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Improving the Preserved Network Lifetime and Coverage With and Load Balance of Wireless Sensor Networks

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ABSTRACT*:* One of the essential factors of WSN's is to provide complete coverage of a sensing field as long as possible. Most of the application's suchas objecttrackingand battlefieldintrusion detection—requires complete coverageatall thetime. Sensing nodes are in the networks have limited energy and these are deployed in such a way that they are capable of monitoring all the discrete points of interest. Alternate activation and deactivation of these nodes provides better quality of surveillance. Providing the connectivity in between sensor nodes along better coverage is also the important factor to be considered in the WSN's. In this paper we are using MCLCT algorithm with Enhanced leach algorithm to achieve the better coverage, connectivity, network lifetime. In this system we are using Enhanced leach algorithm for cluster formation, AODV routing algorithm for finding the shortest path. In this paper we are using SET-IBS scheme for malicious node detection, which helps in secured data transmission and for the efficient consumption of the energy. Through the proposed system burden on the sensing nodes is equally distributed among the nodes such that energy is efficiently consumed. Extensive Simulation results obtained by this proposed system outperforms the results of the existing system and provides longer network lifetime, better coverage and connectivity between the nodes and efficient energy consumption**.**

KEYWORDS: Wireless sensor networks (WSN'S), Coverage, Connectivity, Network lifetime maximization, efficient energy consumption.

I.INTRODUCTION

Connected wireless sensors form Wireless sensors network. These connected sensor nodes should be compact and should have the capability of sensing, processing, storing the environmental information and as well as communicating with each-other nodes in the network [1]. Main advantages of WSN's are high-fault tolerance, strong adaptability and comprehensive sensing coverage [1]. Wireless sensor network are used in mainly application such as home health monitoring, battlefield intrusion detection, industrial monitoring etc. Recent days these WSN's are also used in the research field even. Connectivity in between the sensor nodes and between the sensor nodes and BS (Base station) is provided by the trans-receivers present in them. Events occurring in the sensing area can be sensed by sensor nodes along with providing the better coverage and connectivity. The sensor nodes are placed in the remote area near the discrete point of interest, and are powered by non –rechargeable batteries. Obtaining the good coverage and maintaining the good connectivity between the sensor nodes of sensing area is of the major concern now-a- days.

DPIO's locations in the sensing area and how well these DPIO's are covered by these sensing nodes decides about the coverage of that particular sensing area. Previously certain rules were used for the placement of the nodes in the sensing areas [2]. The results of the techniques could not give the better results. Further some studies on node scheduling approaches were done for the random node deployment [3]. These scheduling approaches decide the duration of the activation and the deactivation of the nodes in the network. Scheduling techniques also help in the reduction energy consumption by the nodes in the network. Some techniques were used in which sensor nodes are grouped into maximal number of disjoint or non-disjoint cover sets [3]. These studies were related to the non-deterministic Polynomial Complete problem.Multi-hop technique for the data transmission was not taken into

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consideration by the existing techniques. In this paper the proposed system adapts multi-hop technique for data transmission along with the selection of shortest path and malicious node detection. This proposed system also provides efficient way of energy consumption, longer lifetime, and better coverage along with maintaining the connectivity between the nodes in the network. The secured data transmission is also taken into consideration in the proposed system and this is done by checking for the authentication of nodes by malicious node detection.

II.RELATED WORKS

In the recent days obtaining the complete coverage and maintaining the connectivity is of the major concern. Many of the WSN application require complete coverage and connectivity at all the times. Energy consumption is also the important factor to be considered while providing the connectivity and coverage. Efficient Scheduling and routing techniques should be used in order to reduce the energy consumption. In the previous studies Target connected-coverage problem was taken into account in which nodes were formulated in set-covers to increase the network lifetime [4].Integer Programming Solution was developed for the CSC problem (Connected set covers) [4]. But this IP formulation was not able to give correct results for larger scenarios [4]. In further studies Integer Programming-Based heuristic was developed based on IP formulation, CSC were established by heuristic, this checks for validity of the set covers[4]. To overcome the drawbacks of the previous methods, Greedy Heuristic method was developed for the CSC problem, in which heuristic recursively built the set covers. Sensing nodes and relay nodes along with sub-tree that connects sensing nodes and relay nodes were taken into consideration. Breadth –First search algorithm was used to guarantee the Base station connectivity. The draw back this method was there was no provision of providing the reuse of the already active supervisor nodes [4]. To overcome this drawback "Distributed and localized heuristic" method was developed, in which neighbor nodes information within a constant number of hops was utilized by each node for decision procedure. Better dynamic and good topologies were adapted in this method.

The results of the existing methods are difficult to be applied to practical sensing field due to exclusion of in-situ geographical information [1]. Data transmission by using multi-hop technique along with the maintaining the connectivity in between the nodes was not taken into account by the existing systems. The proposed system takes into consideration data transmission by using multi-hop technique and by maintaining the connectivity between the nodes. Meanwhile, the proposed system reduces the energy consumption and increase the network lifetime and even the security is taken into consideration along with secured data transmission by malicious node detection in this system.

III. PROPOSED SYSTEM

The proposed MCLCT algorithm with Enhanced leach algorithm mainly concentrates on maintaining the connectivity between the nodes in the sensing field, improving network lifetime and efficient energy consumption. It deals with MCT (maximum cover tree) problem.

Cluster formation using enhanced leach algorithm:

In Wireless sensor network the nodes that are deployed in the remote areas should be monitored in reliable manner and the data should be gathered and sent to the base station. In the proposed paper Enhanced leach is flexible and has the ability of self- configuring cluster formation. Prior to the cluster head formation, network initialization in the proposed system is done according to the following flow chart.

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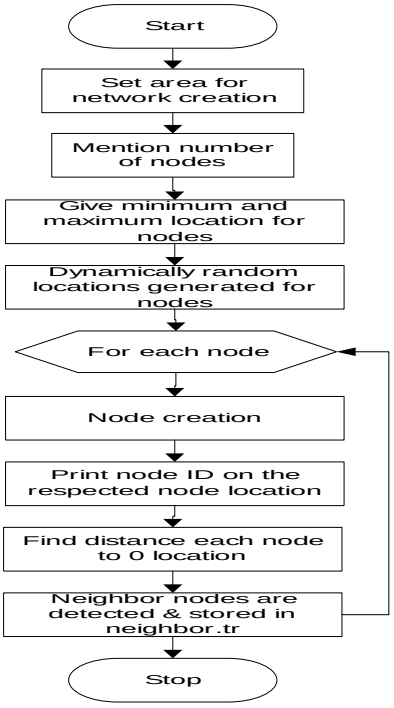

Fig .1 Network initialization flow chart

Enhanced leach algorithm mainly consists of five phases they are [5]-[6]:

Advertisement phase: In this phase Cluster head selection is done in the similar way as that of the Leach protocol. The threshold value of each node in the network is computed and it is compared with some random number (either 0 or1).CSMA –-MAC protocol is utilized by this phase. The probability of each node becoming the cluster head in zero rounds is given by [13]:

$$P(n) = p/(1-(p\times(r \bmod p^{-1})) \quad (1)$$

p- Optimum no. of cluster-head in a round.

r- Round number.

Cluster Set-up phase: This phase handles Non-uniform energy distribution. In this method each node in the cluster declares that it belongs to that particular cluster-head. The selection message is sent to the Cluster head using CSMA-MAC protocol.

Schedule creation phase: This phase uses TDMA scheduling to inform the cluster nodes that at which time slot that particular node is allowed to transfer the sensed data to the Cluster-head. CDMA scheduling is used to build the communication between each other nodes in the cluster.

Data transmission phase: In this phase each node transmits the data to its cluster-head on the basis of TDMA scheduled time slots.

Future cluster-head update phase: After the data transmission of each node, if the cluster-head is still alive it computes the probability of each node in the cluster to become the succeeding CH of that particular cluster and it transmits the update message.Formation cluster-heads in further rounds considers the residual energy of each node after data transmission .The node having the highest residual energy will have highest probability of becoming next CH. The distance between the nodes in the network and the edge count is considered in the proposed system. In this proposed system we are using below formula to calculate the residual energy.

$$RE \text{ (Residual energy)} = E_i - E_p \quad (2)$$

E_i= Initial energy of node in the cluster.

E_p= Present energy of the node in the cluster after the data transmission to CH.

Dynamically CH is created depending upon the residual energy in the further rounds. Almost all nodes in the network are covered which shows that the coverage is increased and the connectivity is maintained as residual energy is taken into consideration. Almost all the nodes in the networks are covered such that energy can efficiently be consumed.

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Burden of nodes in data transmission and load is distributed among the nodes. Alternative activation and deactivation of the nodes depending upon the TDMA time scheduling helps in the efficient energy consumption. Dynamic cover tree is formed where Source node acts as the sensing nodes and the cluster head acts as the relay nodes and BS is considered as the sink node.

AODV routing for building the communication path in the network:

AODV is the type of the Distance Vector routing protocols. In this method each node maintains its own routing table. This table mainly consist of destination address, sequence number, hop count, next hop. Four message are used in this method to build the communication between the nodes in the network they are Route request (RREQ), Route reply (RREP), Route Error (RERR), HELLO message [7].In the proposed system to build the routing path for data transmission in the network, the source node and destination node is selected. Each node in the network maintains its own routing table. To build the routing path the source nodes transmits the RREQ message to the neighbor nodes, depending upon the routing table information, these neighbor nodes checks whether it is the required destination node or not. If it is the required destination node than the nodes RREP message back to the source node and the path is build through which the data transmission takes place.If the node is not the destination node, these neighbor nodes retransmit the RREQ message to further neighboring nodes. This procedure continues until the destination node is found. Each time the RREQ message is transmitted the routing table is updated. Once the destination node is found RREP message is sent to the previous node and this procedure is continued until this RREP message reaches the source node, and each time the routing table is updated. The path which is having the smallest hop count is selected in order to reduce the energy consumption of the network.If there is any link failure in between the two nodes in the network RERR message is sent to the source node.

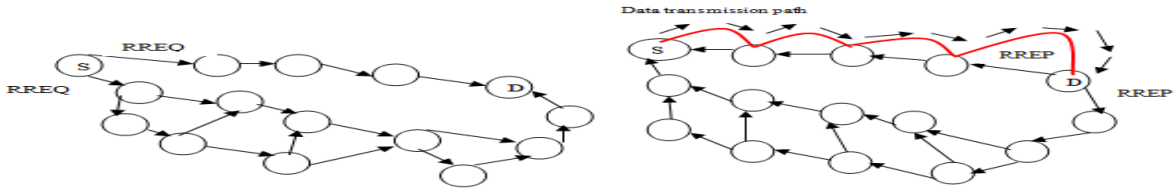

Fig . 2 (a) Fig . 2 (b)

Fig.2(a) Transmission of RREQ form source node S to all the nodes to find the route to the destination D. (b) Transfer of RREP message form destination to source node. Selection of shortest path after RREP is received by the source node depending upon the hop count. (Red path indicates the shortest transmission path).

Malicious node detection and secured data transmission:

Networks are usually prone to various kinds of attacks namely Passive attacks, Active attacks and node compromising attack. These kinds of attacks have to be detected and blocked. In the proposed system we are using the SET IBS scheme for the malicious node detection and for the authentication of node and for the secured data transfer. Here we are using ID based signature to check for the authentication [8]-[9].*IBS Scheme:* This scheme used in the proposed system mainly consists of five phases. In the Set up Phase "Master key" (msk) and the"Public key "are generated by the Base station (BS) and is given to all the sensor nodes in the network. Next in the Extraction Phase "Private Key" (SekID) is generated using the "Master key" ID. In the next phase Signature is generated by the sending node for the given "Message", "Time Stamp" and the "Signature key", this phase is called Signature singing Phase .When the receiving node receives the data packets from the sending nodes ,it checks for the validation using the given "ID", "Message" and "Signature"(SIG). It accepts the data only if "SIG" is valid or else it reject the data packets from the sending node and marks that sending node as malicious node. If the sending node is authenticated it receives the data from that node and send backs the acknowledgement.

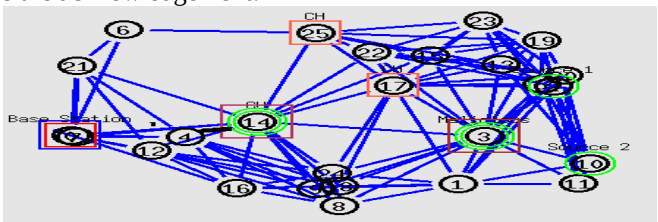

Fig . 3 Malicious detection by using SET-IBS scheme.

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IV. SIMULATION RESULTS

The simulation results of the proposed system mainly show the improvement in the load balancing, network lifetime and efficient way of energy consumption. The proposed system is implemented in Network Simulator 2 (NS2). In the proposed system we are using 30 nodes, simulation area of 500×500m, communication range of 200-250m,initial energy of 100J, and packet size of 1024kb.The graph below Fig.4 depicts that the proposed MCLCT algorithm with Enhanced leach algorithm has got the longer network life time compared to the existing system. Dynamically CH formation takes place and all the nodes are covered and even the edge counts are taken into consideration by the proposed system. Euclidean distance is taken into cosideration to calculate the distance between the nodes in the network i.e.

$$D = \sqrt{(a_2 - a_1)^2 + (b_2 - b_1)^2} \quad (3)$$

a_2, a_1= X-axis position of two nodes.
b_2, b_1= Y-axis position of two nodes.

As the burden on each node is distrubuted and secured data transmission of the proposed system consumes less energy compared to the existing method and this extends the network life of the system and even the connectivity between the nodes is maintained .

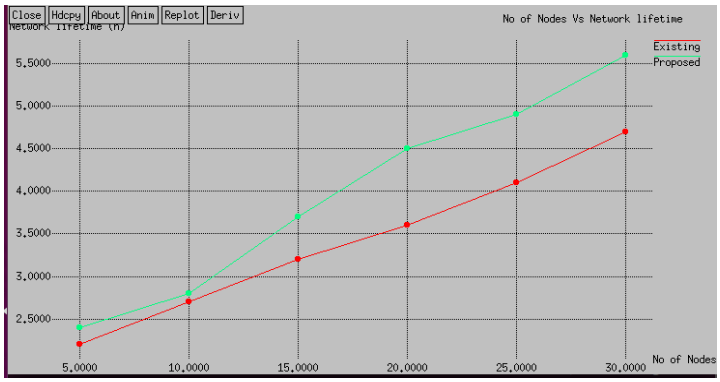

Fig . 4 Graph showing the improvement in the network lifetime of the network by using MCLCT algorithm along with Enhanced Leach algorithm.

As the burden on each node is distrubuted and secured data transmission of the proposed system consumes less energy compared to the existing method and this extends the network life of the system and even the connectivity between the nodes is maintained .The below graph Fig.5 (a) depicts the expected load in the network and the load balancing in the network. Dynamic load balance tree formation helps in the balancing the load of the network. Graph represents that there are no sudden fluctuations in the load like that of the existing system. These sudden fluctuations may lead decrease in network lifetime and loss of data packets in the system. In this proposed system almost all the nodes in the network are covered and load is equally balanced by all the nodes in the network.

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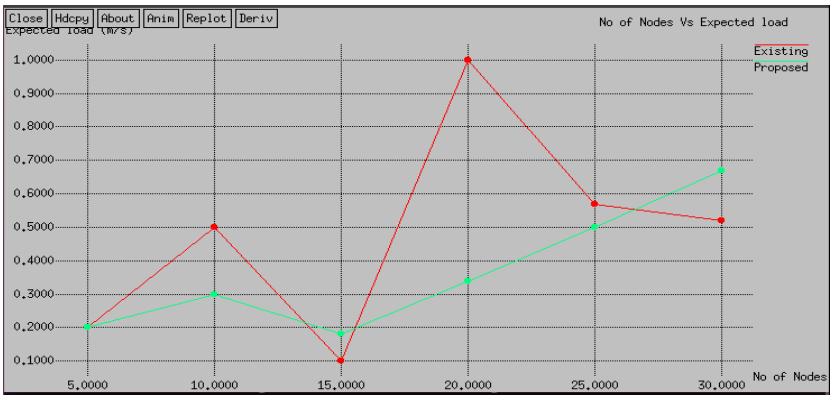

Fig . 5 (a)

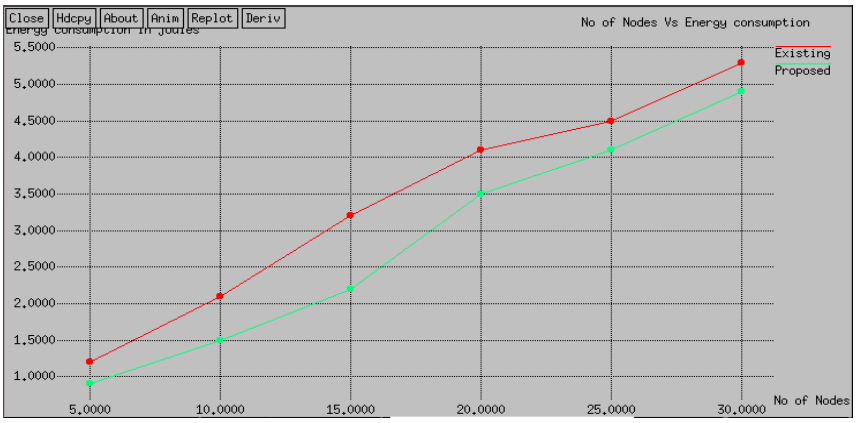

Fig . 5 (b)

Fig . 5 (a) Graph showing expected load versus number ıowing Energy consumption versuses number of nodes

Another important factor that is considered in the proposed system is the energy consumption. Dynamic load balanced tree formation and secured data transmission leads toefficient way of energy consumption. Energy in each of the node is not wasted in any way by malicious nodes which lead to loss of data packets. The energy consumption by using Enhanced Leach protocol is given by the equation:

$$E = \frac{p}{1 - p \times (r \bmod p^{-1})} \times \frac{E_{p\_current}}{E_{in\_current}} \times \frac{X_{avg\_dist}}{\sum X_{node\_dist}} \times \frac{X_{CH}}{X_{C\_avg}} \quad (4)$$

$E_{p\_current}$= Present energy of the node.
$E_{in\_current}$=Initial energy of the node.
X_{avg_dist}=Average distance of the nodes in the cluster.
X_{node_dist}=Distance between the two nodes.
X_{CH}=Average distance from neighbour CH to the node.
X_{C_avg}=Average distance of neighbour CH from the centre of the cluster.
In the proposed system, from Fig.5 (b) the energy consumption is 4.9 Joules for 30 nodes. On an average its energy consumption is 1.3 Joules less than that of the existing system.

V. CONCLUSION

The proposed MCLCT algorithm with the Enhanced leach algorithm outperforms the existing systems performances in terms of network lifetime, load balancing, connectivity, and energy consumption. The malicious node

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detection provided by the proposed system provides the security to the network. This proposed system can have its application in the networks where more secured data transmission along with longer network lifetime with efficient energy consumption is required.The Proposed system can be enhanced still by using better and complex routing algorithms so that faster and secured data transmission can be done. In future, advancements in the formation of dynamic load balanced cover tree can be used to provide longer network lifetime for the network which includes large number of nodes.

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