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Devising Low-Cost Mobile Platforms in Wireless Sensor Networks Using Incremental Approach

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ABSTRACT

The data concentrated applications are widely used in wireless sensor networks (WSN) like micro-climate monitoring, agriculture, habitat monitoring, etc. The foremost challenge faced in sensor nodes is limited power supply but all the data generated must be transmitted within the lifetime of the application. A low-cost mobile transmission and reception is proposed to reduce the energy consumed by data concentrated WSN. The proposed approach consists of two approaches, the first approach does not require complex planning steps for mobile nodes and it suits for low-cost mobile platforms. The second approach considers the energy consumed by both mobility and wireless transmissions into a structure. The structure consists of three algorithms as the first algorithm calculates a best routing tree with immobile nodes while the second algorithm adds new nodes to the tree and finally the third algorithm improves the routing tree by relocating the nodes without changing the tree structure. These incremental algorithms unite on optimal position for every node with the condition that the routing tree structure does not change.

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INTRODUCTION

The wireless sensor networks (WSN) are employed in a variety of data concentrated applications like micro-climate, habitat monitoring (Fatme El-Maoukaddem, 2013) and also audio/video surveillance (Szewczyk, R., 2004). Mostly the data must be transmitted to the base station for analysis due to limited storage capacity of sensor nodes since they operate on limited power supplies like solar panels (or) batteries. The goal is to transmit the data generated within the lifetime of the application to the base station where the WSN should utilize minimum energy.

Several approaches have been proposed to reduce the energy cost of WSNs by using node mobility. For instance, a robotic unit collects data from static node by moving around the network through single (or) multi-hop transmissions (Ganesan, D., 2003; Gandham, S.R., 2003; Luo, J. and J.P. Hubaux, 2005; Wang, Z.M., 2005; Kansal, A., 2006). The mobile node can act as base station to transport data between the static node and the base station (Xing, G., 2008; Jea, D., 2005). The mobile nodes can also be used to transmit and receive data to and from source nodes and base stations for which it includes several movement strategies (Jain, S., 2006; Wang, W., 2005).

The following are the key features addressed during energy conservations in mobile nodes as,

i. In the total network energy consumption, the costs of moving mobile nodes are also calculated. The problem occurs here are that the mobile nodes are always considered to have continuous supply of energy but it is not always possible due to physical environments.

ii. It is not simple to plan the movement of mobile nodes which indirectly introduces design complexity and manufacturing costs. The challenge occurs because the nodes needs to continuously monitor for the best path to move i.e. the location and speed of movement may change which is not suited for mobile sensor platforms using low-cost.

For this paper, a low-cost mobile transmission and reception for reducing the total energy consumption of data concentrated WSN. The mobile data transmission and reception is not similar to mobile base station since, they do not forward data but they only move to different locations and remains fixed so, that the data can be

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communicated along the paths from the source to the base station. Unlike other approaches mobile nodes does not perform repeated relocations.

The proposed approach makes use of several low cost mobile sensor nodes due to the key advantage that their manufacturing cost is low and can be disposed. The major part is that the approach requires only single relocations in the design after disposal.

The following are the problem formulated and contributed throughout the paper,

i. A problem called Best Path Mobile Transmission and Reception (BPMTR) in data concentrated WSN is formulated. The objective is energy conservation during mobility in transmission and reception and also wireless transmission. A trade-off for energy consumption between mobility and transmission in mobile transmission and reception is studied.

ii. The effect of initial setup on final result is studied and a best path solution for building initial tree strategy for static nodes without movement is designed.

iii. Two algorithms are developed that incrementally extracts the mobile transmission and reception configuration. The first algorithm does not guarantee for best solution but improves the tree structure by addition of new nodes. The second relocates the nodes without distributing the tree structure to improve routing.

Related Works:

The three different approaches namely mobile base station, data carriers, mobile transmission and reception are reviewed which reduce the energy consumption in WSN by using mobility.

i) The mobile base station collects the data from the nodes in a network by either single (or) multi-hop transmission. The goal is to calculate a mobility path along the visited nodes to collect data before the nodes undergo buffer overflows. A several meeting point based algorithms have been proposed in which the mobile base station visits only a selected set of nodes within the limit called meeting point which is responsible for gathering data from sources.

ii) Data carriers are similar to mobile base stations since they collect data from sensors and transport it to the destinations. These data carriers collect data from different sources, transport them over some distances and then transmit it to the base station through the network. The goal is to find the path of movement to minimize communication and movement energy consumption.

iii) The network consists of mobile reception and transmission between the static base station and data sources but actually they do not transport data rather relocates to different locations for minimizing transmission costs. The mobile nodes only move during benefit for which the midpoint of neighbors is considered as position.

The formulated best path mobile transmission and reception problem accounts the energy consumption of both mobility and transmission. The approach relocates the mobile transmission and reception only once immediately after positioning. Here, in addition to midpoint of neighbors all possible locations are considered as target locations.

The sensor networks considers only the mobility cost leaving the communication cost since, the cost function for best path mobile transmission and reception is entirely different from other problems for which the exiting problems cannot be applied directly because they does not provide good solutions.

Overview:

The mobile transmission and reception acts as fixed forwarding nodes after relocation for which the energy consumption is to be reduced during mobility and transmission. Since computation, communication and movement of nodes consumes energy. The communication and movement makes use of radio frequencies which is the major cause for battery drainage. The radio frequencies consume major part of energy even in the idle state which can be minimized by a number of sleep plan protocols.

A wheeled sensor network with two wheels, each of which is controlled by independent engines is considered for movement. An energy consumption model proportional to distance is assumed for these nodes.

Let the consumed energy be Ec (s) after moving over a distance (s). The modeling can be done as,

$$E_c(s) = zs$$

Here, z is a parameter denotes speed of node. Generally, z will be lower at best possible speed. In order to model energy consumption through transmission, the observation results obtained by two radios CC2420 and CC1000 are analyzed.

$$E_{et}(s) = n\left(c + gs^2\right)$$

Here, n is the number of bits transmitted and c, g are the constants that arises from the environment.

The network consists of multiple sources one transmission and reception node and one destination node. The data is transmitted from every source to transmission and reception node and finally to destination.

Let i_s be the mobile transmission and reception node. $L(i_s)$ be the collection of source nodes transmitting to is and the destination node i_{s+1}. The cost obtained by is in the configuration W are,

$$f(W) = n \| w_s - i_o \| + cd_s + gd_s \| w_{s+1} - w_s \|^2$$

Here, d is the total amount of data transmitted from is to i_{s+1}.

Before, beginning of any transmission it is assumed that all the movements are done so that there are no obstacles to affect mobility or transmissions.

The network consists of one source i_{s-1}, one mobile transmission and reception node is and one destination i_{s+1}. Here, the best position for transmission and reception node is calculated. The nodes in the network are assumed to be in 2 – dimensional plane U^2.

Let, the original node position is be $i_o = (a_x, b_y)$ and the destination position be $v_p = (h_x, j_y)$. The total transmission and reception node in the configuration W is,

$$f_i(W) = z \| v_i - i_o \| + cd + g \| v_{i+1} - v_i \|^2 z$$

It can also be defined as,

$$F_i(W) = f_i(W) + cd + g \| v_i - v_{i-1} \|^2 z$$

The distance covered by the mobile transmission and reception is nothing but the distance between its initial position and its designed position which can cause short delays in mobile transmission and reception relocation.

The problem formulation is achieved over a network with more than one fixed source nodes that stores the data collected by other nodes and a fixed destination. The key is to find,

i) A regulated routing tree from source to destination.

ii) Minimizing the total energy consumed for transmitting data from source(s) to destination by find the best position of mobile nodes in the tree.

iii) The energy consumed by relocating the mobile transmission and reception.

But according to the problem formulation,

i) The source node acts as storage points which hold the data gathered by other nodes and transmits it periodically to destination according to the user needs.

ii) The initial position of nodes and amount of data to be transmitted from source to destination is only considered.

The formulation can be done as, for best path mobile transmission and reception the input I, be a list of ‘n’ nodes $(i_1,\ldots, i_n)$ in the network. L, a list of ‘n’ locations $(l_1,\ldots,l_n)$ where l_i is the initial position of node is. h_i is the weight of node is which is computed later which equals to total number of bits transmitted by node is.

A setup is defined with a pair of two sets <D, F> where, D is the regulated arcs (i_s, i_o) representing the regulated tree where, all sources are leaves and root F is the destination. A list of locations $(l_1,\ldots,l_n)$ where, l_i is the transmission position for node.

The formulation can be done as, for best path mobile transmission and reception the input I, be a list of ‘n’ nodes (i1,…., in) in the network. L, a list of ‘n’ locations (l1,…,ln) where li is the initial position of node is. hi is the weight of node is which is computed later which equals to total number of bits transmitted by node i_s.

A setup is defined with a pair of two sets <D, F> where, D is the regulated arcs (is, io) representing the regulated tree where, all sources are leaves and root F is the destination. A list of locations (l1,…,ln) where, li is the transmission position for node.

The cost for setting up <D,F> are,

$$f(<D,F>) = \Sigma ch_i + g \| w_i - wo \|^2 h_i + z \| i_o - w_i \| \; (i_s, i_o) \epsilon D$$

Incremental Approach:

The best path mobile transmission and reception breaks the problem into,

A. Fixed Tree Construction:

The algorithm is applied to each and every step to solve a particular sub-problem. It is best suited for fixed environment where the nodes are not mobile.

B. Adding Node:

It improves the structure of routing tree which restricts the mobility of new nodes.

C. Optimal Tree:

It allows relocating of nodes without changing the structure of tree to improve routing.

The incremental algorithm combines the best position for each given node with the condition that the structure of routing tree remains fixed. The insertion of node and optimal tree solves the simple case of mobile transmission and reception setup problem with single source, single destination and single transmission and reception node. The approach does not guarantee to produce an optimal setup since the optimal structure is not found.

A. Fixed Tree Construction:

There are several applications which relate different conditions to the routing tree. In order to minimize the energy consumption a tree with best solution without mobility is chosen. The construction of tree is done as,

i. Some applications are restricted for selecting the routes which are pre-defined according to some other factors.
ii. It is possible to update the given routes provided the main structure of tree is maintained.
iii. In case, if the applications define conditions, the solution is started at different phases of algorithm.
iv. In case, there are no restrictions the first step is constructing a tree or else with fixed root optimal tree algorithm is applied directly.

A tree is constructed using shortest path strategy for which a weight function h is defined. For each pair of nodes, is and io in the network the weight is defined as,

$$h(i_s, i_o) = c + g \left\| o_{is} - o_{io} \right\|^2$$

Here, o_{is} and o_{io} are the original positions of nodes is and i_o. c and g are the energy parameters.

It is observed that using weight function, an optimal tree within fixed environment agrees with the shortest path tree rooted at destination so the shortest path algorithm starting at destination to all the source nodes is applied to obtain initial structure.

B. Adding Node:

The routing tree can be improved by addition of nodes to the routing tree without considering the movement of inserted nodes. For every node, the i_{out} is the optimal position which will not be included in the tree but to calculate the reduction in the total cost along with is, i_o, i_{out} will also be included. Then, the data will be routed from is to i_{out} and then to i_o rather directly from is to i_o.

Upon each and every addition of nodes the reduction in total cost and optimal position is calculated. At the end, the structure of routing tree will be fixed and its mobile nodes can start relocation into their optimal positions.

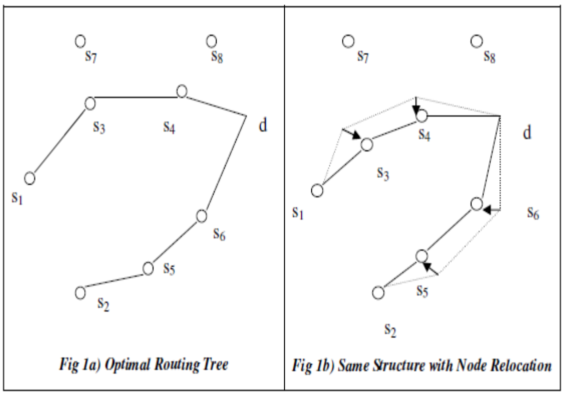


Fig. 1: Optimal configuration illustrating the data transmission.

C. Optimal Tree:

A sub-problem of finding best positions for transmission and reception for routing tree is considered where the structure is fixed. Here, the leaves form the sources and the destination forms the root. If two separate messages of length d_1 and d_2 use the same path (i_s, i_o) the total number of bits transmitted is $d_1 + d_2$.

The adding node and optimal tree algorithms use optimal position algorithm.

D. Incremental Approach:

A simple incremental approach for calculating the best position vi for each node si is proposed. The approach starts by grouping followed by weighting step. For grouping purpose breadth first traversal of the tree is used. The grouping can be done either as odd/even. The root is grouped as even and each of its children is grouped as odd.

The weight of a node is the sum of message length over all the paths passing through the node. It starts from leaves. In case of intermediate nodes, the weight is the sum of its children weight. The incremental approach is started after each node obtains its group and weight.

```
procedure best path (U^0)
unite ← false;
j ← 0;
repeat
anymove ← false;
j ← j +1;
for i_dx = 2 to 3 do
for i = i_dx to n by 2 do
moved ← best position (o_io, L(i_s), i_s+1);
move ← move (or) moved
end for
end for
unite ← NOT move
until unite
end procedure
```

Fig. 2: Algorithm to compute optimal positions.

In odd increments the position of each odd group node is computed and for each odd group node the distance is minimized without bothering the even group node or vice-versa. In order to optimize the destination a fixed location for child node and parent node is required. Before performing alterations between odd and even group nodes, the approach guarantees that node progress towards the optimal position.

Analyzing Efficiency and Optimality:

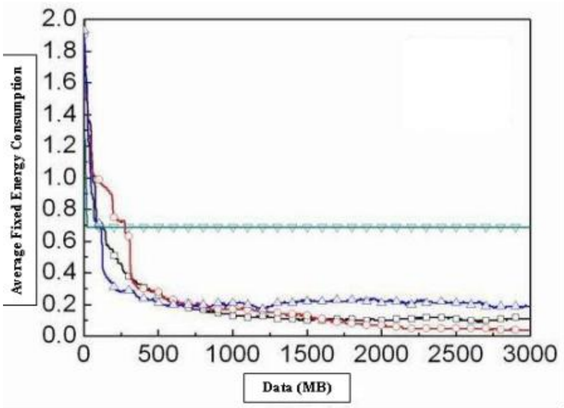
For efficiency, the fixed tree construction algorithm is the shortest path algorithm with time complexity $O(n^2)$ where, n is the number of nodes. The adding node algorithm needs to calculate the reduction cost for each pair of node with time complexity $O(n^2)$. The optimal tree algorithm executes until the position change for each node falls below pre-defined threshold. The value of this threshold represents trade-off between accuracy and cost and upon decrease in threshold a number of increments are required to unite. At the end, the node cannot to move by itself to improve the overall cost. The time complexity for the full approach is $O(n^2)$.

For optimality, the resulting setup is not necessarily optimal since there is no optimal structure. The two algorithms,

i. Fixed Tree Construction produces best solution in a fixed environment where the nodes are immobile so only the original node positions are considered.

ii. The final step in optimal tree contains no node to move by itself for improving the overall cost globally. Relocating multiple nodes cannot improve overall cost.

A trade-off for energy consumption in fixed environment is chosen.



Graph 1: Graph of average fixed energy consumption.

Conclusion:

For this paper, an approach to minimize the total consumed energy by both mobile transmission and reception also the wireless transmissions are proposed. Both the sources of energy consumption are modeled where the optimal position of node receives data from single (or) multiple neighbors and unites to this optimal position. Initially, the routing tree in the fixed environment contains immobile nodes then new nodes are inserted into the tree and finally the optimal positions of transmission and reception nodes in the given tree are

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computed for a fixed structure. These algorithms are suited for a variety of data concentrated WSN. This approach can be implemented in a federal (or) scattered fashion.

REFERENCES

Fatme El-Maoukaddem, Eric Torng, Guoliang Xing, 2013. Mobile Relay Configuration in Data-Intensive Wireless Sensor Networks, IEEE Transactions on Mobile Computing, 12(2).

Gandham, S.R., M. Dawande, R. Prakash and S. Venkatesan, 2003. Energy efficient schemes for wireless sensor networks with multiple mobile base stations, in Globecom.

Ganesan, D., B. Greenstein, D. Perelyubskiy, D. Estrin and J. Heidemann, 2003. An evaluation of multi-resolution storage for sensor networks, in SenSys.

Goldenberg, D.K., J. Lin and A.S. Morse, 2004. Towards mobility as a network control primitive, in MobiHoc, pp: 163-174.

Jain, S., R. Shah, W. Brunette, G. Borriello and S. Roy, 2006. Exploiting mobility for energy efficient data collection in wireless sensor networks, MONET, 11: 327-339.

Jea, D., A.A. Somasundara and M.B. Srivastava, 2005. Multiplecontrolled mobile elements (data mules) for data collection insensor networks, in DCOSS.

Kansal, A., D.D. Jea, D. Estrin and M.B. Srivastava, 2006. Controllably mobile infrastructure for low energy embedded networks, IEEE Transactions on Mobile Computing, 5: 958-973.

Luo, J. and J.P. Hubaux, 2005. Joint mobility and routing for lifetime elongation in wireless sensor networks,in INFOCOM.

Luo, L., Q. Cao, C. Huang, T.F. Abdelzaher, J.A. Stankovic and M. Ward, 2007. Enviromic: Towards cooperative storage and retrieval in audio sensor networks,in ICDCS, pp: 34.

Shah, R., S. Roy, S. Jain and W. Brunette, 2003. Data mules: Modelinga three-tier architecture for sparse sensor networks, inIEEE SNPA Workshop.

Somasundara, A.A., A. Ramamoorthy and M.B. Srivastava, 2007. Mobile element scheduling with dynamic deadlines," IEEE Transactions on Mobile Computing, 6: 395-410.

Szewczyk, R., A. Mainwaring, J. Polastre, J. Anderson and D. Culler, 2004. An analysis of a large scale habitat monitoring application, in SenSys.

Wang, W., V. Srinivasan and K.C. Chua, 2005. Using mobile relays to prolong the lifetime of wireless sensor networks, in MobiCom.

Wang, Z.M., S. Basagni, E. Melachrinoudis and C. Petrioli, 2005. Exploiting sink mobility for maximizing sensor networks lifetime, in HICSS.

Xing, G., T. Wang, W. Jia and M. Li, 2008. Rendezvous design algorithms for wireless sensor networks with a mobile base station," in MobiHoc, pp: 231-240.