Literature Survey reveals that if aggregation or tree based routing or clustering is used along with CS. Only aggregating nodes or parent nodes or cluster heads perform compression. In this case the network no longer remains homogeneous. Nodes using compressive sensing have CS encoder in cooperated in hardware. While non CS performing nodes or call them raw nodes do not have so network is not uniform throughout. CS theory at present is designed mainly to exploit intra-signal (temporal correlation) structure at a single sensor. We are exploiting the spatial-temporal correlation/redundancy. Techniques that exploit temporal redundancy do not require additional coordination/communication among sensor in a network. For temporal correlation the sensor nodes hardware is modified with the CS encoder as shown below. For spatial redundancy coordination/communication among sensor is required, which adds to the overhead and communication cost. Battery operated nature of sensor node asks for reduction in this cost. Hence we reduce this overhead cost by modifying the cluster in a WSN.

OBJECTIVES

To apply Compressive sensing on densely deployed sensor node to exploit both spatial and temporal correlation. In long term monitoring applications like, environmental, habitat etc monitoring, temporal correlation exists.

Since sensor nodes are densely deployed the redundancy of sensor nodes results in highly correlated data transmission from nodes due to overlapped sensing regions. The degree of spatial correlation increases with increase in overlapped sensing area between the nodes (i.e. decreasing inter-node distance). Therefore every sensor node observing the event need not be active for sensing and communication. A significant amount of energy saving is possible by taking advantage of spatial correlation. By capturing the spatial correlation of a sensor field we form clusters and apply CS at Cluster head.

METHODOLOGY

In this work we propose to form cluster of nodes sensing similar values within a given threshold i.e. spatial correlation, and apply CS at the cluster head to exploit temporal correlation. Reliability in terms of coverage and connectivity is also achieved

ASSUMPTIONS

- Sensor nodes have limited power
- Initially the power of all the sensor nodes are equal
- Base Station is more powerful and hence ours is a base station assisted cluster formation

Each node has limited battery power to operate, the primary challenge is to focus on a network life span by conserving the battery power. Also communication among nodes consumes more power than computation. Effective deployment will decide how efficiently the communication is managed over the network. Hence we formulate the problem as a construction problem, by deploying a hexagonal topology, with further subdivision of the hexagon in six equilateral triangles. The Base station calculates the geographical central point that is centroid of each cluster area and broadcast the information to all sensor nodes to elect CHs .After electing CH a cluster based on the same sensing value of the cluster head is formed. Further each CH; send messages to six nodes at an angle of 60^0, which is at transmission distance twice the sensing distance. These elected nodes become sub cluster heads and find redundant nodes in their sensing range. Thus, we achieve spatial correlation. Area of Overlapping Circles

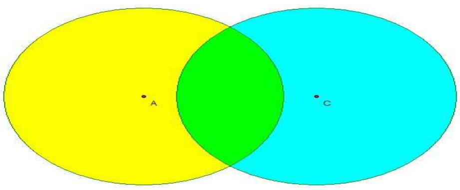

Figure 1

We explored how the distance (d) between the centres of the circles affects the size of the intersection area. Some observations: when d= 0 the area of the intersection is $\pi r^{2,}$ when $d \geq 2r$ the area of intersection is 0. Now, how can we measure the overlapping area? Note that this area is formed by two overlapping sectors.

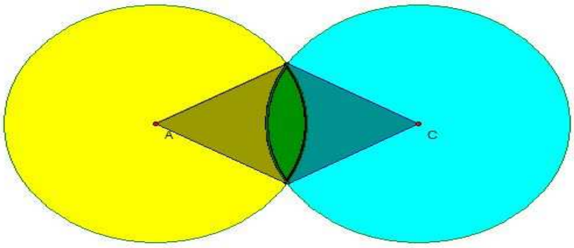

Figure 2

Measure of the Overlapping Area

Now that we have the area of the sector segment to find the area of the overlapped section of the circles we only need to multiply it by two. The total area of the overlapped section of two circles with the same radius (r) can also be expressed by $A = 2r^2 \cos^{-1}\left(\frac{d}{2r}\right) - \frac{d}{2}\sqrt{4r^2 - d^2}$ with $0 \leq d \leq 2r$, where d is the distance between the centres of the circles. The following graph shows the relation between d and A, $A = 2r^2 \cos^{-1}\left(\frac{d}{2r}\right) - \frac{d}{2}\sqrt{4r^2 - d^2}$,

When r = 1. Note that the maximum area is obtained when d = 0 (i.e. when the distance between the centres is zero.)

A is the median of the equilateral triangle. Any node in close proimity or at position A will the cluster head with sensing range Rs and will from a cluster with all the sensors in its sensing range as members of the cluster. All the nodes in the radius Rs will be spatially correlated to node A and we call these nodes redundant and keep them in the silent state for saving energy and transmission. The sensing range of these nodes overlap with the sensing range of the node loacted at point A (partially or fully). The cluster head will maintain a routing table with the highest entry of the node whose overlap area in maximum with it and so on. So that in the next round the Cluster head whose area of overlap is maximum will be the next cluster head likewise. Basically exploiting spatial correlation in WSN, by forming clusters based on the sensing range of the sensor nodes. Normally to find spatially correlated data between sensor nodes, nodes require to exchange data with each other. But this leads to communication cost. We want to reduce the power of a battery operated node, by putting it to sleep, hence at any given point of time only one node will be awake in a cluster. But this will lead to many clusters, since size of the cluster is equal to sensing range. In the paper ' Transmission efficient by –Xie' two communications are present intra and inter. Our method eliminated intra cluster communication. The number of clusters in a WSN can be reduced by increasing the size of the cluster, but this will lead to multi hop and also the nodes at the edge of the cluster will be less correlated. Hence we form a cluster with sensing range:

Flow Chart

Wireless Sensor Network

↓

Compressive Sensing

↓

Temporal Correlation (on sensor node)

Spatial Correlation

↓

Clustering

(sensor sensing same data)

↓

Transmission Efficient

↓

Performance Evaluation

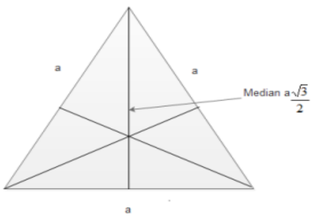

Figure a

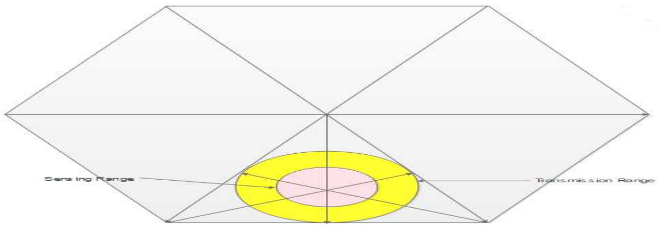

Figure b

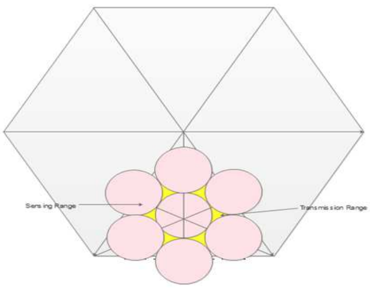

Figure c

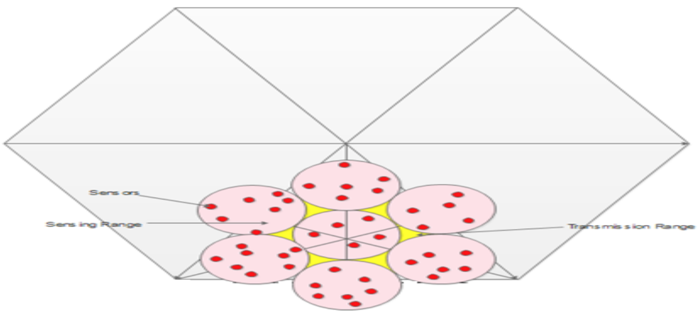

Figure d

Figure 3

PERFORMANCE PARAMETERS

- Transmission efficient means: Fewer transmissions
- Less overhead (related to base station assisted)
- Reduced energy consumption/ energy saving(sleeping sensors)
- Balanced the traffic load (clustering)
- Less computation than communication(Using CS)
- Coverage and Connectivity (Sensing and Transmission range)
- Decreased delay

SOFTWARE REQUIREMENTS

Software	:	Cygwin
Simulation	:	NS version 2.35 and MATLAB
Language	:	TCL and AWK Script (C++)

CONCLUSIONS

Cluster Restructuring and compression of data for Transmission Efficient wireless sensor area network giving a effective results using network simulator 2.1, overall communication of clustor provide all the parameters and result in very efficient manner.

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