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Mitigation of Wireless Sensor Network Using NS 3

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Abstract—*We study the energy efficient coverage and connectivity problem in wireless sensor networks (WSNs). We try to locate heterogeneous sensors and route data generated to a base station under two conflicting objectives: minimization of network cost and maximization of network lifetime. We aim at satisfying connectivity and coverage requirements as well as sensor node and link capacity constraints. We propose mathematical formulations and use an exact solution approach to find Pareto optimal solutions for the problem. We also develop a multiobjective genetic algorithm to approximate the efficient frontier, as the exact solution approach requires long computation times. We experiment with our genetic algorithm on randomly generated problems to test how well the heuristic procedure approximates the efficient frontier. Our results show that our genetic algorithm approximates the efficient frontier well in reasonable computation times.*

Keywords:—*Wireless sensor networks, heterogeneous sensors, energy efficiency (lifetime), network cost, connectivity, coverage, node and link capacity, location.*

1. INTRODUCTION

Wireless Sensor Networks (WSNs) are envisioned to observe large environments at close range for extended periods of time. WSNs are generally composed of a large number of sensors with relatively low computation capacity and limited energy supply [3]. One of the fundamental challenges in Wireless Sensor Networks (WSN) is attaining energy efficiency at all levels of design and operation. Many energy efficient communication solutions have recently been proposed for WSNs [23] [29]. In-network processing emerges as an orthogonal approach to significantly decrease network energy consumption [3] [52] by eliminating redundancy and reducing communicated information volume. Example applications include distributed data compression and aggregation [7] [13] [15] [36]. The benefits of in-network processing are especially pronounced in video sensor networks [24] composed of wireless sensors equipped with cameras, where data streams from neighboring nodes can be highly correlated with considerable data volume. A simplified motivating example of video sensor networks is shown in Figure 1.1, where four calibrated camera sensors collaboratively detect an intruding vehicle's features such as location, vehicle type, and threat level.

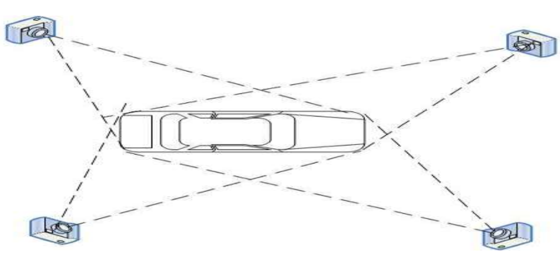

Figure 1: Four calibrated camera sensors collaboratively detect an intruding vehicle's features such as location

The sensors first estimate the intruder's features by themselves, then fuse the intermediate results to eliminate estimation errors. Compared to the original images, the resulting data volume can be reduced by several orders of magnitude. Thus, it is more energy-efficient to send the processed data than delivering the raw data in large-scale WSNs, where base stations can be multiple hops away. However, such in-network processing applications may require computationally intensive operations to be performed in the network subject to certain constraints. For instance, in target tracking applications [42] sensors collaboratively measure and estimate the location of moving targets or classify targets. To conserve energy and reduce communication load, operations such as Bayesian Estimation and data fusion must be executed in the WSN. In the case of tracking or detecting multiple high-speed moving targets, these operations must be finished in a timely manner with an eye toward limited energy consumption. For video sensor networks, in-network processing such as image registration and distributed visual surveillance may demand considerable computation power that is beyond the capacity of each individual sensor. Thus, it is desirable to develop a general solution to provide the computation capacity required by in-network processing.

Traffic Analysis & Modeling for WSNs

WSNs consist of a large number of tiny and cheap sensor nodes that cooperatively sense a physical phenomenon. Existing research results and products have provided the possibility to build effective WSNs for many applications. If the traffic features inside WSNs were better understood then the WSNs could be made to be even more effective. For example, better routing protocols and sensor deployment strategy could be designed if the traffic burden among the sensors was better understood.

1.2 Network Optimization for WSNs

There are many network optimization problems to be solved in WSNs, such as rate control, flow control, congestion control, medium access control, queue management, power control and topology control, etc. It is difficult to provide a complete overview in relation to all issues relating to network optimization in WSNs. However, it is worthwhile, none the less, to aim for a fairly comprehensive summary of important topics, with particular emphasis on energy optimization

1.3 Energy-Efficient Routing Design

Because communication dominates the critical energy consumption, routing design is usually considered to be the core of sensor network design. Many routing algorithms have been proposed in prior research. The shortest path is the typical and fundamental consideration for network flow routing problems. A simple translation of this consideration in sensor network routing is the minimum hop (MH) routing. The AODV routing is an example of using the number of link hops as its routing metric. However as the limitation of battery power is one of the most fundamental aspects of sensor networks, routing algorithms for sensor networks generally attempt to minimize the utilization of this valuable resource. Many researchers have proposed shortest path algorithms in order to minimize the utilization of energy. For example, the minimum total transmission power routing (MTPR) proposed in and the minimum total energy (MTE) routing introduced in attempt to reduce the total transmission energy per data bit, where the path length is the sum of energy expended per data bit during its transmission over each link in the forwarding path. It was realized by the sensor network research community that improving the ratio of packets transmitted to energy consumed by the network is, by itself, not a good measure of the efficiency of the network proposes an algorithm which attempts to minimize the variation in node energy levels. This metric ensures that all the nodes in the network remain up and running together for as long as possible.

- A flow augmentation (FA) algorithm

incorporates MH, MTE, and other residual energy considered routing algorithms together with adjustable parameters.

- The maximum residual energy path (MREP) routing is an algorithm based on similar considerations which attempts to postpone the death of the first node by using the maximum remaining energy path.
- To provide more insights into the energy-efficient routing design, a theoretical analysis concerning the optimal routing performance has also been conducted. In [8], the authors consider the problem of choosing routes between a set of source.

1.4 Network Optimization for WSNs

Nodes and a set of sink nodes of an ad-hoc network so that the time until the first battery expires, is maximized. The authors note that choosing a route that results in minimum total energy expenditure is not always desirable because some of the nodes may have an excessive relaying burden, and hence these nodes may expire too soon. This in turn could lead to a loss of connectivity. To overcome this problem, the authors suggest that the routes should be chosen with the ultimate objective of maximizing the time until the first battery expires. In order to achieve this objective, the minimum energy paths are not necessarily the best choices. In [8], such an energy-efficient routing problem reduces to a linear programming problem which is described as the following:

max Lifetime
s:t: 1. Energy Constraint

Flow Conservation Constraint

Where *Lifetime* is the network operational time till the first battery expires, *Energy Constraint* specifies that the energy expended by sensing, communication and other operations cannot surpass the initial energy reserves, and *Flow Conservation Constraint* specifies that the number of outgoing data flows of each node should be equal to the sum of the number of incoming data flows of that node plus the number of data flows originating at that node. Obviously, the data flows which maximize the lifetime correspond to the optimal routing strategy.

2 . RELATED WORK

Depending on applications and network scale, task mapping and scheduling can be achieved either network-wide or in a localized manner in WSNs. In small-scale WSNs, it is plausible to take a global approach to optimize the system performance at the network level. In [39], the DFuse framework is proposed to dynamically assign data fusion tasks to sensors in a WSN. The design objective of DFuse is to find mapping from task graph vertices to network nodes with balanced energy consumption. **T**ask **A**llocation among clusters in **C**luster-based **S**ensor **N**etworks (TACSN) is discussed in [66]. The objective of TACSN is to maximize network lifetime via task allocation, which is modeled as a nonlinear optimization problem with constraints such as application deadlines. However, neither DFuse nor TACSN explicitly addresses communication scheduling in WSNs.

According to the simulation results, solutions provided by CoRAl are comparable to the optimal solutions obtained by the non-linear optimization tool of Matlab. On the other hand, CoRAl has a much higher execution speed than the Matlab tool. However, in CoRAl, tasks of applications are assumed to be already assigned on sensors, and task mapping remains an open problem. Furthermore, energy consumption is not explicitly considered in [26], which is a fundamental problem in WSNs.

2.1 Wireless Sensor Network Assumptions

The following assumptions are made regarding the wireless sensor network:

- A wireless sensor network is composed of homogeneous sensors.

3.1 Proposed Algorithm

Proposed Algorithm contains following finite steps to evaluate the QoS of Wireless sensor network –

1. **Simulation Setup-** In this nodes has been defined in NS-3 using following scenario
   a. Static Topology
   b. Mobile Topology

Following types of nodes are required to deploy the sensor network scenario in NS-3
   a. Normal Node
   b. Sink Node- work as a receiver (sense) from normal node

1. ***Applying Routing-*** for efficient routing mechanism, proposed method uses the MANET routing protocols to evaluate the effectiveness of the sensor network. For this two protocols have been chosen: OLSR and AODV (table driven and on demand).
2. ***Energy*** – Energy is the core things in WSN, to achieve this energy module has been applied to each node in WSN.
3. ***Performance Evaluation-***To evaluate the performance of WSN following parameters has been used-
   i. Minimum Delay of the path
   ii. Maximum packet delivery ratio
   iii. Max residual energy remain

4. SIMULATION AND RESULT

(A)

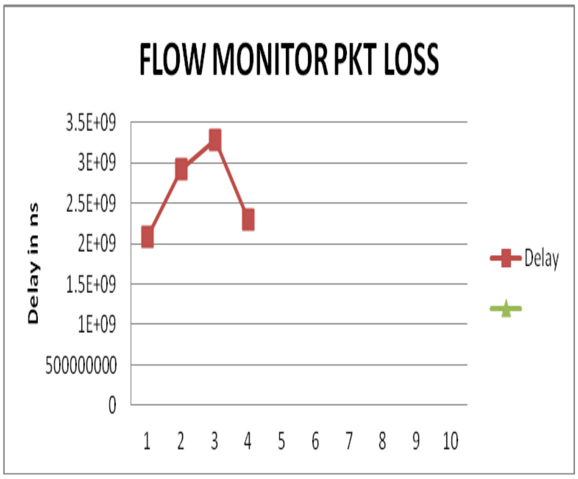

Figure 3: Flow Monitor Result

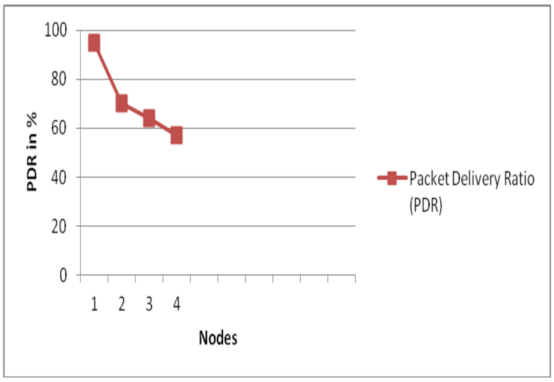

Figure 4:Packet Delivery Ratio

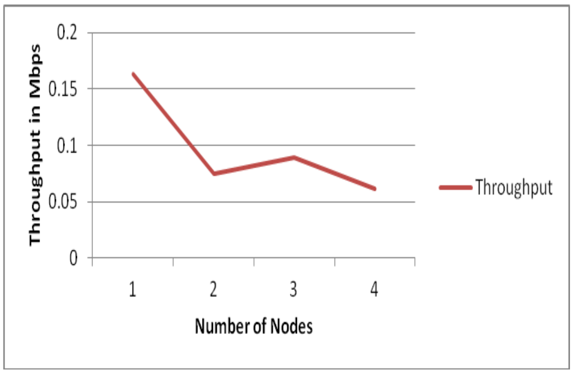

Figure 5. Throughput

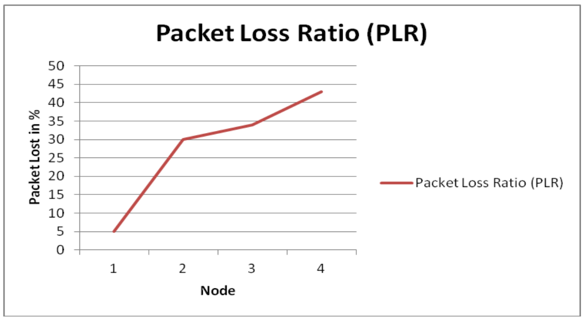

Figure 6. Packet Loss Ratio

5. CONCLUSION

In this dissertation, we address the task mapping and scheduling problem to enable collaborative in-network processing in large-scale WSNs. We consider WSNs composed of homogeneous wireless sensors grouped into clusters, within which applications are iteratively executed. Since energy consumption efficiency is one of the most critical consideration for any WSN solution, our proposed solutions aim to achieve energy-efficiency from different aspects. To enhance information processing capacity in WSNs, schedule length optimization is also part of our design objectives. The contribution of this research can be summarized as follows.

Nodes may be equipped with multiple sensors detecting different events. Depending on applications, the detected events may occur in an aperiodic pattern. Therefore, a dynamic intra-sensor scheduling algorithm should be proposed to handle these events and efficiently allocate sensor resources

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