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An Adaptive Distributed Clustering with Topology Control approach for Sensor Networks

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ABSTRACT

Adaptive distributed clustering with topology control is added in the sensor network for organizing the sensor nodes in an effective approach and energy consumption. In a cluster, effective inter-and intra-node communication is essential for the workload sense of balance among the nodes, updating new nodes in the network, increasing the network lifetime and valuable resource exploitation. This mechanism is suitable for streaming of data, scalable to huge dimension networks, detachment of the sensor nodes in to level headed sets faster and extensively speeds up the communication among nodes compared to the adaptive and optimal distributed clustering algorithm. This proposal includes the least connection algorithm which directs link connections to the cluster head with the least number of established connections among the nodes. Simulation results show that the performance of adaptive distributed clustering provides higher throughput and energy consumption.

Keywords : Cluster Head, Energy Consumption, Least Collection Algorithm, Medium Access Control, Tool Command Language.

I. INTRODUCTION

Sensor networks are spatially distributed autonomous sensors to observe physical and environmental conditions such as temperature, sound, pressure etc. it is used to cooperatively communicate and process data with the neighbouring sensor nodes. The sensor nodes are small size in nature and limited battery power supply. Minimizing energy expenditure and scalability are very important issues in sensor networks because of limited battery resource. Several approaches are introduced for energy efficiency such as scheduling the data packets in the sub layer of data link layer called medium access control layer, sending and receiving of data packets in the network layer and clustering and multiparty processing. Many sensing tasks require a sensor network system to process data cooperatively and to gather data and control packets from various sources. In order to balance the energy, cluster head must be selected appropriately. For the selection of cluster head, various parameters are to be considered such as distance between the sensor node and cluster head, control message and data packets transmission range, list of nearby nodes and so on. Cluster head transmits the control message called group head periodically. If this message is received by the nearby nodes, the nearby nodes will transmit the reply message called bond. Cluster is formed by sharing these control messages. The Least Connection Scheduling algorithm is adapted with the adaptive and distributed clustering to control the network topology.

II. METHODS AND MATERIAL

A. Literature Review

Numerous protocols have been introduced for energy utilization. Saving the energy is an important issue to increase the lifetime of a sensor network. S-MAC, PADAMACS, APRECP, Distributed Clustering algorithm, Weighted Clustering Algorithm have been proposed for energy efficiency. Time Division Multiple Access Mechanism (TDMA) has been introduced to reduce the collision and save the battery power. Heinzelman [2] proposes a centralized version of Low Energy Adaptive Clustering Hierarchy (LEACH) is purely task oriented; cluster and TDMA based MAC protocol which integrates the clustering technique with simple routing. It is mainly designed for longer network lifetime. In case of Online Data Gathering, each sensor node broadcasts its control information such as its present position and energy level to cluster head. In order to keep away from inactive listening S-MAC introduces sleep mode. In this scheduling algorithm, the node which is not involved in transmit/receive be in sleep mode. Whenever any wants to transmit or receive data packets can be in active mode. Additionally control signals such as Request To Send and Clear To Send are used for energy efficiency. In case of Power Controlled Multiple Access Protocol, User Busy tone is used instead of Request To Send and Clear To Send signals. An adaptive Power Resourceful and Energy Conscious Protocol consists of four phases such as understanding the identifying the nearby nodes, collecting various information for scheduling from various sensor nodes, and reschedule whenever it is needed [3]. In case of CSHC, Cluster is formed by constructing Breadth First Search Tree with various parameters like the distance between nodes, transmission range of nodes. It is possible to reduce energy consumption in the network layer also by allowing some nodes for routing and keeping other nodes with no participation. Tabu search uses intra node search ie, within small coverage area and it follows the step by step process for moving from one solution to other until the condition is satisfied. K-Means algorithm uses linear method for the construction of cluster. In this method, nodes which are closer to the cluster head forms a cluster by using mean value and it continues the process until no other nodes are pending.

B. Proposed Method

The main aim of this proposal is for continuous flow of control signals and data packets and it can be increased to large size networks, partitions the sensor nodes in to reasonable sets faster, and significantly speeds up the communication. In order to form the cluster nonlinear data structure is used. In this proposal cluster head collects the data packets from various sensor nodes, aggregates them by using merge-and-reduce technique for streaming. Cluster heads are equally scattered in the entire region, then only it is possible to get proper communication among the sensor network. Otherwise some cluster heads are overhead compared to other cluster heads. Some additional effort is needed for the formation of meaningful cluster. Cluster head performs various activities such as coordination, collection, filters redundant information and sends responses to node collector. Additionally this proposal includes the dynamic scheduling algorithm which directs the network connections to the cluster head with the least number of established connections among various sensor nodes.

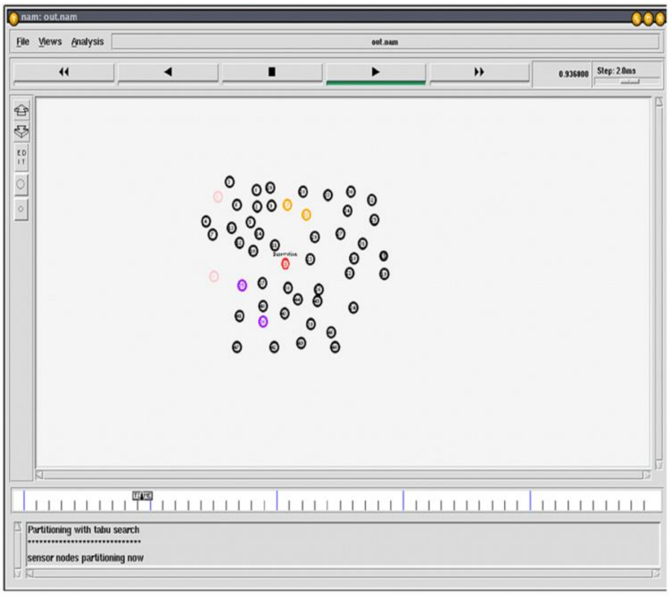

Figure 1. Initial Stage of Cluster Formulation

C. Formation of Cluster

Step 1: choose cluster head CH_1 uniformly at random from region R

Step 2: CH = $\{CH_1\}$

Step 3: for i= 2 to n

Step 4: choose the next cluster head with the probability. CH_{prob}

Step 5: CH= CH U $\{CH_i\}$

Fig. 1 shows the initial stage of cluster formation of adaptive distributive clustering. Node is discovered by using the power level of cluster head and the distance measure either close to or far. Partitioning the entire region R in to two sets called $R_{close\ to}$ and R_{far}. Initially, cluster head sends the control message which carries various fields such as its ID may be CH_i, power level of the cluster head, cost or transmission range, type of transmission such as broadcast or multicast. Based on the region cluster head may choose the node from $R_{close\ to}$ from the region R, if any node is not available in that region, else some other cluster head will choose the node.

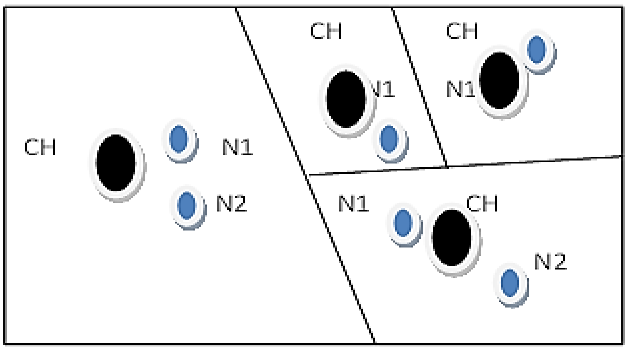

Figure 2. Grouping CH with Region

Figure 2 and 3 represents grouping of cluster head with different regions and dendogram approach for the cluster head selection.

AODC approach is used instead of K-Means clustering algorithm. This approach overcomes the drawback of K-Means clustering algorithm. It solves the main issue of scalable to huge set of nodes, by set of extending beyond called shelter wherein each node is a member of at least one shelter. It can be evaluated as one pass. In the second pass, data stream is formed by using Merge-and-reduce technique, it collects data packets from various nodes and prepares. This greatly reduces the amount of computation involved. Let CH be the cluster head with n elements. The maximum number of subsets in an incomparable collection of subsets is $\binom{n}{n/2}$.

3.2 Least Connection Scheduling

LCS counts the number of connections for each cluster head to estimate its load. The load balancer maintains the connection number of each cluster head, increases the connection number when a new connection is dispatched to it and decreases the connection number when a connection finishes or timeouts. It uses round robin as a base scheduling algorithm which uses a time slice for each node for communication.

3.2.1 Proposed Algorithm

Suppose there are a cluster head set CH = {CH_0, CH_1,CH_2 … CH_n}

W(CH_i) is the cost of a cluster head CH_i

C(CH_i) is the current connection number of CH_i,

```
for (m = 0; m < n; m++) {

   if (W(CH_m) > 0) {

      for (i = m+1; i < n; i++) {

         if (W(CH_i) <= 0)

            continue;

         if (C(CH_i) < C(CH_m))

            m = i;
      }
      return CH_m;
   }

}
return NULL;
```

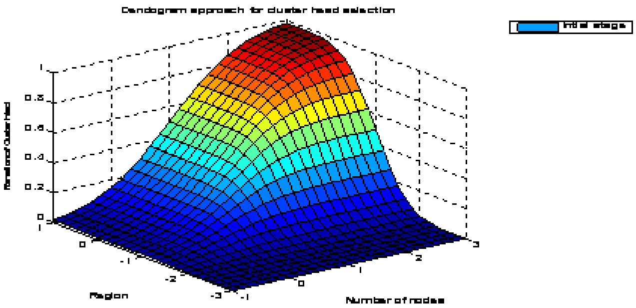

Figure 3. Dendogram approach for Cluster Head Selection

III. RESULTS AND DISCUSSION

The evaluation performance of the adaptive and distributed clustering with topology control was implemented using TCL language utilizing NAM editor and XGraph in NS2 with sensor networks of different sizes and topologies. In this simulation, various parameters have been included such as throughput, energy consumption over number of nodes.

Performance of adaptive and distributed clustering with topology control for wireless sensor was compared with adaptive and optimal distributed clustering for the factors like throughput & energy consumption and the graph (4.1 – 4.2) shows that the performance of adaptive and optimal distributed clustering is comparatively better than the performance of existing method.

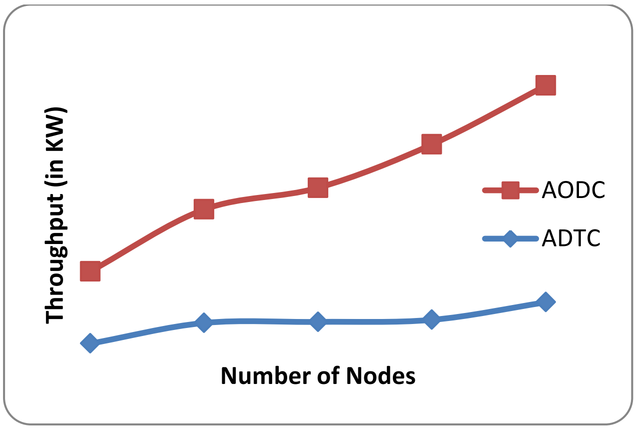

Figure. 4. Number of Nodes vs Throughput

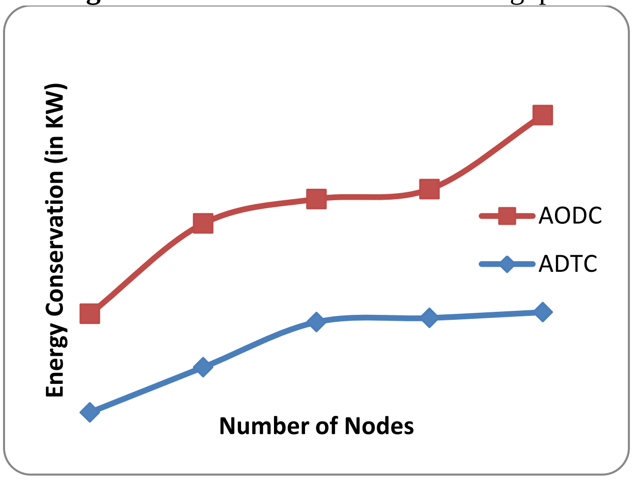

Figure 5. Number of nodes vs Energy Conservation

IV. CONCLUSION

Adaptive and Distributed clustering with topology control uses least connection algorithm for topology control and uses merge-and-reduce technique for data stream and partitions the sensor nodes in to reasonable sets faster and significantly speeds up the communication among nodes compared to the existing method. Simulation results show that the performance of adaptive distributed clustering provides higher throughput and energy consumption and it is suitable for large scale networks.

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