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Efficient and Dynamic Clustering scheme Heterogeneous Wireless Sensor Networks Based on The Energy Forecast

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ABSTRACT

The clustering technique is effective in prolonging the lifetime of the WSN. This project modified the ad- hoc on demand distance vector routing by incorporating signal-to-noise ratio (SNR) based dynamic clustering. The proposed scheme, namely efficient and secure routing protocol for wireless sensor networks through SNR-based dynamic clustering (ESRPSDC) mechanisms, can partition the nodes into clusters and select the cluster head among the nodes based on the energy, and non -cluster head nodes join with a specific cluster head based on the SNR values to solve the problem of routing in sensor networks to maximize the network lifetime.

Keywords— Content-based image retrieval, exploratory search, gesture, interactive visual search, user interaction.

1. INTRODUCTION

TO SOLVE THE PROBLEM OF ROUTING IN SENSOR NETWORKS WHERE THE GOAL IS TO MAXIMIZE THE NETWORK

Wireless sensor network (WSN) are spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity Wireless sensor network (WSN) are spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance.

2. BACKGROUND AND RELATED WORK

In this paper, we consider the heterogeneity of networks and propose a fair cooperative routing method, to avoid unfair improvement only on certain networks. We introduce one or a few shared nodes that can use multiple channels to relay data packets. Assuming that sinks and shared nodes can communicate with any WSNs here, different WSNs can use cooperative routing with each other since shared nodes allow sensor nodes to forward data from another WSN as the function of interchange points among respective WSN planes. When receiving a packet, a shared node selects the route to send the packet, according to proposed route selection methods. This cooperation prolongs the lifetime of each network equally as possible.

2.1. Related Work

Clustering is one of the most famous methods because of its good scalability and the support for data aggregation. Data aggregation combines data packets from multiple sensor nodes into one data packet by eliminating redundant information. This reduces the transmission load and the total amount of data. In clustering, the energy load is well balanced by dynamic election of cluster heads (CHs) . By rotating the CH role among all sensor nodes, each node tends to expend the same amount of energy over time. Nevertheless, as with usual multihop forwarding, a CH around a sink tends to have higher traffic than other CHs. As a result, nodes around sinks die earlier than other nodes, even in clustered WSN.

In general, a single WSN has a single sink. The amount of traffic increases around the sink, therefore nodes around the sink tend to die earlier. This is called energy hole problem. Moreover, in a large-scale WSN with a large number of sensor nodes, the energy hole problem is more serious. Then, some researchers have proposed construction methods of multiple- sink networks . In a multiple-sink WSN, sensor nodes are divided into a few clusters. Sensor nodes within a cluster are connected with one sink, which belongs to that cluster.

In contrast to a single-sink WSN, in which nodes around the sink have to relay data from almost all nodes, nodes around each sink relay smaller amount of data only from nodes that are in the same cluster. Therefore, the communication load of nodes around sinks can be reduced. However, there are some problems such as how to determine the optimal location of each sink and the optimal number of of times that the node have forwarded a packet, instead of focusing on each packet forwarding only. Furthermore, operation start time, the number of nodes and/or sensing area of each other

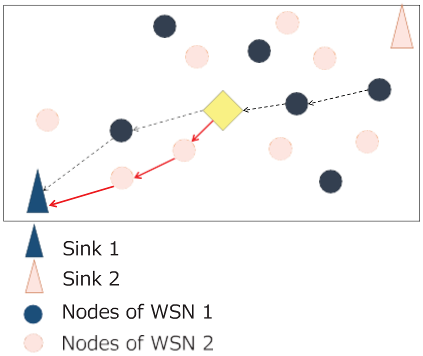
2.2. Cooperation Between Multiple WSNs

In existing studies, most researches assume that a single network is deployed by a single authority in the sensing area. However, as WSNs get utilized more widely, multiple WSNs tend to be deployed in the same area. For instance, in the UK, some different networks of cameras by different authorities such as police, highway patrol, and local city authorities are deployed on the same roads. Recently, some researchers have proposed the cooperation method of multiple WSNs in such situations.

When multiple WSNs are constructed in close proximity, they can help each other by forwarding data so that all networks involved benefit from collaborative effort. In the potential benefits of cooperation in multiple WSNs are investigated. The authors formulated the system model with objective function and a set of problem constraints. Then, a linear programming framework is used to solve the optimization problem.

Since their goal is to investigate the maximum achievable sensor network lifetime with different multi-domain cooperation strategies, optimization objective is network lifetime, which is defined as the time when the first sensor node in a network exhausts its battery and dies. The authors also investigated the cooperation in multiple networks that are deployed slightly different location.

Virtual Cooperation Bond (VCB) Protocol is one of the game-theoretic approaches. It is a distributed protocol that makes different networks to cooperate, if and only if all the networks obtain some benefits by the cooperation. The authors formulated the cooperation problem among different WSNs as a cooperative game in game theory. In VCB protocol, the energy consumption of data communication is used as costs. When the cost gets higher, the payoff of a network gets lower. A sensor node and another node that belongs to another network forward a data packet coming from the other side, only if both networks can obtain the higher payoffs than no cooperation scenario. The simulation results showed that the VCB can save transmission energy between 20% and 30% in a certain environment.



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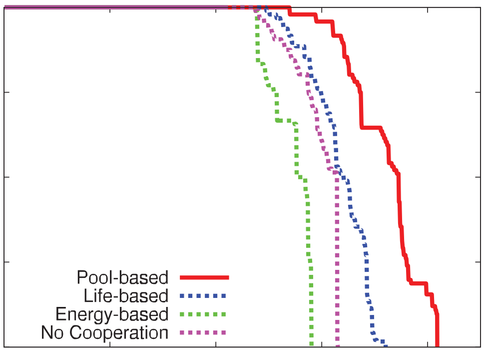


Two WSNs deployed at the same area.

2.3. Problem Description

As discussed above, we assume that multiple WSNs are deployed by different authorities in the same area. Those WSNs operate different applications independently, hence, they have heterogeneous characteristics, such as battery capacity, operation start time, the number of nodes, nodes locations, energy consumption, packet size and/or data trans- mission timing. However, most existing cooperation methods do not consider this heterogeneity. For instance, when batteries capacities on sensor nodes are quite different by a WSN, a cooperative routing method based on residual energy is not appropriate since a WSN which has the maximum battery capacity always forwards packets from other WSNs. As a result, although certain WSNs prolong their lifetime, the other WSNs may shorten their lifetime. In such a situation, fairness of cooperation is a highly important issue.

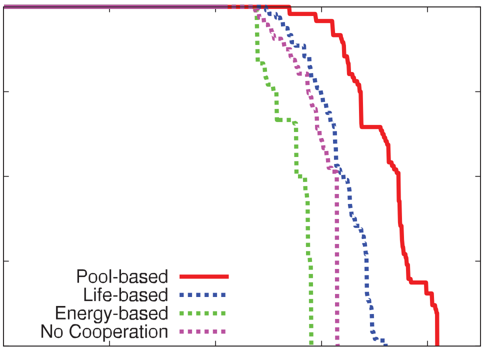
In this paper, we aim to improve all WSNs lifetime by fair cooperative routing in a heterogeneous environment, avoiding improving the lifetime of only certain WSNs.

2.4. Route Discovery

Each sensor node creates its routing table based on a routing protocol. In this paper, we used ad hoc on-demand distance vector (AODV) [19] as a routing protocol, because AODV was developed for wireless ad hoc networks and was adopted for some WSN protocols such as Zigbee [22] and ANT [23]. In route discovery, each sensor node discovers its routes not only to the sink in its WSN but also to all the other sinks in the different WSNs for opportunities to forward data packets from nodes in different WSNs to their sink. Therefore, the routing table of each sensor node has m routes corresponding to each sink in all WSNs.

A shared node discovers its route with a slightly different mechanism. A shared node creates m routes via m different WSNs to a sink. There are m sinks, in total, corresponding to m WSNs. Therefore, a shared node has m m routes.

In AODV route discovery, each node chooses a route that has the minimum number of hops to the sink.



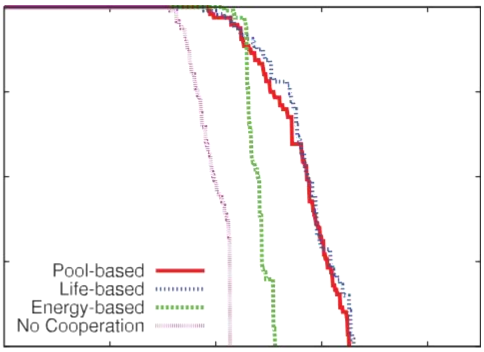
Routing with shared nodes

2.5. Cooperative Data Forwarding

Since the lifetime of WSN depends on the lifetime of the energy-bottleneck nodes in the WSN, cooperative data packet forwarding via alternative nodes belonging to another WSN lifetime of the WSN. An example is described in . Here, the sensor nodes of WSN 2 between the shared node and sink 1 can forward data packets to sink 1 for WSN 1 as an alternative route on another WSN. However, if the alternative nodes are also bottleneck of their WSN, the lifetime of their WSN would be shortened. To avoid this result, a shared node is able to choose the alternative route only if the alternative nodes are not bottleneck. That is, the condition that By this condition, lifetime reduction of each WSN by forward- ing packets from other WSNs is avoided, and the improvement of WSNs lifetime is guaranteed.

As explained in a shared node has multiple routes to the sink, hence an algorithm to select an appropriate route is needed. We propose fair cooperative methods with two route selecting algorithms. The first one is named Pool-based selecting. We resemble the cooperative forwarding to debt of energy resource. Shared nodes maintain the Energy Pool, the total amount of energy consumption used by cooperative forwarding, continuously. When a node nlj in Nl forwards a packet from another network Nu , the Energy-Pool of Nl is increased and that of Nu is decreased. By selecting a route based on the value of Energy-Pool, the cooperation with the fairness of energy consumption is achieved in a heterogeneous environment. In addition, this method is able to balance the energy consumption by cooperation even if each WSN starts to operate from different time.

The other is named Life-based selecting, that selects the route with maximum route lifetime. In contrast to the Energy- based route selection that considers only remaining energy on the nodes, Life-based is focusing on the traffic loads by estimating the route lifetime. Therefore, it is expected that the heavy-loaded nodes balance their loads to other network nodes and it leads to a longer lifetime. Figure 5 shows the procedure of the Life-based route selection.



Receiving rate on WSN

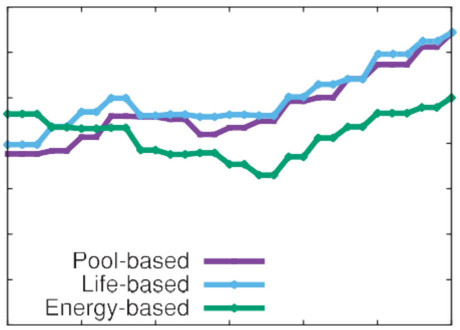
2.6. Simulation Environment

We evaluated the performance of the proposed method with the network simulator QualNet 7.1 [24]. We observed the receiving rate, which is the rate of sensor nodes that send data packets to their sinks successfully. Therefore, we counted a node that cannot communicate with its sink as a dead node, in spite of its remaining battery. The maximum value of receiving rate is 1.

In this simulation model, we set the node configurations using datasheet and information provided by MEMSIC [25]. We simulated four WSNs, WSN 1, WSN 2, WSN 3 and WSN4 as follows. Each WSN had 49 nodes based on a random topology. The sensing field was a 490 m ×490 m square. The PHY model was IEEE802.11b and its data rate was 2 Mbps. The maximum range of radio transmission for each node was 150 m.

Each sink was located at each corner of the field. A shared node was placed at the center of the field. Each node sent 512 bytes data packets asynchronously at intervals of 10 seconds. We assumed that sinks and shared nodes had a sufficiently large battery, and that their battery capacities were unlimited. We set x , the cost of using a shared node, to 0.5. To give opportunities for cooperative forwarding to sensor nodes fairly, all nodes deleted their route entries and discovered new routes at intervals of 720 minutes.

2.7. Average of increasing ratio WSN



Receiving of variant in WSN

In this scenario, we intended to evaluate how the proposed method works in a case where each WSN collects data in deferent timings. In other words, a WSN with larger interval consumes its battery more slowly and may have to forward more packets from other WSNs unfairly. Other parameters are the same as scenario 1 except that all sensor nodes in any WSNs have the equal battery capacity

3. CONCLUSIONS

In this paper, we focused on heterogeneous overlapped sensor networks that were constructed at the same area. In such a situation, it is expected that the lifetime of all networks should be extended by cooperation in multiple networks. However, since the existing methods do not consider the heterogeneity in each network, fairness in terms of lifetime improvement is required. We proposed a fair cooperative routing method with shared nodes, with the aim to achieve fair lifetime improvement in heterogeneous overlapped sensor networks. Simulation results showed that the proposed method extended the network lifetime. In particular, Pool-based cooperation achieved quite small variance of lifetime improvement, that is, it provided quite fair cooperation. As a future work, we try to implement the proposed method on an experimental system and evaluate its feasibility.

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