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# Implementation of Neural Network based Dynamic Clustering Algorithm on NS-2 for Energy Efficient Wireless Sensor Network

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**ABSTRACT**

**One of the major constraints of Wireless Sensor Network is energy consumption. Due to small size of node, the size of battery used by node is also small. Moreover these batteries are irreplaceable as nodes might be deployed randomly in large numbers, over a wide area. The network lifetime of WSN depends upon its energy effectiveness. Various techniques have been proposed by researchers to enhance the lifetime of WSN. Dynamic clustering is one of the best suited methods for this. In clustering nodes are combined to form groups as cluster. Each cluster has only one controller in it called cluster head (CH). The CH is used to communicate with each node and for inter-cluster communication. The selection of CH within the network is critical since cluster heads consume energy faster and have greater influence on lifetime of network than non cluster head nodes. The node is chosen as cluster head, according to the election algorithm. In this paper, novel technique is been implemented which is based on the Dynamic Clustering using LEACH. The Cluster heads in each cluster are changed according to the Neural Network based Election Algorithm and network conditions. The proposed technique is been implemented on NS2. There are many user friendly manuals available but still it is quite difficult for first time user to understand it, therefore the paper also explain the implementation stages of WSN on NS2. Simulation results shows that novel technique will reduce network energy consumption and increase network lifetime.**

**Keywords: WSNs, Sensor Nodes, Dynamic Clustering, NS2, Network Lifetime, Energy Consumption.**

## 1. INTRODUCTION

The wireless sensor network consists of large number of sensor nodes spread over the specific area called sensor field. Research into WSN was mainly motivated by military applications such as 'battlefield surveillance' with the Defense Advanced Research Projects Agency (DARPA). More recently other civilian application such as environment monitoring, agriculture, healthcare, industrial processes, structural health & power monitoring, home automation etc domains have been considered.

Sensors nodes are deployed in the sensor field to collect the information. The sensor nodes communicate with the sink through the radio waves. If the node is not able to communicate with other node through direct link, i.e. they are out of coverage area of each other; the data can be sent to the other node by using the nodes in between them as shown in figure 1.

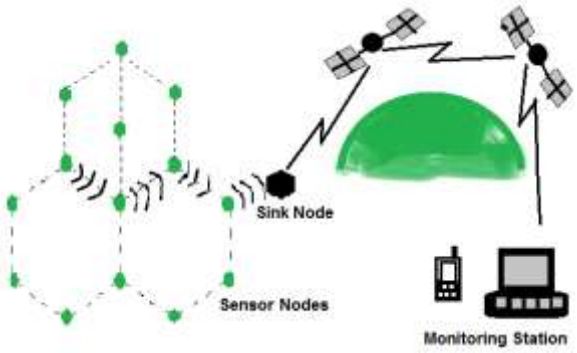


**Figure 1: Wireless sensor network**

Sink is used to inject the query to sensor field. Sensor nodes sense the event which has occurred into field and give response to that query. The data collected by the sensor nodes is send to the sink; sink is like the base station which broadcast the data collected by the sensor nodes to the internet. Sensor node consists of four units which are sensing unit, processing unit, transreceiver unit and power management unit. In sensor unit the sensor is used to sense the changes in the environment, processing unit consists ADC which convert analog signal to digital signal processor or microcontroller and a storage, and transreceiver unit which is used to communicate with other nodes of the network. These three units are connected to the power management module as shown in the figure 2.

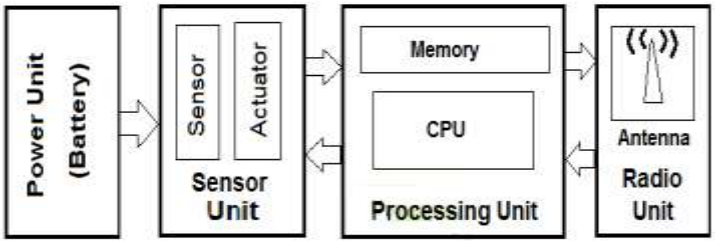


**Figure 2: Architecture of sensor node**

## 2. RELATED WORK

The energy consumption in WSN depends upon transmission distance, routing protocol and amount of data to be transmitted. Therefore for energy efficient WSN dynamic clustering is used. LEACH gives simple distributed clustering scheme for evenly distributing energy dissipation [1]. in clustering algorithm adjacent nodes are grouped into a cluster. Each cluster has a cluster leader called CH that performs special tasks of data fusion and aggregation [2]. A periodically re-election of new CH is the solution to balance the energy consumption among the nodes in each cluster [3]. Clustering of nodes is based upon least distance and high energy source of nodes by knowing its location. Energy efficient clustering algorithm is introduced for WSN in which the sensor nodes decide to join a cluster in peer to peer mode to represent energy level [4]. To maximize the battery lifetime dynamic clustering offers flexibility [5].

## 3. NEED OF ENHANCEMENT IN DYNAMIC CLUSTERING

In dynamic clustering, several control messages are exchanged to choose appropriate CH, which requires a considerable amount of energy and bandwidth. In clustering scheme re-election of CH is required; it results in degradation of upper layer protocols. Cluster structure consists of two sets cluster formation and cluster maintenance. Cluster formation presuming mobile nodes as stable but this is assumption is not practical because mobile nodes are movable. They needs completion of round to get precise information from neighboring nodes to complete cluster formation, as with the increasing of number of nodes there is also increase of number of rounds which increases the static period for nodes [6].

## 4. PROPOSED WORK

Here our main concern is re-clustering of the nodes and cluster head selection. The CHs are chosen according to the intelligent neural network based algorithm.

**Step 1:** Initialize all the nodes and assigned a cluster number to all the nodes between all the clusters.
**Step 2:** Start clustering and select a cluster head randomly using LEACH protocol.
**Step 3:** After transmission of data, calculate fitness factor for all nodes of cluster using neural network logic.
**Step 4:** Choose the node with greater fitness factor as CH and re-cluster the sensor nodes according to their residual energy distance of all the nodes from BS.
**Step 5:** Repeat Steps 3 and 4 till clusters do not change or for a fixed number of times.

## 5. SIMULATION ON NS-2

NS2 is an open source network simulation tool; it is developed at US Berkeley as a part of the VINT project. It is suitable for designing new protocol, comprising different protocols and traffic evaluations. It has been widely used in the research of wireless and wired networks. To implement the problem on NS2, program is written is script language OTcl (object oriented terminal control language). The script is written to setup and run the simulator, to initiate and to stop the event scheduler, to set up network topology using network objects, and to tell the traffic source that when to start and when to stop transmitting packets using scheduler. Script writing for NS2 is explained in the flowchart given below. To visualize the simulation NAM network animator is provided in NS2. Trace files are generated as result of simulation and can be seen graphically. [7,8,9]

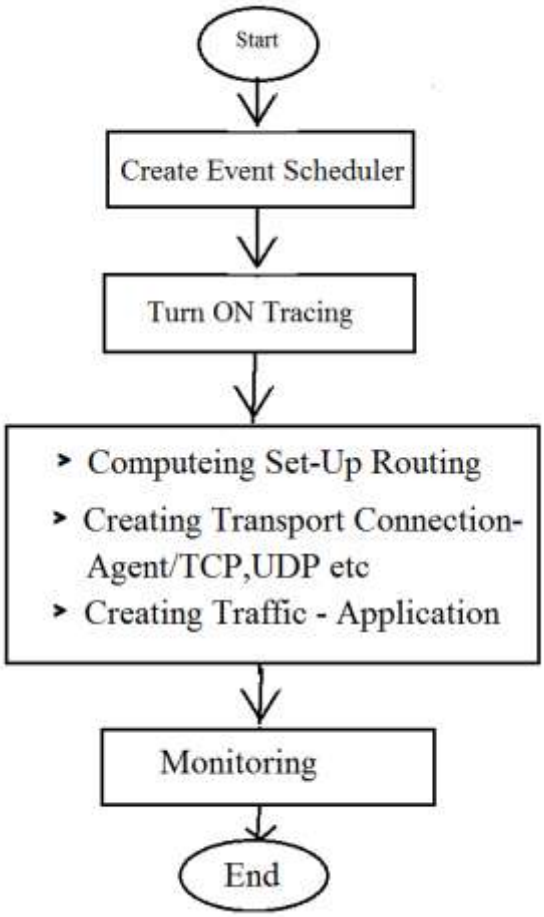


**Figure 3: NS2 simulation phases**

To setup the network following parameters are set.

**Table 1: The simulation parameters for the network deployment**

| Sr. No. | Simulation Parameters | Values |
|---|---|---|
| 1 | Network Topology | 800*800 m2 |
| 2 | Routing Protocol | AODV |
| 3 | MAC | 802-11 |
| 4 | Traffic Agent | TCP |
| 5 | Traffic Source | FTP |
| 6 | Maximum packets | 50 |
| 7 | Total No. of Nodes | 50 |
| 8 | Simulation Duration | 100 sec. |
| 9 | Initial Energy of Network | 100 Joules |
| 10 | Energy Spent in transmission of packet | 1 Joule |
| 11 | Energy Spent in receiving | 1 Joule |

## 6. RESULTS

In order to evaluate the performance of proposed Neural Network based Dynamic Clustering Algorithm over LEACH based dynamic clustering, graphical results of both conditions are shown for comparison. Here the simulation with Neural Network based Dynamic Clustering Algorithm is called new scenario (graph represented in green) and other one is called old scenario (graph represented in red).

**6.1 Energy:** The figure 4 shows the values of residual energy of the nodes contributing in the communication at an instant.

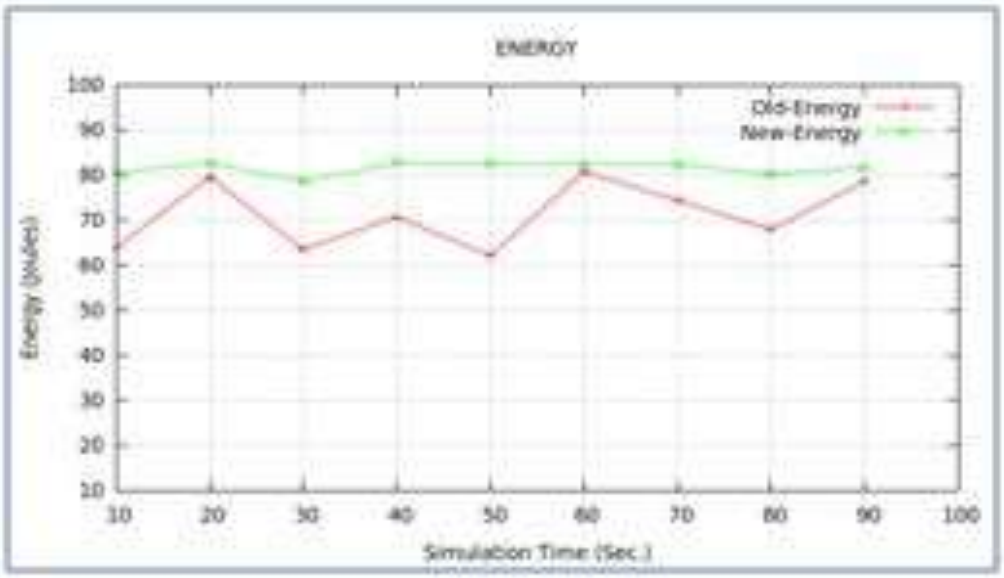


**Figure 4: Energy Level vs. Simulation Time Plot.**

The Simulation result shows unbalanced energy consumption among sensor nodes in old scenario, where as the new scenario gives more stable results when compared the energy consumption.

**Table 2: Values of trace files generated for energy after the simulation**

| Sr. No. | Simulation Time (Sec.) | Energy Old Scenario | Energy New Scenario |
|---|---|---|---|
| 1 | 0 | 67.06 | 77.23 |
| 2 | 10 | 63.93 | 80.65 |
| 3 | 20 | 79.55 | 82.59 |
| 4 | 30 | 63.53 | 78.63 |
| 5 | 40 | 70.72 | 82.69 |
| 6 | 50 | 62.08 | 82.53 |
| 7 | 60 | 80.76 | 82.53 |
| 8 | 70 | 74.39 | 82.37 |
| 9 | 80 | 67.91 | 80.15 |
| 10 | 90 | 78.59 | 81.70 |

The table 2 shows the residual energy of the network nodes which are taking participation in communication of data at different time instants. The simulation is run for 100 seconds and time instants are taken after every 10 seconds. The average residual energy of the new scenario is 81.10 joules and average residual energy of the old scenario is 72.85 joules. The new scenario consumes less energy as compare to the old scenario.

**6.2 Packet Delay:** The packet delay in a network is the time taken by the packet to reach the destination after it leaves the source. The graph shows the delay produced in the network while communication the data packets between the nodes at all time instants during the simulation.

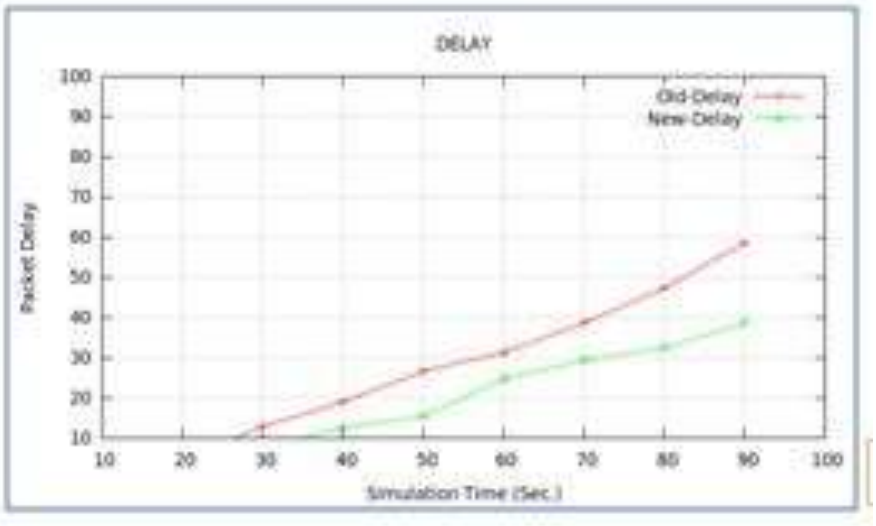


**Figure 5: Plot showing Delay after applying Improved Neural Network Algorithm**

The solution provides less delay as compared to old scenario.

**Table 3: Values of trace files generated for delay after the simulation**

| Sr. No. | Simulation Time (Sec.) | Delay (Old Scenario) | Delay (New Scenario) |
|---|---|---|---|
| 1 | 0 | 0.25 | 0.12 |
| 2 | 10 | 1.20 | 0.88 |
| 3 | 20 | 4.56 | 2.66 |
| 4 | 30 | 12.87 | 7.60 |
| 5 | 40 | 18.99 | 12.63 |
| 6 | 50 | 26.65 | 15.36 |
| 7 | 60 | 31.24 | 24.66 |
| 8 | 70 | 38.66 | 29.36 |
| 9 | 80 | 47.23 | 32.36 |
| 10 | 90 | 58.69 | 38.55 |

The table 3 shows the delay in the networks at different time instants from zero to 90 seconds at the interval of 10 seconds.

**6.3 Throughput:** The network throughput is the rate of successful message delivery over a communication channel. Throughput is measured in bits received per second (bit/s or bps or in data packets per second (p/s or pps) or data packets per time slot.

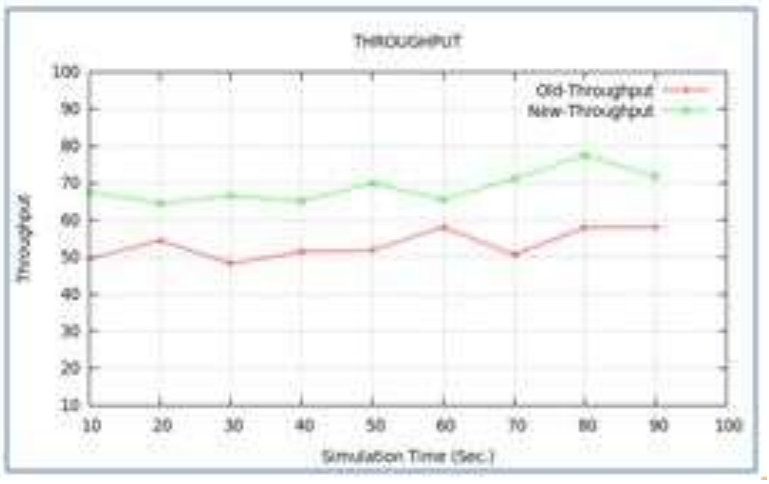


**Figure 6: Throughput vs. Simulation Time**

Plot show the throughput after and before applying neural network algorithm. In the graph, throughput is greater for novel clustering algorithm then dynamic clustering.

**Table 4: Values of trace files generated for throughput after the simulation**

| Sr. No. | Simulation Time (Sec.) | Throughput Old Scenario | Throughput New Scenario |
|---|---|---|---|
| 1 | 0 | 36.13 | 68.31 |
| 2 | 10 | 49.58 | 67.64 |
| 3 | 20 | 54.53 | 64.43 |
| 4 | 30 | 48.24 | 66.58 |
| 5 | 40 | 51.45 | 65.12 |
| 6 | 50 | 51.81 | 69.96 |
| 7 | 60 | 58.16 | 65.44 |
| 8 | 70 | 50.63 | 71.12 |
| 9 | 80 | 57.98 | 77.53 |
| 10 | 90 | 58.11 | 71.77 |

The table 4 shows the throughput of the network nodes which are taking participation in communication of data at different time instants. The new solution has more throughput as compare to the old.

## 7. CONCLUSIONS

Novel Neural Network based algorithm has been implemented for dynamic re-clustering and CH selection of Wireless Sensor Network. This technique reduced the overhead in dynamic clustering and lifetime of the sensor network is increased. Cluster heads are elected using the approach of neural network. The proposed technique is implemented using NS2 and simulation results shows that novel technique reduces nodes energy consumption therefore network lifetime is increased.

The performance is compares on the bases of energy consumption, network delay and throughput. Energy efficiency is improved by 11.33%, delay is reduced by 31.69% and throughput is increased by 33.15%. Overall performance of the network is improved. The simulation result shows that novel technique has reduced network energy consumption and has increased the network lifetime.

## 8. FUTURE WORK

In future more artificial intelligent algorithms can be used to overcome the problems of any autonomous adhoc network. Location Aware Cluster Based Routing can be achieved for mobile nodes in WSN. Neural Network Algorithm can be used for selection of CH and information about the current position of mobile sensor nodes can be gathered by enabling GPS in the Sensors.

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