

Offering New Routing Method in Ad hoc Networks using AntColony Algorithm

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Abstract— The aim of this study is to provide a novel method routing in ad hoc networks using ant colony algorithm. Hence for this study the researcher attempts to discover and create routes with less number of crossings, nodes sustainable and less energy transfer, to reduce latency end-to-end, save bandwidth and to extend the life and increase the lifetime of the network nodes. Research methodology for simulation algorithm has been OPNET software. Therefore, the proposed algorithm's performance was compared with one of the most routing algorithms in mobile ad hoc networks Ant Hoc Net. The results showed that the proposed algorithm compared with Ant Hoc Net has more end-to-end delay, more package shipping, and less routing overhead can reduce energy consumption and thus increases the lifetime of the network nodes. The results of this study indicate that the latency end-to-end, saving bandwidth and increasing lifetime of nodes and network lifetime can be predicted by the proposed algorithm.

Keywords—ant colony algorithm, ad hoc networks, Simulation, Routing

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I. INTRODUCTION

Routing as one of the core activities in ad hoc networks plays a key role in function of network. Therefore, routing algorithms in such networks should be compatible with the topology changes and traffic conditions. To accomplish this goal, the network design algorithms in addition to the robustness must have the ability to work in a distributed manner. This property exists in self-organizing natural systems such as ant colony. Resistance and impacting of collective behavior of ant carriers due to changes in environmental conditions are one of key aspects of their success. Based on optimization methods of ant colony, autonomous agents in a distributed environment using local data and indirect interactions can be a solution to achieve a given problem. Since there are a lot of similarities between ad hoc networks and ant colony environment of a mobile ad hoc network such as non-structured environment which is dynamic and distributed. Colony-based routing algorithm of ants in comparison with other algorithms is more efficient,

stronger, and more consistent with the changes and is able to several routes to one target. In mobile ad hoc networks due to special circumstances and limitations such as shortage of energy and bandwidth, routing targets can be different. In some algorithms only sending packets with the lowest latency is vital and in others, criteria for successful delivery of packet is to increase network lifetime through lower power consumption or less bandwidth consumption which is significant. However, the continuously varying traffic conditions and network topology require that the routing algorithm notice such goals. Targets routing network status can help improve route quality according to condition change of network [6]. In this paper, a multi-objective routing algorithm based on multiple colony of ants is proposed. In the several colonies of ants, several colonies of ants are working together to obtain the best answer. The algorithm can be run in two ways: Homogeneous and heterogeneous. In heterogeneous method each colony has a different behavior to other one. This method is used for solving multi-objective optimization problems where each colony is used to optimize each cluster with different optimization criteria. In implementation of homogeneous, all colonies work together in parallel to optimize a same goal attempt. So far many algorithms were presented to solve multi-objective problems such as colporteur in multi-colony method. Hence for route ad hoc network, our algorithm is the first one which uses heterogeneous colonies to support several different goals [5].

In the proposed algorithm there are three colonies with three different colonies:

- 1) The least number of crossings
- 2) The most stable connection
- 3) The least energy consumption for transmitting to find the best route.

Each colony to obtain the best tracks only uses one of the goals. Sustainability of a node can be specified on the basis of level of participation. Since the probability

of failure of routes including more sustainable nodes is less, selecting

Them as the optimal route can reduce the frequency of process of discovering route. Parameter of the least energy transfer is the amount of energy required to move from one node to the next. The less energy, the less energy consumption and consequently the lifetime of the network increases. Parameter of number of crossings is less and it can also find the shortest route. At each node, there is one factor that will decide when sending data packets in terms of condition available in order to use the right parameter to determine the optimal path [5]. Other elements of the algorithm, is exchange of information among clones. At regular intervals, colony shares its information to have focus on promising areas of search space.

Thus, the possibility of finding routing with more quality increases. Another feature of the proposed algorithm is its combination which uses both active and passive components to be able to address the specific challenges of mobile ad hoc networks. This method is passive and nodes seek to collect routing to destinations that are currently active and communicate with them because by the time connection continues, the nodes maintain routing information and modify it. The algorithm uses a two-stage discovery and maintenance. In the discovery phase the mechanism is passive and carrier ants which are called passive forward ants start moving through source to find several paths and then return to source to establish paths. Directions are defined by local tables of pheromones in nodes. In each node, there is one pheromones table corresponding to each target. After making paths, data packets randomly select one of these paths. During data transmission, the path should be monitored, maintained and if possible improved. This is done by active ants ahead. When the path faces failure, local modifier ants are used to modify the route [4].

In addition, each of the detailed characteristics of the proposed algorithm is explained:

II. MODELS

A. Model of Node Swapping

Displacement models to describe the movement patterns of mobile nodes and changes of place, speed and their accelerations are designed in terms of timing. These models are four groups:

- 1) Random models
- 2) Models with time dependence
- 3) Models with spatial dependency
- 4) Models with geographical restrictions.

In this simulation Random Waypoint Model (RWP) was used [3].

B. Energy Model

The process supervises energy consumption of a wireless node over time. At first, user Specifies primary energy amount for each node and the energy is consumed given to three operating modes of unemployment, packet transmission and package reception [3].

C. Selection process of Routing Objective

In the proposed algorithm, three different objectives are prioritized to optimize. When you run the discovery process route, decision is made on type of goal according to which routing that must be done. The remaining energy of nodes, crowding of current nodes, packet delivery ratio and routing overhead in the network are parameters that the decisions are made based on them. One of the decisions is residual energy node. If rate of decline in energy is high, then paths with minimum transmission energy must be selected. Thus, node lifetime and therefore the lifetime of the network increases.

D. Route discovery process

The process of route discovery is a mechanism that enables us to obtain one or more routes from the source node in order to send data packages. When the source node S sends a package to target destination d, selection process aims at routing specifies route given to current state of network. If the path exists with this feature, data package is sent to target. Otherwise, the route discovery process should be done. In order to perform route discovery process, source node broadcasts one passive forward ant to all the adjacent nodes. The goal of ant is to find a path in which process of goal selection is specified. In each intermediate node, if there is information related to pheromones then we will face unicast Ant and otherwise broadcasting (Donner et al, 2013, 119).

E. Random routing data

In the contact phase, multiple paths were created from the source node to target and placed on tables pheromones. Then, the data according to the values in the routing tables were routed in pheromones. In each node, if there are several Path ways to the destination d, one of them is randomly selected with probability Pnd. Pnd is achieved using Equation(1). The difference is that α is higher than this part to increase the possibility of better routes. Using possible selection strategy several routes may be selected automatically for sending packages. And data load broadcast on each path is according to its quality. If table information is kept up to date, this strategy results in a load balancing (Donner et al., 2013: 119)

F. Route Maintenance Phase

During data transmission, the source node uses proactiveforward to maintain the route. These factors are sent in terms of rate of sending data.(one factor for each n data package) Ants are usually broadcast one by one and seek to calculate next crossing based on pheromone values .But there is a small possibility too in which ants are broadcast in each node.(This probability is usually considered 0.1). Two goals are followed. If forward ant passes total path without even one broadcasting, in fact it samples path available and can update the information. If ant is broadcast, new paths will be discovered [2].

G. Failure to Connect

In this algorithm, each node tries to keep information about adjacent nodes up-to-date at any moment to identify connection failures ASAP before it leads to transmission errors or package loss. Presence of a neighboring node is approved with one Hello message and if there is no message at a specified interval, it is assumed that the new node is disappeared [2].

H. Exchange of Information Among Colonies

In the proposed algorithm, there are three different colonies that exchange information in certain intervals. Information exchange increases the possibility of exploring promising clones in the search space and it also increases the quality of path, therefore wened to maintain colonies ability in exploring new areas. The effort for calculation should not focus on one searching sector only. To achieve these two objectives and for balancing them, colonies use communication policy specifying type of information exchanged, the exchange time and colonies that exchange. The more communication, the more equal answers by all colonies. Meantime, algorithms are calculated more. Thus, we have a problem of multi-objective problem which is reduced to a single goal [6].

Calculated. In the proposed algorithm, the exchange of information through parameter can be set in formula (1).

In order to investigate the effect of exchange of information on the performance of the algorithm, learning coefficient γ changes in two various tests from zero to one in incremental step-by-step mode 0.3. In these trials, 50 nodes were randomly placed in an environment with dimensions of 500 * 1000 square meters and 20 source nodes deal with generation of data traffic with constant bit rate. In the first test, the maximum movement speed of nodes is equal to 10 meters per second, and then in the second test, the movement level of nodes increases to 40 meters per second.Each test is repeated 10 times with different random valuesand the mean results are calculated. Test execution time ofeach is 900seconds.

$$\tau_{nd}^{if(j+1)mod s} = (1 - \gamma)\tau_{nd}^{if(j+1)mod s} + \gamma\tau_{nd}^{if(j)mod s}, \quad \gamma \in [0,1] \quad (1)$$

III. FINDINGS

A. Node Movement Responses

The findings showed that high-speed packet delivery ratio does not have an impact in high speeds, since in high speeds process of discovering route occurs more. So credit of available routes is more and the possibility of packet transmission will be less. Fig 1

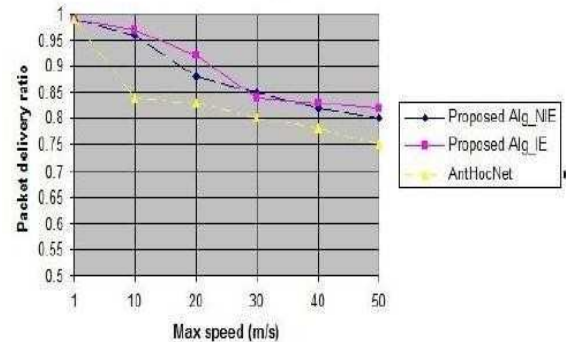


Fig. 1. packet delivery ratio at different speeds

Results also show that the proposed algorithm compared with Ant Hoc Net has more end-to-end average delay. In the proposed algorithms, increasing the dynamics of the nodes causes the decision- making to select more stable routes and the stable routes are not necessarily stable (see Fig 2). The routing overhead rate in algorithms offered is much less than other algorithm. Fig3

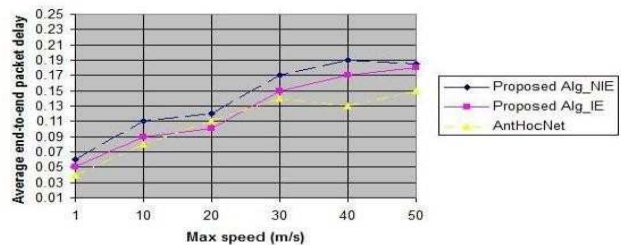


Figure 2. End-to-end delay average in maximum different speeds

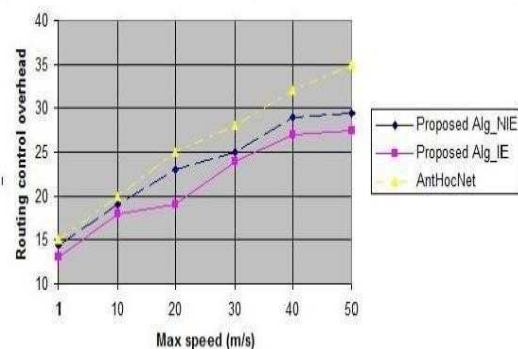


Fig. 3. Monitoring overhead of routing in maximum different speeds

B. Response to changes in network size

Forms (4), (5), (6) and (7) show the proposed algorithm performance compared with Ant Hoc Net. Algorithms suggested can increase packet delivery ratio by development of network and can also reduce routing overhead. This function shows algorithm extensibility.

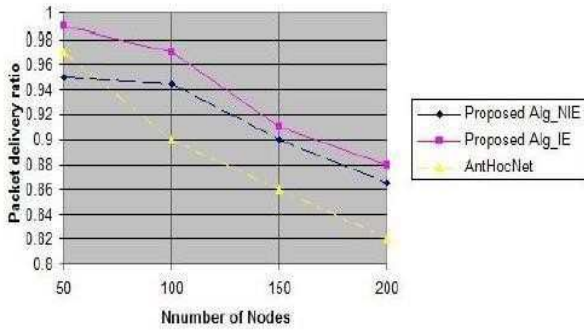


Fig. 4. Packet delivery coefficient in networks with various sizes

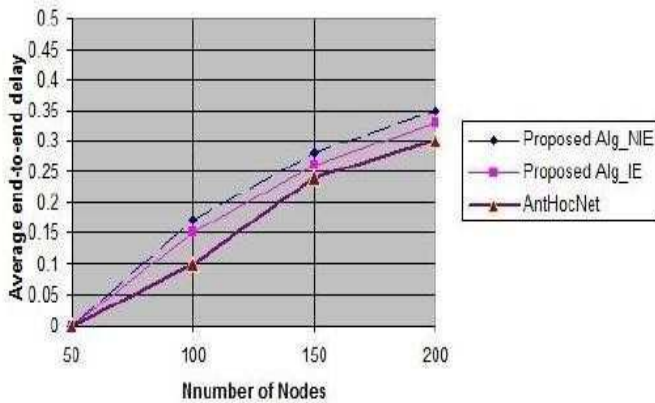


FIG. 5. MONITORED ROUTING OVERHEAD IN NETWORKS WITH VARIOUS SIZES

C. Responding to the exchange of information

The results show that the lowest coefficient of packet delivery happens in an independent and parallel implementation of Colonies $Y=0$ and when adjacent colony response vector replaces current colony response $Y=1$.

In $0.3 \leq \gamma \leq 0.9$ mode with rise of exchange of information among colonies on the quality routes obtained, more number of packages are delivered to destination.

Fig. 6. End-to-end delay average

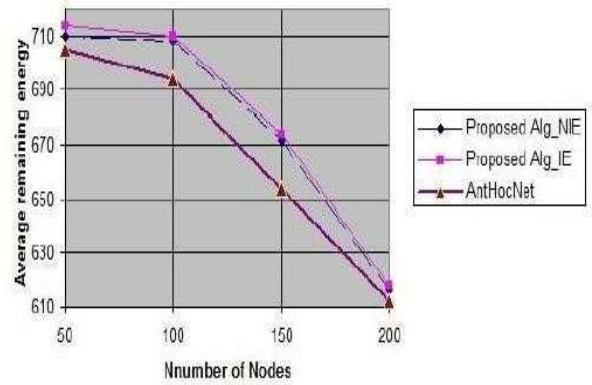


Fig. 7. average energy left in nodes in networks with various sizes

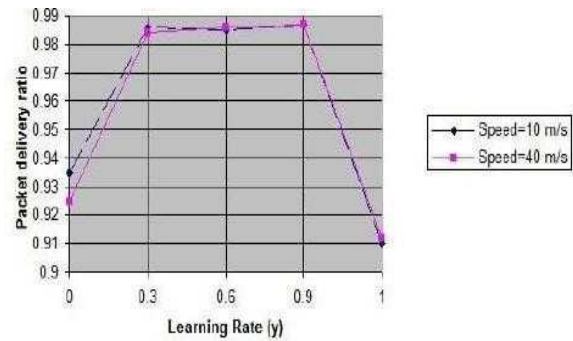


Fig. 8. Effect of learning coefficient on packet delivery coefficient

The findings also show that the exchange of information in many movements of nodes can significantly reduce routing overhead rate and average end-to-end delay and can increase average residual energy of nodes. Fig 9, 10 and 11

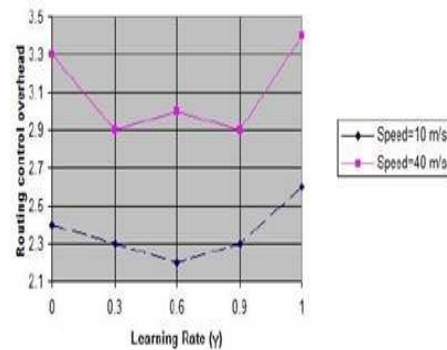
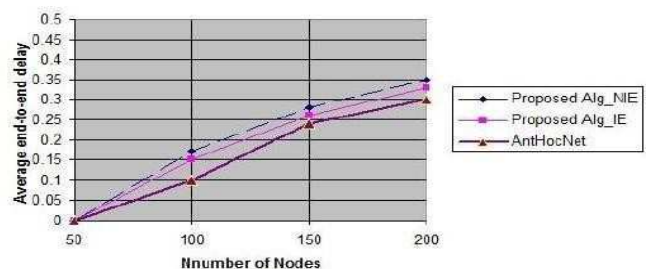


Fig. 9. Effect of learning coefficient on routing overhead rate



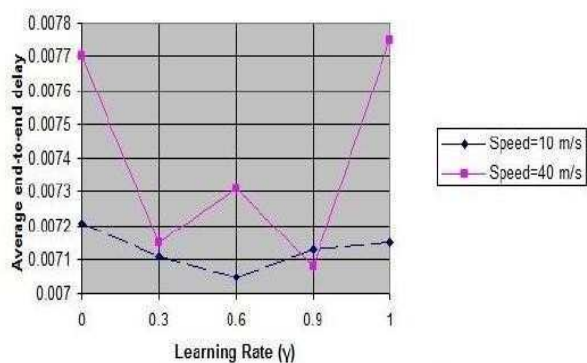


Fig. 10. Effect of learning coefficient on average end-to-end delay

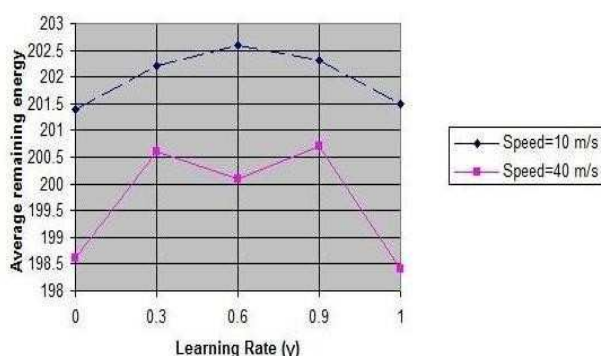


Fig. 11. Effect of learning coefficient on average residual energy of nodes

CONCLUSION

The purpose of this research, was presentation and evaluation of a routing algorithm based on colony optimization method. Hence at first there was a review of existing routing algorithms in ad hoc network and the strengths and weaknesses of each were reviewed. Then mass intelligent technique was introduced indicating that this technique and in particular ant colony optimization can be fine for using in self-motivated routing algorithms because there are many similarities with the ad hoc networks. Charisma of optimization method is based on ant colonies in self-motivated ad hoc routing algorithms and it was approved with several routing protocols which applied this technique. Nearly in all tasks introduced more appropriate function was reported compared to other methods. Then, a new algorithm based on ant colony optimization and consistent with current changes of network was presented. The proposed algorithm is a hybrid algorithm of active and passive elements. In this algorithm routing is done based on the current situation. For this purpose, a decision-making function is added to algorithm, which selects target according to network conditions routing. The purpose of routing can be one of three parameters of crossing, node consistency and minimum energy transmission. Corresponding to each target there exists a clone and a table which maintains information of route for each goal. For better function of algorithm, colonies exchange information of pheromones in regular intervals. Using directional ring topology, each cluster colony transfers

answer related to each goal colony in pheromones table for next one in circle so that new solutions will be based on exploring the next colony. In order to evaluate algorithm function the proposed algorithm became one of the most important self-motivated routing algorithms which was based on ant colony optimization Ant Hoc Net. The results show that using multi-colony and routing target selection based on the current state of the network can be effective in improving performance routing algorithms. Topology is constantly changing in mobile ad hoc networks and on the other hand, energy nodes are restricted, so in this algorithm there was an effort to be notice condition and network limitations in selecting optimized routes. The proposed algorithm can have better function compared to Ant Hoc Net during delivering data package successfully, reducing route overhead and increasing energy left from nodes. In this algorithm ant colony algorithm-based optimization method was used for routing. In ant colony optimization decision is made for choosing next crossing based on pheromones and discovering information and parameters α and β determine their significance level. Fine algorithm function depends on determining the exact performance. For improved performance, future works can deal with effect of these parameters. Also, the exchange of information in multi-colony methods happens using various topologies at regular intervals. Topology and policy information exchange can be effective in improving function. Therefore, in future work we can review effect of selecting any one of these topologies and the different timing of exchange of information among clones examined.

REFERENCES

- [1] Doerner, K., Hartl, R.F, Teimann, M. (2013). "Are COMPE Tants More Competent for problem solving? The Case of Full Truckload Transportation". Central European Journal of Operation Research 11(2):115-141
- [2] Hong, X.Y., XinXu, K., Gerla, M. (2012). "Scalable Routin Protocols for Mobile Ad hoc Network". IEEE Network. July/August: 11-21
- [3] Iredi, S., Merkle, D., Middendorf, M. (2011). Bi- Criterion Optimization with Multi Colony Ant Algorithm. First International Conference on Evolutionary Multi-criterion
- [4] Kamimura, J., Wakamia N., M. (2004).Energy- Efficient Clustering Method for Data Gathering in Sensor Network.BROADNETS04.
- [5] H Dai, EB Khalil, Y Zhang, B Dilkina, L Song. (2017) Learning Combinatorial Optimization algorithm overgraph.
- [6] V Beiranvand, W Hare, Y Lucet. (2017) Best practices for Comparing
- [7] T Agasiev, A Karpenko.(2017) The program system for Outomated parameter tuning of optimization algorithms.
- [8] S Cheng, Y Sun, J Chen, Q Qin, X Chu.(2017) A comprehensive Survey of brian storm optimization algorithms.
- [9] T Efimov, , P Korošec, BK Seljak.(2017) A novel approach to statistical comparison of meta-heuristic stochastic optimization Algorithms using deep statistics.
- [10] R Singh, H Chaudhary, AK Singh.(2017) Defect-free optimal synthesis of crank-rocker linkage using nature- inspired optimization algorithms

- [11] Middendorf, M., Reischle, F. Schmeck, H. (2010). Information exchange in multi-colony ant algorithm, in:J.Rolim, G.Chiola, G.Conte,L.V. Mancini, O.H. Ibarra, H. Nakano(Eds.),Parallel and DistributedProcessing: 15 IPDPS 2000 Workshops, Lecture Notes in Computer Science, vol. 1800, Springer- Verlag,Heidelberg, Germany, pp. 645-652
- [12] Middendorf, M., Reischle, F., Schmeck, H. (2011). Multi-colony ant algorithms, journal of heuristics. 8(3):305 -320