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A Route Discovery Scheme For Inter Cluster Routing With Novel Cluster Head Selection

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Abstract: Any network should have the capacity to operate in harsh environments despite of the constraints taken in WSNs. Multipath, tree, cluster and hybrid topologies are the collection schemes fail to provide a mobility, traffic and end-end connection. In earlier existing system like CIDT, the cluster head will be selected randomly because of it end-to-end delay, no of live nodes ,no of alive nodes, no of hops will more, in order to overcome this, a Velocity Energy-efficient and Link-aware Cluster-Tree (VELCT) scheme is proposed for the data collection in wireless sensor networks. End-to-end connection, delay, traffic coverage distance, mobility and residual energy can be controlled by the proposed VELCT scheme. Based on the cluster head location, the VELCT builds the Data Collection Tree (DCN). The DCN node doesn't take part in sensing, however, it simply receives the data packet from the cluster head and delivers it to the destination. By using DCN node, the proposed VELCT scheme reduces the energy exploitation, reduces the end-to-end delay, number of dead nodes traffic, number of hops and residual energy of the nodes will be more in cluster head in WSNs. The main aim of VELCT algorithm is to build a simple tree structure, thereby reducing the energy consumption of the cluster head and avoids frequent cluster formation.

Keywords: WSNs, VELCT, CIDT, DCN, Cluster Head, Sensor Nodes.

I. INTRODUCTION

Recently Wireless Sensor Networks (WSNs) have become prominent as they compose of Nano technology and MEMS (Micro Electro-Mechanical Systems) which includes networks that have small distributed sensors and actuators. Similarly, power VLSI and embedded computing which is an emerging technology, combined together with communication hardware realized this technology in to reality, this combination of communications and computing revolutionize our life at several stages. It includes day to day applications such as context aware computing, process monitoring, economics, acoustic detection, health care applications, infrastructure protection to alarming applications including seismic monitoring, meteorology, environmental monitoring, mining most important military applications such as undersea navigation, inventory tracking, smart spaces and tactical military surveillance.

The effectiveness of the WSNs lie in their wide range of useful properties such as high sensing quality, more flexibility, less energy consumption, high mobility, increased network lifetime, scalability, vast coverage, etc., that they can offer. Naturally, WSNs are the first choice when any deployment in remote and hazardous environment is required. The soul goal of such Wireless Sensor Networks which are deployed in the above mentioned crucial and weird environments is often to transfer the sensed data from sensor nodes to sink node where the further analysis of the received data is conducted.

These WSNs are made up of "nodes" the number of these nodes may vary over a few in simple networks to several hundred or may be even thousands in some of the complex networks, where each node is connected to one sensor or sometimes to several nodes based on the application where they are deployed. Each such sensor network node typically consists of several vital parts, which includes a microcontroller for processing, a radio transceiver with an internal antenna in some cases or connection to an external antenna and for interfacing with the sensors an electronic circuit and an energy source such as a battery or an embedded form of energy harvesting.

In WSNs topology management forms a major task for reducing various constraints such as delay, traffic, computational resource crisis, limited energy, node failure, long-range communication within a network, communication failure, etc. The topology basically comprises of two types of routing path, namely: unicast and broadcast depending on the size, type of packets and other overheads. By cautiously choosing a right topology can greatly enhance the coverage area, lifetime of the network, also the overall performance of the network and thereby Quality of Service of the network will be improved. An efficient topology is one which ensures that the neighbor nodes are at minimal distance so that during data packet transfer the probability of packet being lost between the nodes is reduced and has low energy consumption energy as energy consumption is directly proportional to the transmission distance between the nodes.

In WSNs it is necessary to monitor the dimension of the sensor node group in order to deal with the addition of new members or deletion of members who leave the

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group. By considering all such aspects, the topology may form superior WSNs that provide increased data collection efficiency with very low energy utilization. On the basis of application, the nature of network is selected and various topologies are followed so as to achieve maximum data collection. The existing WSNs include flat, tree, cluster, chain and hybrid topologies for data collection which have their own merits and demerits. In order to overcome the demerits of existing methods a novel cluster tree data collection mechanism is proposed which is named as VELCT. The proposed VELCT scheme is an efficient hybrid scheme that is suitable for dense wireless sensor networks than any other similar topologies. In case of mobility-based environments, it provides better performance than other methods.

2. PROBLEM STATEMENT

In the static WSNs where either all the sensor nodes directly communicate with the sink or simply forward the data packets to the one-hop neighbor nodes and finally reach to the sink conventional Flat Topology (FT) is employed, but this method has many limitations namely vast delay, more node failure, low data redundancy and high energy consumption also this method cannot be employed in mobile WSNs which led to the design of next method Chain Topology (CT), which provides better performance than FT but it consumes time for data collection as it as to follow the chain route to reach sink. Even though the chain topology offered better performance in relative to FT it also has many demerits like more delay, energy consumption and node failure also CT couldn't adapt to mobility-based WSNs which rise to development of Cluster based data collection.
The cluster based data collection offers better performance with cluster heads but it demands more reliable links for data dissemination from cluster head to cluster head or sink (i.e., direct-hop or multi-hop) resulting in increased energy consumption, also in case of mobility-based environments cluster based data collection results in diminished network lifetime. Later, Tree based topology was developed, which can consumes very less energy compare to cluster and chain based topology but it includes several time stamps for collecting data and in mobility environment, it suffers from delayed transmissions, packet drop and link failure. To overcome these disadvantages a hybrid topology. Cluster and Tree based Topology (CTT) was designed.

As the above topologies become infeasible and cannot be adapted to mobile sensor ambiance a new data collection scheme which is improved version of CTT called as VELCT, with improved throughput, RSS, connection time and network lifetime and with minimal end-to-end delay and energy consumption is being designed.

3. PROPOSED VELOCITY ENERGY-EFFICIENT AND LINK-AWARE CLUSTER-TREE (VELCT)

The Fig.1 shows the simple structure of the proposed VELCT scheme. It has improved network lifetime and carries out an effective data collection task, thus increasing the network lifetime with minimum delay.

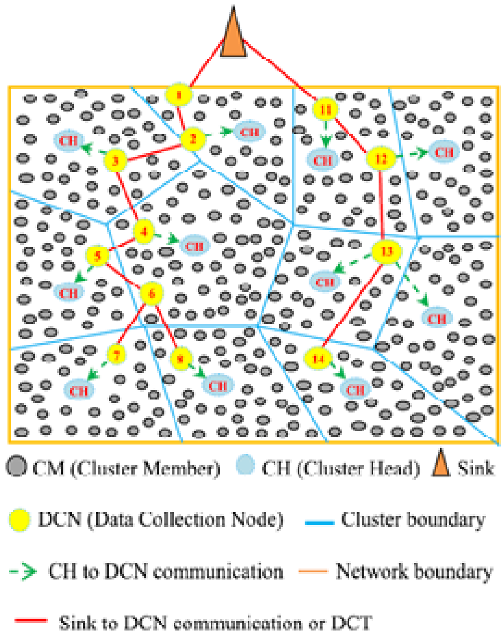

Fig.1 Simple outline of proposed VELCT system

Velocity Energy-efficient and Link-aware Cluster-Tree (VELCT) scheme for data collection effectively encounters the problems of traffic, delay, mobility, coverage distance, end-to-end connection and tree intensity. In the VELCT scheme the Data Collection Tree (DCN) is constructed based on the location of the cluster head. In the DCN, the data collection node will not participate in sensing task; it simply collects the data packet from the cluster head and delivers it to the desired sink. The designed VELCT scheme has more advantages as it minimizes the overall energy exploitation and the end-to-end delay also reduces traffic in cluster head by making effective use of the DCN in WSNs. The strength of the VELCT algorithm lies in the construction of a simple tree structure which reduces the energy consumption of the cluster head and avoids unwanted and frequent cluster formations.

The rest of this paper is organized as follows. In Section II we shall go through the problem statement and Section III presents the VELCT algorithm followed by the implementation of proposed scheme in Section IV. The following section V presents the various simulation results. Finally, Section VI presents the conclusion. The VELCT scheme comprises of two main phases namely: set-up phase and a steady state phase. In the set-up phase, we initiate cluster formation and data collection tree construction so as to identify the optimal path between cluster member and sink. In the steady-state phase the data from the cluster members is transferred to the sink.

3.1. Set-Up Phase

Set-up phase takes place in two stages, the first stage being the intra cluster communication and then the second stage is DCT communication operations. In the process of intra-cluster communication all of the sensor nodes will elect the cluster head and a cluster is formed which has better coverage time, RSS, connection time, and robustness for connection. Once the intra cluster communication is completed the second stage i.e. DCT communication will be initiated so as to collect the data from its cluster head and then the aggregated data packets will be transferred to the sink.

a. Intra Cluster Communication: If we consider large-scale WSNs, the sensor nodes will be deployed densely over the vast region. In the set-up phase, the location and position of the sensor nodes can be identified by using the beacon signal. After identifying all the nearby nodes, in order to elect the cluster head we are going to employ cluster head election algorithm.

b. DCT Communication: Once the intra cluster communication is completed, the DCT communication phase gets started. As we have gone through already in intra-cluster communication phase, a sensor node will be elected as a cluster head to form a appropriate cluster, and then the cluster head collects the data from all its cluster members and also carries out cluster maintenance operations such as data aggregation.

After intra cluster communication, tree formation gets initiated, which carries the task of connecting the cluster head and sink. At this point of time, the sink initiates the DCT formation process. On the basis of the cluster head location and its connection time, a few nodes will be selected as DCN (Data Collection Node) for generating DCT. It is represented in DCT construction algorithm.

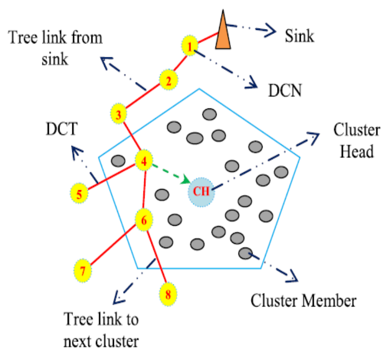

Fig.2 DCT construction for single cluster

For a single cluster DCT construction is shown in Fig.2. Here, we can see that even though the cluster head (CH) can join with any of the DCN-3, DCN-4 or DCN-6 it selects a DCN with better robustness for connection, connection time, coverage distance and with less traffic. Here all the above required criteria is satisfied by DCN-4, hence it is selected. In the similar manner the DCT can expand its tree structure by adding further DCN.

3.2. Steady-State Phase

On the completion of set-up phase, steady-state phase will be initiated. In steady-state phase, collected data from all the cluster members will be forwarded to the cluster head with in the allocated time slots. Then, the cluster head will collects data from all its cluster members and aggregate the data. By this time the DCT communication will be initiated, where Direct Sequence Spread Spectrum (DSSS) scheme will be used to transfer the data from the cluster head to DCN and then finally to the sink. At last, the DCN collects the data from all the corresponding cluster heads and aggregates the data.

4. IMPLEMENTATION

For the implementation of this paper the software requirement includes MATLAB software for simulating the source code. MATLAB is a high performance language which is used for technical computing. It incorporates calculation, perception, and programming in a simple to-use environment where issues and arrangements are communicated in well known mathematical notation.

The methodology involved in implementation of this project is as shown in the Fig.3

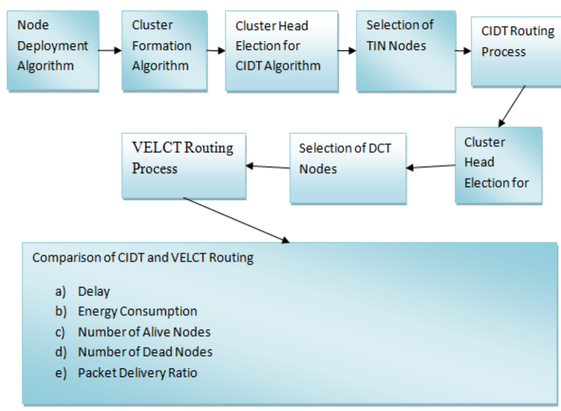

Fig.3 Implementation

The process of implementation begins with the node deployment task, the nodes are deployed in a 100 x 100 area, the overall area is divided into number of clusters which are in turn made up of number of nodes and every cluster will be having a cluster head. Node deployment is followed by the cluster formation then cluster head election which is done randomly. Then selection of TIN nodes followed by the CIDT routing process then cluster head selection based on U criteria for VELCT then selection of DCT nodes which is followed by the execution of the proposed VELCT algorithm. Finally we will compare the performance parameters such as delay, energy consumption, number of alive nodes, number of dead nodes and the packet delivery ratio of proposed VELCT algorithm is compared in relative to existing CIDT algorithm.

5. RESULTS AND DISCUSSIONS

In this section we shall go through the simulation result which mainly concentrates on obtaining the performance parameters for the proposed VELCT algorithm and compare these results with those of existing CIDT algorithm.

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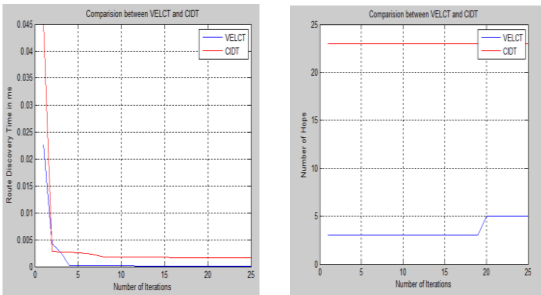
Now, when we implement both CIDT and VELCT algorithms in a scenario where there are same number of clusters and each cluster has same number of nodes and obtain there performance parameters. In case of MATLAB software the results are obtained in graphical form.

a. Route discovery time and Number of Hops:
Fig 4(a) shows the graph of route discovery time v/s number of iterations for VELCT and CIDT algorithm, from the graph we can see that in the similar scenario the route discovery time taken by VELCT compared to that of CIDT is less and thus we can avoid unnecessary delays. Hence, we can say VELCT algorithm is advantageous over CIDT algorithm.

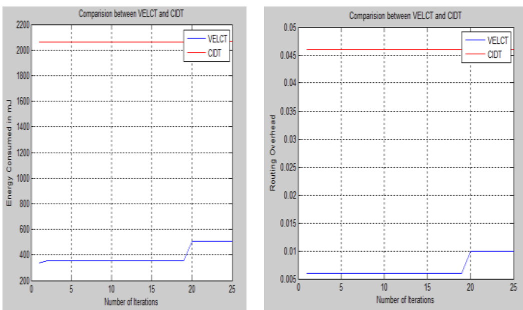
The Number of7intermediate2links from the6source node1to sink node is called Number1of Hops. From5the graph shown in Fig 4(b), we can notice that the number of hops taken by VELCT is greatly reduced compared to CIDT. Hence it is evident that VELCT algorithm is a better option over CIDT. So, by reducing the route discovery time and the number of hops the overall delay can be greatly reduced which in turn enhances the overall performance of the network.



(a) **(b)**

Fig.4 (a) route discovery time and (b) No. of hops

b. Energy consumption and routing overhead:
The energy consumption is one of the vital performance parameter considered while designing any algorithm. Every designer concentrates on reducing energy consumption as much as possible. Fig. 5(a) shows the comparison of energy consumption by VELCT and CIDT algorithms and we can see that the CIDT algorithm is consuming more energy to send a packet from source to sink node when compared to VELCT algorithm.



(a) **(b)**

Fig.5(a)Energy consumption and (b) routing overhead

Fig. 5(b) shows the graph of routing overhead v/s no. of iterations. Routing overhead describes the number of control packets required for sending data packets. If routing overhead is minimum it implies with less number of control packets more data packets can be transferred from source to sink. From graph, we can notice that routing overhead of VELCT is less compared to that of CIDT. Hence, we can say routing is simpler and efficient in VELCT.

CONCLUSION

The raising impact of Wireless Sensor Networks on military and real time applications requires large number of sensor nodes to handle large scale areas. The VELCT2 (Velocity Energy-efficient and Link-aware Cluster-Tree) is a efficient method, which is proposed to build a mobile based network management architecture for wireless sensor networks, to exploit the route discovery time, PDR, residual energy, number of alive nodes, network life, throughput, connection time and RSSI for mobile sensor nodes. In VELCT, each node elects the cluster head with better connection time and sends the data packets to corresponding cluster head in allocated time slot.
Similarly DCN elects the one hop neighbor cluster head or DCN with maximum RSSI, threshold value, connection time and with less network traffic. From the simulation results, it is revealed that VELCT provides less route discovery time , energy utilization with reduced network traffic , better throughput, and more stable links than existing protocol such as CIDT.

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