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OPTIMIZED CLUSTERING ALGORITHM USING GENETIC ALGORITHM FOR BEST NODE SELECTION IN MANET

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ABSTRACT
Mobile Adhoc networks are the prerequisite for any organized, distributed, infrastructure less wireless network particularly for the network-centric field operations such as disaster recovery or other emergency situations. The large-scale deployment of mobile adhoc networks deals with issues such as low throughput, end to end delay and the energy drain problems. To resolve most of these issues in large scale deployment of mobile adhoc networks, a hierarchical structure of MANET has been designed with the cluster head selection. In this work, an attempt to select the best node as cluster head has been proposed with weighted algorithm modified with genetic algorithm, by considering the metrics such as residual energy, link state, node degree, mobility and time factor. The simulation setup was proposed with ns2 simulator and the experimental analysis has been plotted with PYGAD tool in python.
Keywords: Mobile Ad hoc Network, Weighted clustering algorithm, Genetic Algorithm, cluster head.

INTRODUCTION

An adhoc network can be designed with infrastructure-less architecture and the mobile nodes involved in the networks are named as Mobile Aadhoc Networks (MANET). Unmanned Vehicles enhances the effectiveness and usage of MANET as they can operate efficiently with less human intervention. The nodes in a MANET will perform effectively based on different parameters such as battery power, link state, transmission range and mobility of the nodes. In a hierarchical structure, clustering the nodes are adopted with the selection of one of the nodes as cluster head. Weighted clustering algorithm has been used to select the best node as cluster head based on different parameters and the priority of the characteristics of the node. Many research work and algorithms has been proposed in partitioning the adhoc networks based on different metrics and different topologies. The existing works demonstrated that clustering of nodes with the representative node and assigning other nodes as member nodes, will enhance the throughput and minimize the delay. Many protocols have been developed based on the different architecture and arrangement of nodes. In this regard, research works are implemented with additional Gateway node assigned within the vicinity of the cluster. In order to manage the traffic, Intra cluster and Inter cluster communication with multipath routing protocol and broadcasting mechanisms and flooding mechanisms are experimented. In general, Mobility of nodes and link state stability are considered as important metrics in MANET based on the topology of networks. Incorporating additional messages in HELLO messages, reconfiguration of links, computing the signal strength indicator, routing the data only if routes are required are given as solutions for effective throughput in MANET. In [1], a multi path routing protocol is proposed based on probability of the locations. In [2], Genetic algorithm is used to analyse the behaviour of nodes to predict the attacks. In [3], Zone based Manetic Routing protocol has been proposed in which machine learning algorithms are used for effective communication and to enhance the security. Many research works focussed on the machine learning algorithms for the security of the Mobile adhoc networks to identify the intruders and different types of attacks. For multicast routing problem with multiple QOS constraints, genetic algorithm has been used to resolve the problems. Residual battery energy of all the nodes in a multicast routing tree was analysed and multicast route selection has been implemented using genetic algorithm. Many route computation problems and optimization problems are solved using genetic algorithm. The main components of Genetic algorithm depends on the crossover, mutation operations and the design of the fitness function. The objective function is very significant to determine the optimized result.[4]. Hence, the proposed work has been attempted with the genetic algorithm for the selection of best node with specific QOS constraints. In [5], the researchers have optimized the weighted clustering algorithm based on various metrics. In the proposed work by the authors, each cluster head will handle the maximum possible number of nodes for the effective MAC protocol. Based on this work, the proposed work has been implemented. This paper has been organized in the first part as (i) Mobile Adhoc network model and routing with mathematical background and graph theory, (ii) the metrics such as time factor, link state and distance with mathematical formulae and (iii) the probability equation. In the second part of the proposed work, the modifications in the weighted clustering algorithm have been proposed using genetic algorithm has been described and the details of the simulation setup implemented with ns2 simulator and the tested results of the algorithm with PYGAD tool in python are given.

PROPOSED WORK:

Mobile Adhoc network Model and Routing

A mobile adhoc network can be represented as a weighted graph, $G(V, E) = (V(G), E(G))$ where $V(G)$ and $E(G)$ represents the mobile nodes and the corresponding links respectively. Let $S \in V(G)$ be the source node and the destination node may be $M \subset \{V(G) - S\}$.In a multicast tree $T(S, M)$ the total number of nodes are $V(G)$ and the total number of links are $E(G)$. For any link $l \in E(G)$, the delay function is represented as :$E(G) \rightarrow R^+$ and the cost function is represented as :$V(G) \rightarrow R^+$.The propogation delay cost function from source to the destination node is C* $\frac{1}{delay(S.M)}$ where c is the coefficient of positive real number. The battery energy of all the nodes is represented as $\sum_{l \in T(S,M)} B_v(t)$ where B_v represents the battery energy of node v in time t. The residual energy of the node is represented as $Res\left(B_v(t)\right)$. The transmission power of a node is represented as δ_v. Mobile adhoc networks has a frequent pattern of movement. The position of the node depends on the frequent movements and it can be predicted based on the position information such as , the group of nodes within a specific range at a particular time interval T. The position information can be given as:

Time Interval	Node Information
$0 < t < T$	$\{V_5(G), V_7(G), V_{10}(G), V_8(G)\}$
$T < t < 2T$	$\{V_1(G), V_6(G), V_3(G), V_3(G)\}$

If two nodes are in the communication range, it is given as

$$Link\ state\ L_s = \begin{cases} 1 & if\ the\ node\ is\ within\ communication\ range \\ 0 & otherwise \end{cases}$$

Node neighbourhood change will affect the link stability. The speed of the node with respect to the time t will be calculated based on the distance as:

$$Distance = \sqrt{(x - x_{i-1})^2 - (x - x_{i-1})^2}$$

If the link stability is a stationary Markov chain model, then the entropy rate for the link $l_1, l_2 \epsilon\, l_s$ is calculated as

$$(H(l_2\,|l_1) = \sum_{S\in 0,1} P(l_1 = S)$$

Where P represents the probability and H the conditional probability. With these prior information, the weighted clustering algorithm for the cluster head selection procedure is analysed and the procedural steps identified to select the cluster head in MANET are:

Step 1: Find the neighbours of each node in $G(V, E)$, that is the node within the transmission range δ_v such that $\sum_{v' \in V}\{dist(v, v') < tx_{range}\}$
Step 2: The degree difference is computed as $\Delta_v = \|d_v - \delta\|$
Step3: Compute the distance
Step 4: Compute the running average speed
Step 5: Compute the cumulative time
Step 6: Compute the combined weight
$w_\vartheta = w_1\Delta_\vartheta + w_2 D_\vartheta + w_3 M_\vartheta + w_4 p_\vartheta$ where Δ_ϑ is based on transmission range, D_ϑ is based on distance, M_ϑ is based on mobility and p_ϑ is based on cumulative time.

In our proposed work, the weighted clustering algorithm has been modified with the genetic algorithm as: In a MANET, the number of nodes $V(G)$ in the graph $G(V, E) = (V(G), E(G))$ is treated as the population and is represented as

$$P = (V_1(G), V_2(G), V_3(G), \dots \dots \dots . V_n(G)\}$$

With unique node-id. The transmission range, distance and link state stability are calculated and based on the positional information the nodes are allowed to participate in the network. The weighted function parameters are given as:

$$f(x) = w_{min}\left(C * \frac{1}{delay(S.M)}\right) + w_{max}\left(\sum_{l\in T(S,M)} B_v(t))\right) + w_{max}\left(Res\left(B_v(t)\right)\right)$$

For our work, the following simulation parameters with the network topology are assumed:

Number of Nodes	100 to 300
Communication range	100 m
Area of simulation	1000 m*1000 m

Node distribution	Random distribution
Simulation time	30 min
Interface Queue Length	50
MAC	802.11
Speed of nodes	5 to 20 m/s
Mobility model	Random Grid Size 5 m * 5 m
Packet traffic volume	2000 bytes/s

Algorithm:

Procedure:

Initialize the population

While NOT (Convergence condition) DO {

Evaluate the Fitness function

$F = \sum_{i=1}^{n} f(x)$

If F>threshold

Declare the fitness solution

Else

Declare the output guess

End if

Generate new population

Apply selection, reproduction, mutation and crossover

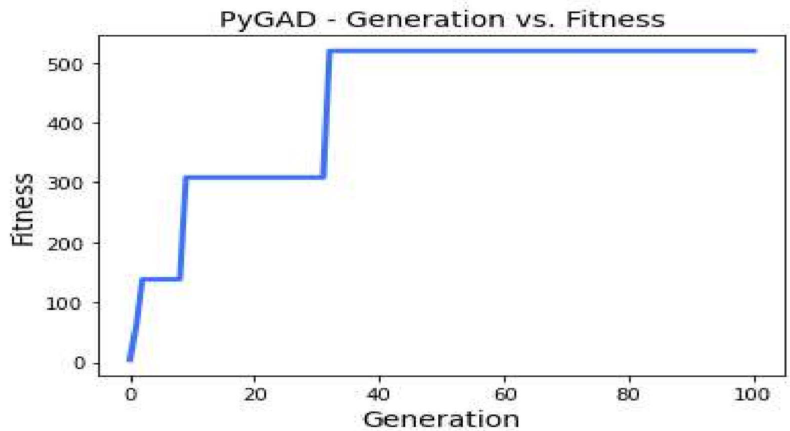
Rank the population

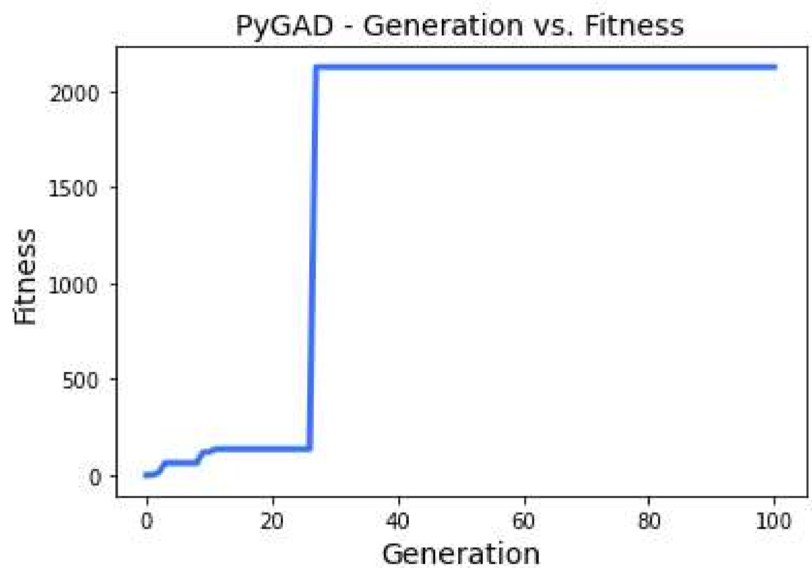
Eliminate the lowest fitness values

Simulation Results:

The computational simulation was implemented in Python using the genetic algorithm PyGad and numpy library. PyGAD supports the optimization problem in Genetic algorithm and the types of crossover, mutation and selection operators by customizing the fitness function.num_generations, num_parents_mating,fitness_func are given the parameters.

initial_population is initialized with the custom initial value representing the node-id. PyGAD also provides interfaces where the parameters are used to specify the mutation and crossover rates, as well as the probability of crossover and mutation.When the minimum delay was very low and high battery energy and residual energy has the following output is displayed with fitness reached after 32 generations.When the delay is high, the fitness values reached with 27 generations.





CONCLUSIONS

This paper addresses the metrics in weighted clustering algorithm and the modification in the weighted clustering algorithm with genetic algorithm using the effective fitness formula. The results are plotted for the fitness value reached after different generations. Since, selection of the optimized node in a clustering algorithm was a challenging task, this work proposed the novel approach to modify the weighted clustering algorithm using genetic algorithm. The fitness function in a genetic representation determines the best solution for a problem. The effective fitness function will predict the optimized result as the mutation encoding and the genetic representations are performed effectively. In the current work, it has been concluded that the proposed fitness function will identify the best node which in turn enhance the throughput of the transmission of MANET.

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