REDUCING DATA-INTENSIVE PROBLEMS IN WIRELESS SENSOR NETWORKS

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Abstract : Several different approaches have been proposed to significantly reduce the energy cost of WSNs by using the mobility of nodes. The network can collect data from static nodes through one-hop or multi-hop transmissions. The mobile node may serve as the base station or a "data mule" that transports data between static nodes and the base station. **Mobile nodes may also be used as relays** that forward data from source nodes to the base station. Several movement strategies for mobile relays have been studied. **In existing work,** the effectiveness of mobility in energy conservation is demonstrated by previous studies, the following key issues have not been collectively addressed. First, the movement cost of mobile nodes is not accounted for in the total network energy consumption. Instead, mobile nodes are often assumed to have replenished able energy supplies which are not always feasible due to the constraints of the physical environment. Second, complex motion planning of mobile nodes is often assumed in existing solutions which introduces significant design complexity and manufacturing costs. In mobile nodes need to repeatedly compute optimal motion paths and change their location, their orientation and/or speed of movement. Such capabilities are usually not supported by existing low-cost mobile sensor platforms. Third Robomote nodes are designed using 8-bit CPUs and small batteries that only last for about 25 minutes in full motion. **In proposed work,** to minimize the total energy consumed by both mobility of relay nodes and wireless transmissions. Most previous work ignored the energy consumed by moving mobile relays. The proposed model both sources of energy consumption, the optimal position of a node that receives data from one or multiple neighbors and transmits it to a single parent is not the midpoint of its neighbors; instead, it converges to this position as the amount of data transmitted goes to infinity, and consider the optimal initial routing tree in a static environment where no nodes can move. However, the proposed approach can work with less optimal initial configurations including one generated using only local information such as greedy geographic routing. It improves the initial configuration using two iterative schemes. The first inserts new nodes into the tree. The second computes the optimal positions of relay nodes in the tree given a fixed topology. This algorithm can reduce data-intensive wireless sensor networks. It allows some nodes to move while others do not because any local improvement for a given mobile relay is a global improvement. This allows us to potentially extend with proposed approach to handle additional constraints on individual nodes such as low energy levels or mobility restrictions due to application requirements. Finally it can be implemented in a centralized or distributed fashion. In proposed work, the following contributions in this project (1). To formulate the problem of Optimal Mobile Relay Configuration (OMRC) in data-intensive WSNs. The objective of energy conservation is holistic in that the total energy consumed by both mobility of relays and wireless transmissions is minimized, which is in contrast to existing mobility approaches that only minimize the transmission energy consumption. The energy consumption between mobility and transmission is exploited by configuring the positions of mobile relays. (2) The study can effect of the initial configuration on the final result. It compare different initial tree building strategies and propose an optimal tree construction strategy for static nodes with no mobility. (3) To develop two algorithms that iteratively refines the configuration of mobile relays. The first improves the tree topology by adding new nodes. It is not guaranteed to find the optimal topology. The second improves the routing tree by relocating nodes without changing the tree topology. It converges to the optimal node positions for the given topology. (4) To conduct extensive simulations based on realistic energy models obtained from existing mobile and static sensor platforms. The framework consists of three main algorithms. The first algorithm computes an optimal routing tree assuming no nodes can move. The second algorithm improves the topology of the routing tree by greedily adding new nodes exploiting mobility of the newly added nodes. The third algorithm improves the routing tree by relocating its nodes without changing its topology. This iterative algorithm converges on the optimal position for each node given the constraint that the routing tree topology does not change. It presents efficient distributed implementations for each algorithm that require only limited, localized synchronization.

IndexTerms: Introduction, related work, data intensive problems, wireless sensor networks

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are increasingly used in data-intensive applications such as micro-climate monitoring, precision agriculture, and audio/video surveillance. A key challenge faced by data-intensive WSNs is to transmit all the data generated within an application's lifetime to the base station despite the fact that sensor nodes have limited power supplies. We propose using low-cost disposable mobile relays to reduce the energy consumption of data-intensive WSNs. Our approach differs from previous work in two main aspects. First, it does not require complex motion planning of mobile nodes, so it can be implemented on a number of low-cost mobile sensor platforms. Second, we integrate the energy consumption due to both mobility and wireless transmissions into a holistic optimization framework. We present efficient distributed implementations for each algorithm that require only limited, localized synchronization. Because we do not necessarily compute an optimal topology, our final routing tree is not necessarily optimal. However, our simulation results show that our algorithms significantly outperform the best existing solutions.

The approach can work with less optimal initial configurations including one generated using only local information such as greedy geographic routing. Our approach improves the initial configuration using two iterative schemes. The first inserts new nodes into the tree. The second computes the optimal positions of relay nodes in the tree given a fixed topology. This algorithm is appropriate for a variety of data-intensive wireless sensor networks. It allows some nodes to move while others do not because any local improvement for a given mobile relay is a global improvement. This allows us to potentially extend our approach to handle additional constraints on individual nodes such as low energy levels or mobility restrictions due to application requirements. Our approach can be implemented in a centralized or distributed fashion. Our simulations show it substantially reduces the energy consumption by up to 45%.

II. RELATED WORK

We review three different approaches, mobile base stations, data mules, and mobile relays, that use mobility to reduce energy consumption in wireless sensor networks. A mobile base station moves around the network and collects data from the nodes. In some work, all nodes are always performing multiple hop transmissions to the base station, and the goal is to rotate which nodes are close to the base station in order to balance the transmission load [4], [5], [6]. In other work, nodes only transmit to the base station when it is close to them (or a neighbor). The goal is to compute a mobility path to collect data from visited nodes before those nodes suffer buffer over flows[7], [8], [14], [15]. In [8], [19], [20], several rendezvous based data collection algorithms are proposed, where the mobile base station only visits a selected set of nodes referred to as rendezvous points within a deadline and the rendezvous points buffer the data from sources. These approaches incur high latencies due to the low to moderate speed, e.g. 0.1-1 m/s [14], [16], of mobile base stations. Data mules are similar to the second form of mobile base stations [9], [10], [11]. They pick up data from the sensors and transport it to the sink. In [1], the data mule visits all the sources to collect data, transports data over some distance, and then transmits it to the static base station through the network. The goal is to find a movement path that minimizes both communication and mobility energy consumption. Similar to mobile base stations, data mules introduce large delays since sensors have to wait for a mule to pass by before starting their transmission.

In the third approach, the network consists of mobile relay nodes along with static base station and data sources. Relay nodes do not transport data; instead, they move to different locations to decrease the transmission costs. We use the mobile relay approach in this work. Goldenberg et al. [13] showed that an iterative mobility algorithm where each relay node moves to the midpoint of its neighbours converges on the optimal solution for a single routing path. However, they do not account for the cost of moving the relay nodes. In [22], mobile nodes decide to move only when moving is beneficial, but the only position considered is the midpoint of neighbours. Unlike mobile base stations and data mules, our OMRC problem considers the energy consumption of both mobility and transmission. Our approach also relocates each mobile relay only once immediately after deployment. Unlike previous mobile relay schemes [13] and [2], we consider all possible locations as possible target locations for a mobile node instead of just the midpoint of its neighbours. Mobility has been extensively studied in sensor network and robotics applications which consider only mobility costs but not communication costs. For example, in [23], the authors propose approximation algorithms to minimize maximum and total movement of the mobile nodes such that the network becomes connected. In [4], the authors propose an optimal algorithm to bridge the gap between two static nodes by moving nearby mobile nodes along the line connecting the static points while also minimizing the total/maximum distance moved. In [5], [6], the authors propose algorithms to find motion paths for robots to explore the area and perform a certain task while taking into consideration the energy available at each robot. These problems ignore communication costs which add an increased complexity to OMRC, and consequently their results are not applicable. Our OMRC problem is somewhat similar to a number of graph theory problems such as the Steiner tree problem [7], [8], [9] and the facility location problem [3], [1]. However, because the OMRC cost function is fundamentally different from the cost function for these other problems, existing solutions to these problems cannot be applied directly and do not provide good solutions to OMRC. For example, there is no obvious way to include mobility costs in the Steiner tree problem.

III. EXISTING WORK

Several different approaches have been proposed to significantly reduce the energy cost of WSNs by using the mobility of nodes. The network can collect data from static nodes through one-hop or multi-hop transmissions. The mobile node may serve as the base station or a "data mule" that transports data between static nodes and the base station. Mobile nodes may also be used as relays that forward data from source nodes to the base station. Several movement strategies for mobile relays have been studied**. In existing work,** the effectiveness of mobility in energy conservation is demonstrated by previous studies, the following key issues have not been collectively addressed. First, the movement cost of mobile nodes is not accounted for in the total network energy consumption. Instead, mobile nodes are often assumed to have replenished able energy supplies which are not always feasible due to the constraints of the physical environment. Second, complex motion planning of mobile nodes is often assumed in existing solutions which introduces significant design complexity and manufacturing costs. In mobile nodes need to repeatedly compute optimal motion paths and change their location, their orientation and/or speed of movement. Such capabilities are usually not supported by existing low-cost mobile sensor platforms. Third Rob mote nodes are designed using 8-bit CPUs and small batteries that only last for about 25 minutes in full motion.

Limitations of Existing work

- First, the movement cost of mobile nodes is not accounted for in the total network energy consumption. Instead, mobile nodes are often assumed to have replenish able energy supplies which are not always feasible due to the constraints of the physical environment.
- Second, complex motion planning of mobile nodes is often assumed in existing solutions which introduces in significant design complexity and manufacturing costs.
- In mobile nodes need to repeatedly compute optimal motion paths and change their location, their orientation and/or speed of movement.
- Such capabilities are usually not supported by existing low-cost mobile sensor platforms.

IV. PROPOSED WORK

In proposed work, to minimize the total energy consumed by both mobility of relay nodes and wireless transmissions. Most previous work ignored the energy consumed by moving mobile relays. The proposed model both sources of energy consumption, the optimal position of a node that receives data from one or multiple neighbors and transmits it to a single parent is not the midpoint of its neighbours; instead, it converges to this position as the amount of data transmitted goes to infinity, and consider the optimal initial routing tree in a static environment where no nodes can move. However, the proposed approach can work with less optimal initial configurations including one generated using only local information such as greedy geographic routing. It improves the initial configuration using two iterative schemes. The first inserts new nodes into the tree. The second computes the optimal positions of relay nodes in the tree given a fixed topology. This algorithm can reduce data-intensive wireless sensor networks. It allows some nodes to move while others do not because any local improvement for a given mobile relay is a global improvement. This allows us to potentially extend with proposed approach to handle additional constraints on individual nodes such as low energy levels or mobility restrictions due to application requirements. Finally it can be implemented in a centralized or distributed fashion.

In proposed work, the following contributions in this paper: (1). To formulate the problem of Optimal Mobile Relay Configuration (OMRC) in data-intensive WSNs. The objective of energy conservation is holistic in that the total energy consumed by both mobility of relays and wireless transmissions is minimized, which is in contrast to existing mobility approaches that only minimize the transmission energy consumption. The energy consumption between mobility and transmission is exploited by configuring the positions of mobile relays. (2) The study can effect of the initial configuration on the final result. It compare different initial tree building strategies and propose an optimal tree construction strategy for static nodes with no mobility. (3) To develop two algorithms that iteratively refines the configuration of mobile relays. The first improves the tree topology by adding new nodes. It is not guaranteed to find the optimal topology. The second improves the routing tree by relocating nodes without changing the tree topology. It converges to the optimal node positions for the given topology. (4) To conduct extensive simulations based on realistic energy models obtained from existing mobile and static sensor platforms.

The framework consists of three main algorithms. The first algorithm computes an optimal routing tree assuming no nodes can move. The second algorithm improves the topology of the routing tree by greedily adding new nodes exploiting mobility of the newly added nodes. The third algorithm improves the routing tree by relocating its nodes without changing its topology. This iterative algorithm converges on the optimal position for each node given the constraint that the routing tree topology does not change. It presents efficient distributed implementations for each algorithm that require only limited, localized synchronization.

Advantages of Proposed Work

- The approach takes advantage of this capability by assuming that we have a large number of mobile relay nodes.
- On the other hand, due to low manufacturing cost, existing mobile platforms are typically powered by batteries and only capable of limited mobility.
- Consistent with this constraint, our approach only requires one-shot relocation to designed positions after deployment.

Compared with our approach, existing mobility approaches typically assume small number of powerful mobile nodes, which does not exploit the availability of many low-cost mobile nodes.

- Mobile Relays
- Sink
- Source Nodes
- Tree Optimization

Mobile Relays

The network consists of mobile relay nodes along with static base station and data sources. Relay nodes do not transport data; instead, they move to different locations to decrease the transmission costs. We use the mobile relay approach in this work. Goldenberg et al. [13] showed that an iterative mobility algorithm where each relay node moves to the midpoint of its neighbours converges on the optimal solution for a single routing path. However, they do not account for the cost of moving the relay nodes. In mobile nodes decide to move only when moving is beneficial, but the only position considered is the midpoint of neighbours.

Sink

The sink is the point of contact for users of the sensor network. Each time the sink receives a question from a user, it first translates the question into multiple queries and then disseminates the queries to the corresponding mobile relay, which process the queries based on their data and return the query results to the sink. The sink unifies the query results from multiple storage nodes into the final answer and sends it back to the user.

Source Nodes

The source nodes in our problem formulation serve as storage points which cache the data gathered by other nodes and periodically transmit to the sink, in response to user queries. Such a network architecture is consistent with the design of storage centric sensor networks. Our problem formulation also considers the initial positions of nodes and the amount of data that needs to be transmitted from each storage node to the sink.

Tree Optimization

We consider the sub problem of finding the optimal positions of relay nodes for a routing tree given that the topology is fixed. We assume the topology is a directed tree in which the leaves are sources and the root is the sink. We also assume that separate messages cannot be compressed or merged; that is, if two distinct messages of lengths m1 and m2 use the same link (si, sj) on the path from a source to a sink, the total number of bits that must traverse link (si, sj) is m1 + m2.

V IMPLEMENTATION

In implementation section Intel Core 2 Duo processor used with 1 GB RAM, Hard disk 300GB. Operating system windowsXP, and application server used Apache Tomocat 5.0/6.x, front end HTML, JAVA 6.0, JSP, database connectivity through JDBC connection and Database maintenance MYSQL5.0.

Screen.1 Data sending page from sensor 1

Description: In this screen we select the file send through the sensor1.

Screen 2 Data sending page from sensor 2

Description: In this screen we select the file send through the sensor2.

Screen 3 Data sending page from sensor 3

Description: In this screen we select the file send through the sensor3.

Screen 4 Data sending page from sensor 4

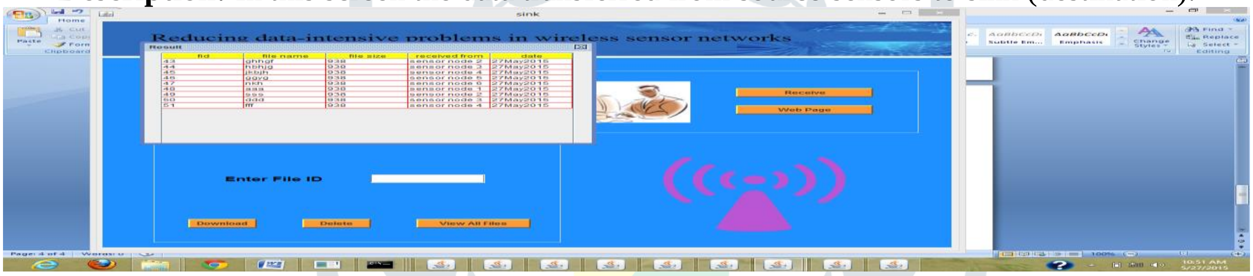
Description: In this screen we select the file send through the sensor4.

Screen.7 Data Receiving page

Description: In this screen we receive the sending data through the sensor.

Screen 8 Data transferring page

Description: In this screen the data transferred from source sensors to sink (destination).



Screen 9: Data view page

Description: In this screen we seen total sending data in tabular format