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Impact of NP-Complete in Triangle Segments Tree Energy Efficiency Model in Wireless Sensor Networks

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ABSTRACT

One of the essential applications of Wireless Sensor Networks (WSNs) is to control and monitor several events and evaluate values where an extensive sensing task is needed and mankind cannot reach to it. We entail to give the solution to the peculiar sensor network dilemma to have power saving because the evaluator requires to collect the data for a lengthy locution and replacing device batteries is not feasible after deployment.
In this research paper and for vitality economic indexing we propose segments tree that splits the network space into a number of triangles and the calculation of network space area will be according to various stages. In first stages the evaluation will conduct over two set triangle and in second stage whole area evaluation will conduct, which all combine triangles represent the stage two. According to our first stage, the energy consumption is based on our proposed algorithm for evaluation the tree which all the parents have the complete detail of its area child. In this paper to make use of energy saving in a data assembly we make data convocation routing tree by consideration for a reliable communication in two ways.
For Energy saving gathering model, we try to design energy efficient data gathering for routing in tree model while we can have trustworthy communication at the time of broadcasting and collision avoidance. In this method the demonstration for dilemma is through NP-Complete as an individual case is consider, and to show the efficiency the backtrackings algorithms are implement.
KEYWORDS: Prime's Minimum Spanning Tree, energy aware protocol, power efficient gathering in sensor information systems, energy efficient data gathering, min-power symmetric connectivity.

1. INTRODUCTION

Currently, the idea of implementing of sensors has been changed. This aim, bring the new applications the multifunctional peripherals, which embodies new tiny electronics and wireless communication technology, to fulfil other than sensing measurements also [1, 2]. This small peripheral even incorporates multifunctional sensors for sensing and deploy with an average processor and not large memory for processing with a wireless trans-receiver in communication with support of batteries. Sensor networks can be used for physical asset values measurement to monitor or detect particular areas to evaluate even occurring. The main idea behind this research paper is to examine and develop a technique to make the energy saving on various nodes for wireless sensor networks. Power constraints are the most sensitive interrogation to admit the networks fulfilment and extend enough to operate with limit power resources. Furthermore, as generally these sensors implemented in areas which either is not accessible by mankind or do the battery replacement and recharging, the use of particular efficiency theorem is visible. As Figure 1 is showing the most power consumption is related to the trans-receiver task [3]. Generally, the current deployment is over the idle mode, which consumed much energy and gives the idea to propose a better efficiency model with referring and take the advantage of sleep mode.

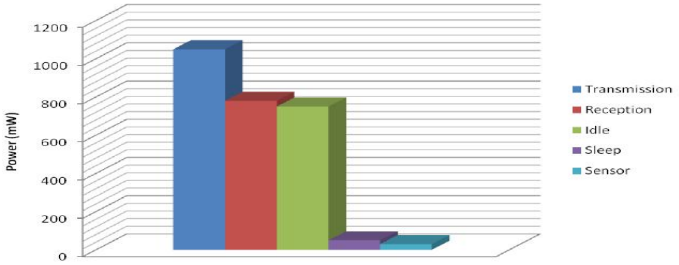

Figure 1. Comparison between various sensor node modes in WSNs.

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2. BACKGROUND

Wireless sensor networks dwell of spatially distributed self reliant sensors for monitoring various situations like motion, pressure and other deployment propose for motivation of military applications [1, 2, 4] and afterwards find its place in several automation monitory and control in industrial [1, 5, 6]. In the recent computation and also communication bandwidth to increase the network energy efficiency critical it has present a valuable role [7]. In various researches the analysis of creation network energy saving has been proposed.

In [8] also focused on maximizing the network lifetime of WSNs by using sink mobility. Energy formula that determines the moving times of sink based on residual energy of sensor nodes is proposed in this work [9]. Furthermore, approach to calculate optimum path is used, which results in increasing the network lifetime.

Another study, shows the well efficiency in shortest hop routing tree to calculate the closest neighbour packet and give the ability to reach to a good performance offer the energy delay and in compression to PEGASIS [10] (Power Efficient Gathering in Sensor Information Systems) and BINARY.

Energy Aware Protocol (EAP) is introducing clustering calculation to elect a head cluster [11], which takes the capacity of hydrogenous energy.

In CHs or Cluster Heads method the evaluation is based on clustering which all normal cluster heads and nodes use a tree structure to communicate with the cluster heads [3].

In minimum transmission energy routing protocol, each node transmits to its nearest node, so the nearest nodes die at a faster rate because; they receive data from the farther nodes [12]. In LEACH there is a localized coordination amongst the nodes for clusters set up and locally compress the data to reduce global communication. CHs in LEACH are rotated randomly.

3. ANALYSIS OF CLUSTER TREE MODEL

In this model, all the nodes together build the tree and the information transmits through this tree until the bottom of construction. In global view of this method, the energy efficiency is representing a good and sufficient mode while a system will face postponed the problem. As Figure 2 shown, the topology behaviour of the routing determination is exclusive and in node alternation the model reaches to saving energy consumption. In this topology, the parent child relation is deployed by leaving the child nodes and reach to the parent node, which one node that calls the parent can relate to any other route but a child cannot be enclosed with two routes.

In this methodology, the routers and end nodes are two types of the wireless nodes and the nodes, which the node can contribute in multi-hop routing as routers. For such cases the nodes that don't admit to corporate with other nodes are referred as end nodes. The nodes are formed in groups, which called clusters and every router forms a cluster, which refers to its own head and all of its child nodes are associated to the cluster, and the head handles all their communications.

As you can see in Figure 2, we can have an adjacency square matrix M_1 with the total number of nodes, which has M_{ij} and is equal to 1 in case the j router is the parent of i node and in the reverse is equal to 0.

The time demeanour of every cluster is occasional and each cluster has two portions, which are: (1) Dynamic; which enables a cluster head transmitted information in its own cluster and sluggish that part, (2) Inactive part, (low power mode).

Every router except of the main router has two clusters, once as a head of the cluster and once as a child. Therefore, every router must be waking up when one of these two clusters is become activate otherwise it goes to the second portion which is the low power mode.

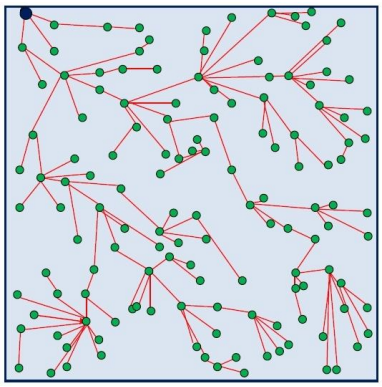

Figure 2. Simple cluster route model

Each router has to maintain the active portion timing of each parent cluster and its own dynamic portion, and it acts as a child node in the former active portion while in the next dynamic portion it acts as cluster head; In the meanwhile the transmission from the cluster children to their parents is terminated, and in the relative time consumption of these portions is delimitate by the start time parameter [13].

4. EVALUATING OF PROPOSAL MODEL

In our proposal model, we assume that each node in a selected area has two fold locations that one is related location to the whole selective area and second is the segment area and to construct segments two main stages should be passed.

Stage 1, in this stage, the main parent which is the primary router, has to transmit the information to the entire *n* nodes, and send data to all the nodes. In the next, data initiated to barter in the whole selected area of the complete network and the total number of segment *S* area (which is a combination of two set reverse triangle). The location of sink node aid each segment to resolve a sub-root between all conducted nodes, which are the nearest to the stabilizer location to barter in the whole chosen area. In this stage, all the sensor nodes over the network find the location and reckon segments and the segments number, which they are affiliated to them. For the next step, they barter their data by transmitting a message to their own neighbour, and barter data within the triangles. Finally, all the nodes at the end of this stage should have their require information for their next movement. This information is including the main parent location, the triangle number, which is allocated as its neighbour and neighbours' location and the segment that it is affiliated to.

Stage 2, this stage is divided into two main categories. In the first category, we assume that all the trees in triangles are resolute by PMST (Prime's Minimum Spanning Tree) algorithm to build each segment. For the initial in every segment node compute their location to the stabilizer location from the neighbours to themselves. Here a feasible condition is shown that if the nearest node to the stabilizer location is the node itself, that node will be districting sub-root of that triangle, and there will be no transmission between these nodes. In the next, after while the sub-root node transmits their data to all the other nodes in the same triangle to construct the virtual tree.

For such an instance distributed tree construction is deploying that transmission tree constructed message to forward recursively until all the nodes receive the message and establish their levels, and again after an immense time the leaf nodes will commence the reverse tracking to the triangle sub-root, so all the nodes (sub-root nodes) will have the imagination of the segment. Now in the current situation each district sub-root node will run PMST algorithm to erect their power saving of segment trees.

By taking the advantage of this algorithm, it is ultimately, establish the tree that can confer a particular node as a root, and it will be continued until obtain an optimal solution for power saving. As we have shown in the Figure 3 by our proposal model, which taking the advantage of PMST algorithm in comparison with cluster tree model, which mostly implemented by a simple tree algorithm the power consumption when a message by pass and deliver to another node with various numbers of nodes and energy can show the efficiency of our model.

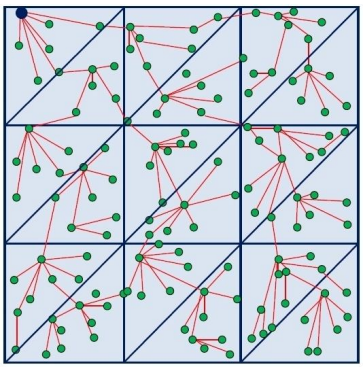

Figure 3. Structure of Triangle segments tree model

With the aim of our algorithm which is work in Euclidean distance, on the link, once again, the weight of the commence range of sensor nodes does not influence to the shape of the tree scenes in all cases. This make that it goes to the closest node, which may not, included in the current spanning tree.

In the second category, the triangles' tree is going to be connected to each other and create one united tree, which is the combination of whole segments. To construct these vast trees, which a message can distribute to any node $S + S (n_n)$ in the network, where n_n is the intermediate of neighbours of sub-root nodes the following steps should take place. Initially, sub-root nodes barter messages with their intersegment nodes, which are gone to the segment on the contrary within its range, and later, segments sub-root nodes can use one of the intersegment neighbours as a link to communicate triangle trees to each other. Afterwards, construction of a segment cost of $6n+ S (1+n_n)$, which in highest value it will be $7n$ since $S + S (n_n) <= n$ should be done. Finally, cost of tree constructed is $O(n)$. To contrast, differentiate of energy utilization by applying the proposed algorithm and simple cluster tree is shown in Figure 4.

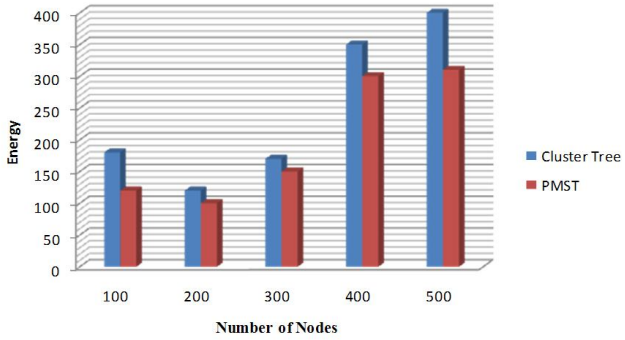

Figure 4. Experimental comparison between proposed model and simple cluster tree in energy consumption

Proposed Algorithm:

Step 1: For each segment do
Step 2: Start counting the number of neighbours through sub-root
Step 3: If step 2 > 0 then
Step 4: For each neighbours do
Step 5: If neighbour is not in other segment and selecting an angle made by location of sub-root, the neighbour and the main parent <= 30 then
Step 6: Return connect-segment node with smallest angle
Step 7: Else if connect-segment node's set is empty
Step 8: Return separate segment.

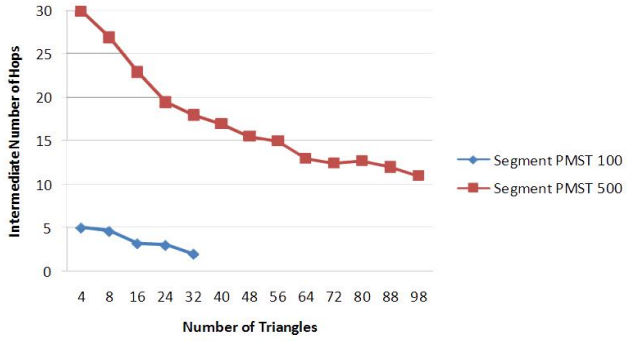

Figure 5. Simulation of intermediate number of hops in terms of number of Triangles

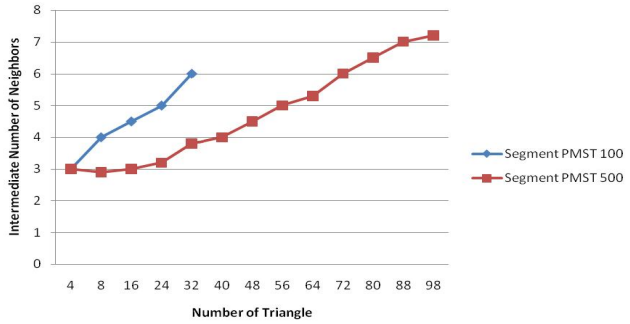

Figure 6. Density simulation of intermediates neighbors number in terms of Triangles number

In Figure 5 and Figure 6 the nodes correspond with numbers are shown by 500 as compact case and 100 intend for distributed of nodes. Our proposal algorithm at all the times traverses a tree with minimum distance.

On the other hand, when the radio range altered and has been incremented, it causes the neighbours number also increase and consequently, hops number will decrement.

5. EXPERIMENTAL ANALYSIS AND RESULTS

In this paper, we implement our sensor node randomly to take the output for the simulation. In our simulations, all the sensors uniformed and the most top left node of the network area is selected as a sink. The radio range simulation initially was 40 m and adjusted to all nodes.

As we have mentioned, before the isolation of a node may happen in deployment, and those are not considered for our result calculation.

In the last simulation comparison, which shows the efficiency of the proposed model (Figure 7), the energy utilization of the cluster tree model at the initiated time is much more than the proposed model, and it is near by 33000; however in the same radio range the initial consumption of our model is near by only 7000. Here we should mention that the energy utilization of the cluster model is rapidly decreased when the radio range is less, but its initial consumption causes an unmanageable battery level control.

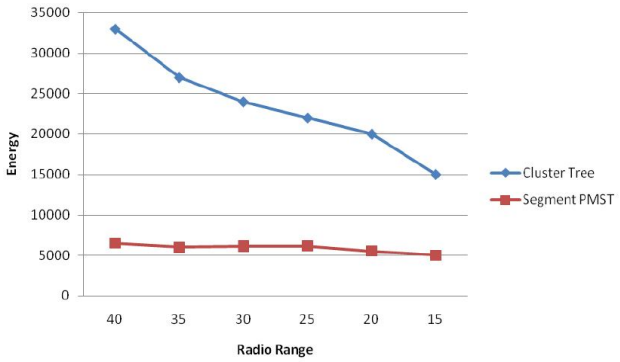

Figure 7. Energy utilization in terms of various radio ranges

6. COST OF ENERGY EFFICIENCY DATA GATHERING (EEDG)

Commonly a node is consuming the energy by the time of receiving or sending and somehow in overhearing for a particular packet or either the node is in idle status; while by considering Basu P. and Redi J. method [14] in energy saving, it deliberates for overhearing of the packets energy utilization. Generally overhearing of a message is when a message can not deliver to a particular target so estimate the quantity of this energy consumption is require to include overall transmission energy utilization from a source to destined node.

6.1. EEDG THROUGH THE NP-COMPLETE SOLUTION METHOD

To demonstrate the NP-complete method for the problem, at first we start to make the corresponding problem to NP-complete dilemma, which is Minimum Power Symmetric Connectivity [15]. So, the evidence confirm that the EEDG dilemma may have the MSC problem and that can define as in such condition limitation is included on instance for EEDG dilemma, then the result can come out through the limited problem which may correspond to the MSC problem.

Here is specified that the sensor nodes amid the highest radio range frequency and selected as a sink node. To initial the data collection from all available sensor nodes and transmit the data and communicate to the finally sink node, the particular sink node may receive the consequence data. To show this method the occurrence of the edge dilemma can be adequate to add to the those MSC problem, however, ordinary occurrences for the both problems are having an edge, a tree and also radio range frequency which has been obligated. Imbedded energy obligation for EEDG by adding the MSC while it wants to persuade the following condition for the allocated energy can be:

$r_i \geq |ij|$ and $r_j \geq |ij|$ *(1)*

Now the overhearing nodes are incorporated in occurrences of EEDG, which is utilize for the cost utilization while it is excluded from MSC, and the dissimilarity among the dilemma can be find out in weight function for the

edges in its explanation. Therefore, to distinguish, the following problems are revealing. Firstly the weight function can have three arguments in-case of EEDG, but only one for MSC; and secondly in the edge dilemma the total weight for the edges is at the minimize and even at the same time MSC is minimized at the nodes.

These distinction is because for MSC is try to get a tree which included the total of all nodes which has been minimized the weight in a specify network, and in the meantime for EEDG this total is for the minimize of the weight for the all included edges of the same network, which the weight of edges show the utilize energy of the nodes.

6.2. BACKTRACK ALGORITHMS IMPLEMENTATION

The backtracking entail that an edge which has been implemented for a resolution can remove by the algorithm with a fresh edge that can minimize the sum of weight of a tree in the same step. As an extension to the Prime's Minimum Spanning Tree to expand backtrack algorithm one step and two step backtrack can be define and implement.

In one step method of backtracking it implies to include a node to spanning tree but the weight of that edge should has the minimum cost. This is obligate since the radio range of sender and receiver is employ as an edge weight for this method, and it is increment in spanning tree to go further to cover all the weight of whole edges, which touch this node, and it should re-evaluate and compute again. This happen for the reason that while the radio range is amplified or either one of the arguments in the function is altered can have an effect on the weight. The beneficent of this method, is, that is working on a possibility method. In-case in an earlier step if there is an edge that can have more energy saving, it would alter, so, the solution can be more optimal, and it is while they are generating the spanning tree, but somehow if the minimum edge weight does not find, the present spanning tree will be utilized. In two-step backtracking method backtracks go furthered for two prior steps to find an optimal solution.

6.2.1. PROPORTION ACHIEVEMENT

To measure the achievement of these algorithm methods, we compare the utilization energy for two discussed algorithms, one step and two steps backtracking with Energy Conserving Routing Tree (ECRT), and the evaluation has shows in the following figure (Figure 8).

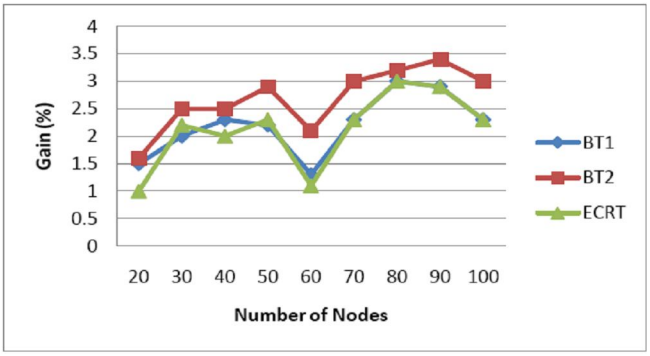

Figure 8. Proportion achievement or gain according to the number of nodes

For evaluation to find the influence of different data size the gain is calculated for them also. As you can see in Figure 9 the gain is decreased as the data size in bytes is increased and it denotes that in the idle mode the energy consumption for data communication is less than the gain of all algorithms.

ECRT is approximately equal to one step backtracking, but in case of two steps backtracking is outperform in data size in comparison with other algorithms. In the final assessment the energy consumption and its influence is calculated and it is shown in Figure 10. To compute the likely ratio of energy consumption in the idle mode when the node is waiting to receive the data, different ratios have been calculated. The result is included the present experimental values and is compared with [16, 17, 18]. The two step backtrack algorithm shows the best performance in compare to all further algorithms; however the most logical value for ratio is its outcome, which is less than 1.

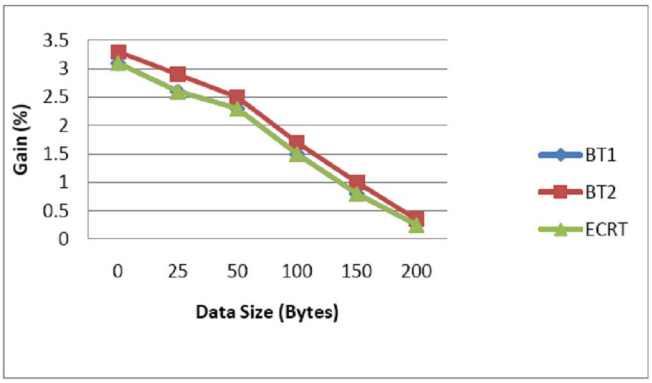

Figure 9. Achievement on Data Size

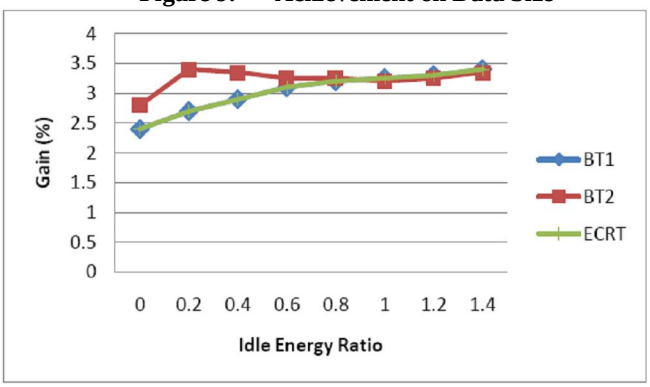

Figure 10. Ratio in Idle mode energy consumption for receiving data

6.2.2. OPERATION TIME

The real operation time for regular case should measure and analysis. Earlier, we have shown that two step method backtracking generate a tree which may utilize the minimum energy weight than the one step backtracking and also in PMST all types of various constraints like data size, number of nodes and energy is analysed, finally the outcome shows that the two step backtracking can saves more energy than one step, and also we can mention one step backtracking even saves more energy in compare to PMST. The Figure 11 shows that the operation time for all these algorithms according to reversed order of weight to the number of nodes.

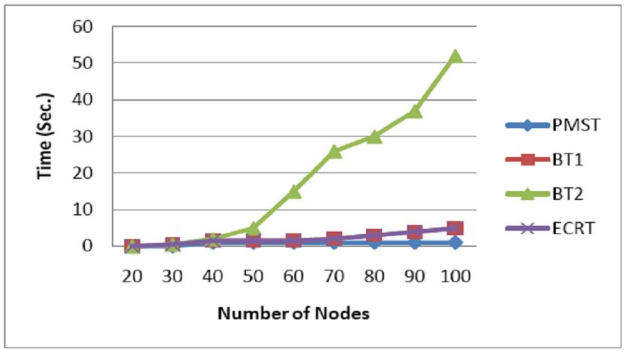

Figure 11. Operation time according to Number of Nodes

7. CONCLUSIONS

We erect a set of the triangles' tree within every segment, thus the shape of a tree is important and helpful that capable of simply recognizing the parent of each triangle and furthermore segment. Minimizing the triangle border and location of trees, aim the sensor to save the power, which is spontaneous since can prevent flooding a

network and just direct particular query to applicable nodes and always try to minimize the query which consequence the transmission reduction and finally power efficiency.

We propose the segmental model, which has triangle sub trees in various segments and divide our sensor network. After that, proposed PMST algorithm nodes can arrange to communicate and their energy, so they signal range may just meet their parents and children, and it can help the number of node reduction to overhear the messages from the transmitter.

The proposed model has virtual segments that have the triangle set tree, and it shows its efficiency when a special query propagate to a region where information is announced to the particular main parent.

In this paper, the EEDG tree dilemma is defined as a minimum weight (cost) for spanning tree, which is based on edge weight and we have shown that through the NP-Complete how this dilemma can solve. For simulation the both way data communication that can be included energy consumption idle mode and overhearing is calculated for each edge weight in data gathering tree. One and two step backtracking algorithms is utilized and we have shown that for district solution we can get the satisfactory result as they are generating spanning tree model also. These two algorithms can give more efficient result for adequate cost saving and energy efficiency.

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