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A Bio-Inspired Optimized Path Detection (OPD-BA) Routing Protocol for Mobile Ad-hoc Networks

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Abstract
Nature-inspired algorithms are among the most powerful algorithms for optimization. In this study, a new nature-inspired metaheuristic optimization algorithm, called bat algorithm (BA), is introduced for the optimized route discovery. The proposed OPD-BA is based on the echolocation behaviour of bats. After a detailed formulation and explanation of its implementation, OPD-BA is verified using two important optimization criteria. OPD-BA has been carefully implemented and carried out optimization for four well-known optimization tasks. Then, a real time implementation comparison has been made between the proposed algorithm and other existing algorithm using NS2 Simulator. The optimal solutions obtained by the proposed algorithm are better than the best solutions obtained by the existing methods.

Keywords: Mobile Ad-hoc networks, Bat Algorithm, Routing protocols: AODV

I. Introduction:

Mobile ad hoc network (MANET) is an appealing technology that has attracted lots of research efforts. Ad as conventional networks. In MANETs the nodes function hoc networks are temporary networks with a dynamic topology which doesn't have any established infrastructure or centralized administration or standard support devices regularly available as wireless routers by discovering and maintaining routes to other nodes in the network. In contrast with infrastructure networks MANETs should be self-built, self-configured, and adaptive to dynamic changes.

In this paper, the application of BAT algorithm for mobile ad hoc networks (BA) is introduced used to solve the routing problem and to managing the network life time. In this paper, concentrate at the received signal strength of the nodes. Section II describes Bat Algorithm (BA)-a bio-inspired technique for optimized route discovery. In Section III, the potential of using BAT algorithm in the ad hoc environment and how a real BAT technique solves its shortest-path problem is presented. This section also gives the structure of the proposed algorithm is described showing the concept of RSS and LAT. Section IV has the simulation and performance evaluation of the proposed algorithm. Section V describes the conclusion of the proposed system.

Fig.1. Mobile Ad-hoc Network

protocols define a set of rules which governs the journey of message packets from source to destination in a network. In MANET, there are different types of routing protocols each of them is applied according to the network circumstances. Figure 1 shows the basic classification of the routing protocols in MANETs.

Routing protocol for ad-hoc network can be categorized in three strategies.

- Pro-active routing protocol
- Re-active routing protocol
- Hybrid protocols.

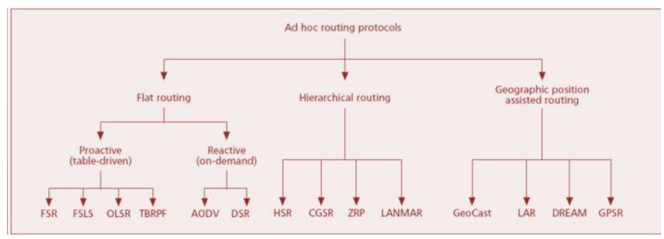


Fig.2. Routing Protocols

Ad-Hoc on Demand Distance Vector Protocol (AODV):
AODV is distance vector type routing where it does not involve nodes to maintain routes to destination that are not on

active path. As long as end points are valid AODV does not play its part. Different route messages like Route Request, Route Replies and Route Errors are used to discover and maintain links. AODV is reactive protocol, when a source wants to initiate transmission with another node as destination in the network, AODV use control messages to find a route to the destination node in the network. AODV will provide topology information (like route) for the node. The following figure shows the message routing for AODV protocol. Node "A" wants to send messages to another node "F". It will generate a Route Request message (RREQ) and forwarded to the neighbours, and those node forward the control message to their neighbours‟ nodes. Whenever the route to destination node is located or an intermediate node have route to destination. They generate route reply message (RREP) and send to source node. When the route is established between "A" and "F", node then they communicate with each other.

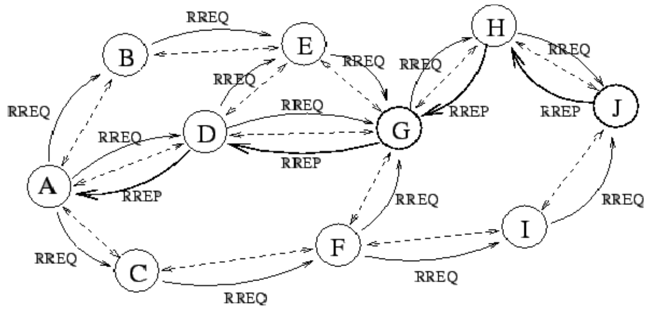


Fig 3. Routing in AODV

RREQ-A route request message is transmitted by a node requiring a route to a node. As an optimization AODV uses an expanding ring technique when flooding these messages. Every RREQ carries a time to live (TTL) value that states for how many hops this message should be forwarded. This value is set to a predefined value at the first transmission and increased at retransmissions. Retransmissions occur if no replies are received. Data packets waiting to be transmitted (i.e. the packets that initiated the RREQ). Every node maintains two separate counters: a node sequence number and a broadcast_ id. The RREQ contains the following fields:

Source Address	Broadcast ID	Source sequence no.	Destination address	Destination sequence no.	Hop count

The pair <source address, broadcast ID> uniquely identifies a RREQ. Broadcast id is incremented whenever the source issues a new RREQ.

RREP-
A route reply message is unicasted back to the originator of a RREQ if the receiver is either the node using the requested address, or it has a valid route to the requested address. The reason one can unicast the message back, is that every route forwarding a RREQ caches a route back to the originator.

RERR-
Nodes monitor the link status of next hops in active routes. When a link breakage in an active route is detected, a RERR message is used to notify other nodes of the loss of the link. In order to enable this reporting mechanism, each node keeps a ―precursor list", containing the IP address for each its neighbors that are likely to use it as a next hop towards each destination.

Route Table Management:
Each mobile node in the network maintains a route table entry for each destination of interest in its route table. Each entry contains the following information:

- Destination
- Next hop
- Number of hops
- Destination sequence number
- Active neighbors for this route
- Expiration time for the route table entry

The other useful information contained in the entries along with source and destination sequence numbers is called soft-state information associated to the route entry. The info about the active neighbors for this route is maintained so that all active source nodes can be noticed when a link along a path to the destination breaks. And the purpose of route request time expiration timer is to purge the reverse path routing entries from all the nodes that do not lie on the active route.

II. Bat Algorithm –Over view
If we idealize some of the echolocation characteristics of micro bats, we can develop various bat-inspired algorithms or bat algorithms. For simplicity, we now use the following approximate or idealized rules:

1. All bats use echolocation to sense distance, and they also `know' the difference between food/prey and background barriers in some magical way;
2. Bats fly randomly with velocity *vi* at position *xi* with a fixed frequency *fmin*, varying wavelength λ and loudness *A0* to search for prey. They can automatically adjust the wavelength (or frequency) of their emitted pulses and adjust the rate of pulse emission *r* in the range of [0, 1], depending on the proximity of their target;
3. Although the loudness can vary in many ways, we assume that the loudness varies from a large (positive) *A0* to a minimum constant value *Amin*.

Another obvious simplification is that no ray tracing is used in estimating the time delay and three dimensional topography. Though this might be a good feature for the application in computational geometry, however, we will not use this feature, as it is more computationally extensive in multidimensional cases.
In addition to these simplified assumptions, we also use the following approximations, for simplicity. In general the frequency f in a range [*fmin*, *fmax*] corresponds to a range of wavelengths [λmin, λmax]. For example a frequency range of

[20 kHz, 500 kHz] corresponds to a range of wavelengths from 0.7 mm to 17 mm.
For a given problem, we can also use any wavelength for the ease of implementation. In the actual implementation, we can adjust the range by adjusting the wavelengths (or frequencies), and the detectable range (or the largest wavelength) should be chosen such that it is comparable to the size of the domain of interest, and then toning down to smaller ranges. Furthermore, we do not necessarily have to use the wavelengths themselves; instead, we can also vary the frequency while fixing the wavelength λ. This is because □ and f are related due to the fact λf is constant. We will use this later approach in our implementation.
For simplicity, we can assume f is within [0, *fmax*]. We know that higher frequencies have short wavelengths and travel a shorter distance. For bats, the typical ranges are a few meters. The rate of pulse can simply be in the range of [0, 1] where 0 means no pulses at all, and 1 means the maximum rate of pulse emission.
Based on these approximations and idealization, the basic steps of the Bat Algorithm (BA) can be summarized as the pseudo code shown in the following

Pseudo code of Bat Algorithm (BA):
1. define objective function
2. initialize the population of the bats
3. define and initialize parameters
4. while(Termination criterion not met)
{
generate the new solutions randomly
if (Pulse rate (rand) >current)
select a solution among the best solution
generate the local solution around the selected
best ones.
end if
generate a new solution by flying randomly
if (Pulse rate (rand) >current)
select a solution among the best solution
generate the local solution around the selected best ones
end if
generate a new solution by flying randomly
if (loudness & pulse frequency (rand) < current)
accept the new solutions
increase pulse rate and reduce
loudness end if
rank the bats and find the current best
}
5. Results and visualization.

III. BAT inspired Optimized Path Detection Algorithm-(OPD-BA):

The new proposed algorithm OPD-BA is an Optimized path Route detection scheme that uses the behaviour of the real Bats to find dynamic multiple optimal paths between source and destination nodes.

Route Detection Process:

1. In this process all the nodes will exhibits the behaviour of Bats. Whenever the source node S wants to send data to the destination node D, it floods the RREQ in the network. The bats which are small control packets carrying the D-id, travel in all available paths to D, and use their behaviours echolocation and loudness to collect details about the path they travel to reach the D.
   a) Echolocation behaviour calculates the received signal strength used to calculate the distance between the nodes to find its neighbours.
   b) Loudness behaviour measures the link availability all the nodes in the path it travelled to reach D.
2. Upon receiving the RREQ, the destination D in turn rebroadcasts the Reverse RREQ in all available paths to source S.
3. The Reverse RREQ (R-RREQ) while travelling from D to S, collect the distance and link availability of each node to reach the source and the total average residual energy of all nodes in the path they travelled.
4. In the OPD-BA, the intermediate node stores the incoming RRREQ during a particular time interval along with their link availability and distance travelled to reach the node. The R-RREQ which has the maximum received signal strength and link available time is selected and forwarded to the neighbors.
5. In order to reduce the number of R-RREQ bats flooding and to select the best next hop node among the existing next hop nodes, the bat uses its loudness and echo property. A hello packet which carries the D-id will be sent to all the next neighboring nodes for checking the availability of paths to the destination D through them. The R-RREQ bats will be forwarded to the neighboring nodes that have paths to D and responded for the hello messages within the stipulated time period.
6. Upon receiving multiple Reverse RREQ Bats from D, the source filters only the node disjoint paths represented by the bats and discards the other paths.
7. The selected paths (N) are ranked based on the higher RSS value and maximum link availability time.
8. The number of required paths which also satisfies the QoS requirements of the application are selected as the best paths in the list and data transmission is distributed among them.

Route Updating Process:
As the loudness Ai (LAT) of each bat usually decreases when a bat(path) is involved in data transmission, it has to be updated as the data transmission proceeds. In order to maintain an updated path list, the source node floods RREQ at regular intervals through the selected paths (N) to collect the current Energy level and time delay. Then the paths are again ranked with the new collected values and the numbers of required best paths are selected for data transmission.

Route Maintenance

In OPD-BAT algorithm, the routes are maintained as follows: If a node along a path moves or a route fails due to irregular circumstances, a link failure message will be sent to the source through the intermediate nodes to inform the erasure of the route. Upon receiving the link failure message, the source node removes the broken route from the existing path list and redirects the data packets in the remaining available paths in the path list. Thus the overhead is drastically reduced due to the avoidance of frequent route discoveries and uninterrupted data transmission.

DISCOVERING NEIGHBOURING MOBILITY:

This section estimates nodes mobility in MANETs. In this process the mobility of a node is calculated by finding the distance between node and its neighbors and can be done by using two methods:

Calculate the distance

A. Calculate the distance using RSS and LAT:

RSSI is a generic radio receiver technology metric, which is usually invisible to the user of the device containing the receiver.

Uses Recieved Signal Strength(RSS) changing rate to predict Link Available Time(LAT)

- RSSi, j(t)
- _RSSi, j(t) = RSSi, j (t)−RSSi, j (t0):t−t0, t > t0
- Transmission Range(TR), Di, j(t), Si, j (t)
- LATi, j (t) = TR±Di, j (t) Si, j (t)|

B. Calculate the distance by the angle:

1. We calculated the heading angle for all nodes depending on the node position and angles in different quadrants of the networks.
2. Procedure: Handle Request (angle process)

a) If packet received for the first time add it to Routing Table.

b) If the rout is new, update the Routing Table.

3. Calculate the Angle between the two Nodes:

Nod1: the sender node.
Node2: the receiver node.
Def = |Node1Angle-Node2Angle|
i f Def>180 Angle=360-Def else Angle=def
End if Return Angle;

4. Calculate the distance between the nodes by angle.
5. If the new route (new angle) is a better than the available (current angle) update the Routing Table.
6. After selecting the lowest distance difference, than we can send the data.

IV. Simulation Results

Analysis of Performance between AODV and OPD-BA:

The Network simulator (NS-2) is used to evaluate the performance of the proposed algorithm. The simulation is carried out for 40 mobile nodes which move in a 500 meter x 500 meter rectangular region for 300 seconds simulation time. It is assumed that each node in the network moves independently with the same average speed. All nodes have the same transmission range of 250 meters. The simulated traffic is Constant Bit Rate (CBR). The random waypoint model is used to simulate nodes movement. The motion is characterized by two factors: the maximum speed and the pause time. The pause time is defined as the period of time a node stays stationary before heading for a new random location. Each node starts moving from its initial position to a random target position selected inside the simulation area. The node speed is uniformly distributed between zero and the maximum speed. The following table lists the simulation parameters and environments used.

Table 1.Simulation Scenario

Simulation Terrain Dimension	500 X 500 meters
Transmission Range	230 m
Mobility model	Random way point
Number of Nodes	40
Node Speed	0-10 m/s
Routing protocols	AODV, OPD-BAT
Traffic Source Model	Constant Bit Rate
Channel Data Rate	2 Mbps
Initial energy	20 Joules

Results in Simulation:

Conventional Method of AODV:

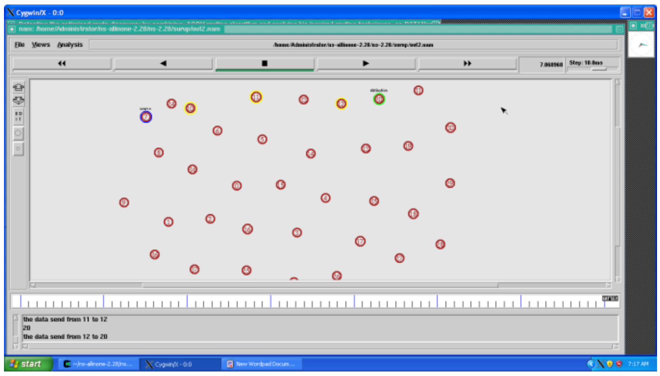


Fig4. Path selection in AODV

Proposed OPD-BA:

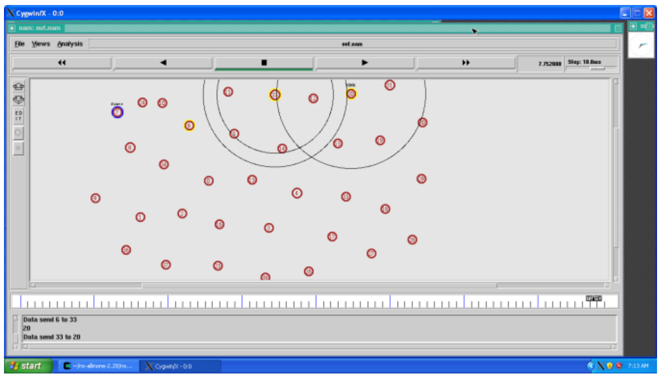


Fig5. Path selection in OPD-BA

Results:

Packet Delivery Ratio:

It is the ratio of amount of data packets received by the destination and the total number of data packets sends by source. The routing protocol which has the better PDR that protocol is best and efficient and provides good performance.

Packet Delivery Ratio = Packets Delivered / Data packets Generated

Fig6. PDF Graph of AODV and OPD-BA

2. End-to-End Delay:

It is the interval time between sending data by the source node and receiving data by destination node. The routing protocol which takes less time for sending data from source to destination node is better protocol and provides good results.

End to End Delay = Σ (Arrive time-Send Time) / Σ (No. of connection

Fig7. PDF Graph of AODV and OPD-BA

Throughput:

Throughput is defined as the total size of useful packets that received at all the destination nodes in a unit time. Throughput of Source node to Destination node is:

Throughput = No of Bits from Source node to Destination node / Duration

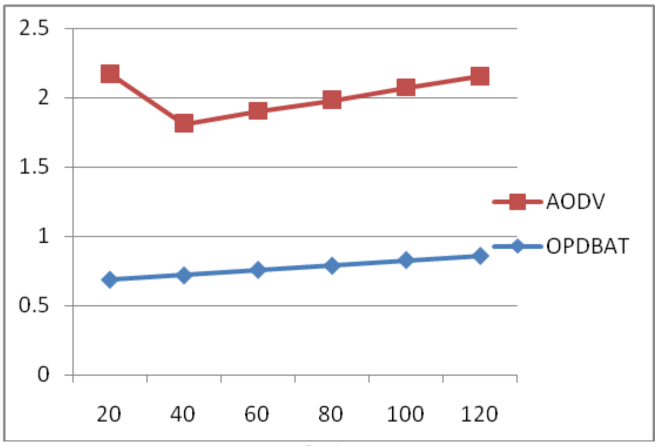
Fig 8. PDF Graph of AODV and OPD-BA

The following table shows some of the evaluated results from the proposed system using NS2 simulator

Angle	Distance			PDR
0: 7-23.13010235415601	0	1	193.775643	1.1000000000000001 13
1: 7-80.96787218266167	0	2	109.480592	1.1500000000000001 19
2: 7-01.13197618821783	0	3	183.741666	1.2000000000000002 25
3: 7-21.73048393461568	0	4	216.092573	1.2500000000000002 31
4: 7-35.80519906529389	0	5	120.768373	1.3000000000000003 38
5: 7-348.1322681024339	0	6	137.233378	1.3500000000000003 44
6: 7-47.25471052686714	0	7	275	1.4000000000000004 50
8: 7-85.94539590092285	0	8	207.634294	1.4500000000000004 56
9: 7-55.24268067411455	0	9	276.904315	1.5000000000000004 63
10: 7-.8297446679090648	0	10	215.522621	1.5500000000000005 69
11: 7-10.39923811238722	0	11	219.100434	1.6000000000000005 75
12: 7-3.308920356875825	0	12	312.846608	1.6500000000000006 81
13: 7-51.24565262614146	0	13	317.320028	1.7000000000000006 88
14: 7-347.5321776637868	0	14	193.940713	1.7500000000000007 94
15: 7-32.30052719194504	0	15	100.04499	1.8000000000000007 100
16: 7-11.23014623707815	0	16	111.986606	1.8500000000000008 106
17: 7-29.26674248684185	0	17	324.729118	1.9000000000000008 113
18: 7-40.16658352938498	0	18	431.393092	1.9500000000000008 119
19: 7-53.27957638905366	0	19	418.025119	2.0000000000000009 125
20: 7-.9980420992033783	0	20	394.791084	2.0500000000000007 131
21: 7-4.644867194730461	0	21	394.993671	2.1000000000000005 138
22: 7-2.155446872335073	0	22	321.864878	2.1500000000000004 144
23: 7-2.434651620092694	0	23	294.491086	2.2000000000000002 150
24: 7-9.420773127510991	0	24	329.200547	2.25 156
25: 7-03.29517805523022	0	25	206.286209	2.2999999999999998 163
26: 7-19.60629785064185	0	26	324.692162	2.3499999999999996 169
27: 7-30.38744128423161	0	27	426.812605	2.3999999999999995 175
28: 7-36.64597879401299	0	28	511.121316	2.4499999999999993 181
29: 7-47.70282282600169	0	29	514.024318	2.4999999999999991 188
30: 7-357.6499188063209	0	30	528.531929	2.5499999999999989 188
31: 7-5.64161405327813	0	31	494.71608	2.5999999999999988 198
32: 7-3.567193123666211	0	32	468.136732	2.6499999999999986 205
33: 7-.2906707733550062	0	33	262.240348	2.6999999999999984 211
34: 7-09.24173983563321	0	34	118.004237	2.7499999999999982 217
35: 7-39.77514056883194	0	35	333.174129	2.799999999999998 223
36: 7-72.71823320183898	0	36	266.833281	2.8499999999999979 230
37: 7-286.7133356698908	0	37	234.367233	2.8999999999999977 236
38: 7-11.13555969036219	0	38	272.154368	2.9499999999999975 242

Performance Comparison between AODV and OPD-BA:

The following figure shows the routing control overheads for different node pause time.



Techniques

Fig9. Routing heads of AODV and OPD-BA

VI. Conclusion:

The Optimized path Routing algorithm using BA optimization (OPD-BA) proposed in this chapter improves the QoS parameters delay and PDR. The proposed algorithm selects the paths with the minimum delay and the maximum RSS and LATs at nodes. The OPD-BAT produces better results than the existing AODV in terms of packet delivery ratio, end-to-end delay, and residual energy at nodes and normalized routing load. The performance of OPD-BA is also compared with the existing AODV protocol and it is observed that OPD-BAT outperforms AODV routing protocol.

References:

1. Bat algorithm: a novel approach for global engineering optimization, Xin-she Yang[1] Amir Hossein Gandomi[2]
2. Vaibhav Godbole*Defence S & T Technical Bulletin, Science & Research Technology Institute for Defence (STRIDE), Vol. 5, No. 2, November 2012, pp. 114-134, ISSN: 1985-6571
3. DISTANCE'S QUANTIFICATION ALGORITHM IN AODV PROTOCOL, Meryem Saadoune 1, Abdelmajid Hajami² and Hakim Allali³ Department of Mathematics and Computer Sciences, Hassan st University, Settat, Morocco
4. CH. V. Raghavendran., I.J. Intelligent Systems and Applications, 2013, 01, 81-89 Published Online December 2012 in MECS (http://www.mecs-press.org/) DOI: 10.5815/ijisa.2013.01.08
5. Harris Simaremare, Abdelhafid Abouaissa, Riri Fitri Sari, Pascal Lorenz,
6. IEEE ICC 2014 Communications Software, Services And Multimedia Applications Symposium.10-14 June 2014Page(s):1843-1848INSPEC Accession Number:14545325
7. Tarun Varshney, Aishwary Katiyar, Pankaj Sharma 2014 International Conference On Issues And Challenges In Intelligent Computing Techniques.
8. Hetal P. Mistry, Nital H. Mistry IJIRT 100231-INTERNATONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY, © 2014 IJIRT | Volume 1 Issue 5 | ISSN: 2349-6002
9. Gaige Wang, Lihong Guo, Hong Duan, Luo Liu, and Heqi Wang The Scientific World JournalVolume 2012, 2012, Article number 418946
10. Bhawna Talwar, Anuj K.Gupta 2012 International Conference on Technical and Executive Innovation in Computing and Communication (TEICC 2012), ISBN: 978-81-923777-0-4 588
11. B.Pooja sree prasanna, G. Krishna kishore World Academy of Science, Engineering and Technology International Journal of Mathematical, Computational, Natural and Physical Engineering Vol:9, No:3, 2015
12. An improved multipath MANET routing using link estimation and swarm intelligence, Prapha R and Ramaraj N
13. Performance analysis of AODV and DYMO Routing protocols in MANETs using Cuckoo search optimization.
14. E. M. Royer and Chai-Keong Toh, "A Review of current Routing Protocols for Ad Hoc Mobile Wireless Networks, " IEEE Personal Communications, April, 1999.
15. Nadia Qasim, Fatin Said and Hamid Aghvami, "Mobile Ad hocNetworks simulations using Routing protocols for Performance comparisons", Proceedings of the world congress on Engineering, WCE, VOL I, 2008
16. Congestion Control in Adhoc Network Gaurav Sharma* Akhilesh K. Bhardwaj, Kurukshetra University SKIET, Kurushetra, University Kurukshetra, India Kurukshetra, India.