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Modified Ant Colony Optimization and Dynamic Source Routing for Efficient Cluster Head Selection and Routing on Manet

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Abstract
A type of wireless network, where mobile nodes collection is positioned arbitrarily and dynamically to make a contact between each other is called as Mobile Ad-Hoc NETwork (MANET). These nodes do not make a fixed configuration since the nodes can go in any direction. These MANET nodes can converse along with other nodes in the radio range. In the existing system, Ad hoc On-Demand Distance Vector (AODV) routing and Particle Swarm Optimization (PSO) approaches are introduced for energy efficiency. However these methods have issue with best Cluster Head (CH) node selection in larger network. Thus the overall performance is reduced significantly. To avoid the above mentioned drawbacks, in the proposed system, Dynamic Source Routing (DSR) protocol and Modified Ant Colony Optimization (MACO) algorithms are proposed. The proposed method contains three phases such as system model, CH selection using MACO and routing using DSR. In the system model, nodes are connected to send and receive the packets. Energy model and mobility model are constructed to give efficient packet transmission over MANET. In second phase, the MACO algorithm is focused to select the best CH node using fitness function. Distances between nodes are used along with this to compute utilization of energy. In the third phase, the DSR protocol is used to produce efficient routing path over MANET. The result concludes that the proposed MACO+DSR algorithm provides higher throughput, lifetime of network, lower end to end delay, and consumption of energy than existing PSO and AODV approaches.

Keywords: MANET, Dynamic Source Routing (DSR) Particle Swarm Optimization (PSO), AODV, Modified Ant Colony Optimization (MACO), Cluster Head (CH), Routing path.

1. Introduction

MANETs is an infrastructure-less, active system encloses movable wireless nodes set that makes the communicate between them without any centralized authority. Every node in a MANET is without charge to move freely in any route, and hence modify its links to other nodes often [1] [2]. In a MANET, every node has its own radio broadcast range. Two nodes can have communiqué with every other openly only if they are in the similar radio communication series. If two hubs are not in the similar radio transmission range, they can still transmit but using the intermediate nodes. Every time the nodes in the MANET are concerned in transmission, battery energy of those nodes will get reduced.

Cluster-Heads selection of ad-hoc networks is significant thing for clustering. CH node is selected by the node with maximum amount of neighbours. Node with high connectivity is chosen as a CH [3]. Cluster heads are chosen based on the computation of local stability. Among the neighbourhood of a node, node with high stability is selected as a cluster head and this node will have low value of local stability.

In MANET, there are two types of routing protocols. They are reactive and proactive. Route of Destination node without having known route from source node is computed in reactive routing [4] [5]. Topology data is swapped by node intermittently in order to gather the information continuously when they want to transmit a data in proactive protocols.

The aim of this work is to analyze the routing performance of DSR and to develop optimization algorithm to select head of cluster to ensure improved energy efficient routing in MANETs. Organization of the paper is organized as follows: Section 2 describes review of literature works in energy efficiency and cluster head selection algorithms over MANET. Section 3 describes proposed modified PSO optimization algorithmand DSR routing protocol. Section 4 discusses about result of experimentation with discussion. Section 5 concludes the research work.

2. Literature Survey

Kai, A. A. and Jan, H, R [6] implemented adaptive topology control protocol to node's which are moving. In order to preserve energy, energy-efficient routing can be supported by a node. For mobile node, a beacon message broadcasting is minimized by this protocol. Beacon power is decreased by a energy efficient preservation rule utilization. 4 to 5 beacon intervals are exposed by a change in power. Based on energy level and mobility of a node, parameter of a node is organized in adaptive configuration rule. Poor utilization of energy is resulted by this.

Rajaram, A. and Sugesh, J [7] implemented a power utilization routing which is termed as energy aware ad hoc on demand multipath distance vector scheme. Power condition table is sustained by power condition table in place of route cache which is maintained in ordinary protocols. Route passing is mapped to this and equivalent retained power are recorded. Route, last process time, quantity of power taken, destination id, source id and demand id of next access is included in this.

Li et al [8]proposed MAODV multicast routing protocol which is based on enhanced selection of cluster head in MANET. Cluster head node selection's randomness is reduced by QoS mechanism in this enhanced algorithm. It also considers bandwidth and delay of a network. Packet delivery ratio and average delay between end-to-end and overhead of routing is also enhance by the proposed model.

Ali et al [9] used multi-objective particle swarm optimization(MOPSO) algorithm to propose a multi-objective solution. Nodes energy dissipation and cluster numbers in ad hoc network are optimized by this method. Traffic in network is reduced while giving energy efficient solution. In this solution, cluster head manages the traffic in intra-cluster and inter cluster. Mobile node's battery power consumption, power of transmission, degree of nodes are considered by this algorithm. At a time, set of solutions is provided by this.

P.S.Karadge, Dr.S.V.Sankpal [10] used residual energy of nodes in a path to choose a power resourceful route which is known as Maximum Energy Level Ad Hoc Distance Vector (MEL-AODV) protocol. Route request process is initiated by source node which is having a packet to transmit to destination node. Best route corresponds to the route with high accumulated energy.

Istikmal [11] uses the optimized method in DSR routing algorithm. It employs Ant optimized algorithm which is utilized to estimate and the estimation is completed via some statistical equations. This work examined and computed the performance of the routing algorithm in diverse circumstances and also performed the output along with DSR routing approach. 48% small delay is achieved by DSR-ant with 1.37 times reduced hop-count and increased throughput about 3.6 times as shown by comparison.

3. Proposed Methodology

In this research, MANT+DSR algorithm is introduced for improving efficiency of energy by producing optimal CH node selection over MANET. Figure 1 shows the proposed method's overall block diagram.

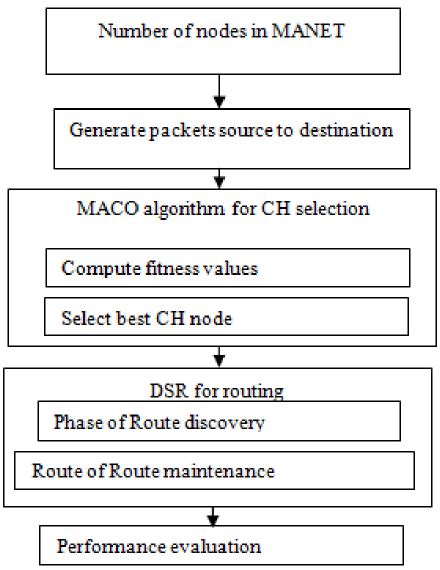

Fig 1 Proposed system's Overall block diagram

3.1 System model

The proposed system considers the network environment, which is structured with no central authority. The nodes placed on the network can send and receive packets via multiple indirect hops. Assume the MANET network along with N number of identical mobile nodes, n number of neighbour nodes, source node, destination node, links and routing path along with particular distance.

To a destination node, packet is delivered by a source node [12]. Relay nodes corresponds to an intermediary nodes. Delay of packet, lifetime of a network, energy distribution during delivering a message to destination and throughput are computed.

3.1.1 Mobility model

Model of mobility shows movement of nodes in MANET in system depends on the location, rapidity and pace. This scheme discovers the implementation of the scheme in the network for information data communication. Consider n1 and n2 be two MANET nodes located at (a1, b1) and (a2, b2), respectively. At a time l = 1, both the nodes travels to a new position (a_1', b_1') and (a_2', b_2') such that the association of the nodes is within a particular place. The Euclidean distance among MANET node is given as

$$d(0) = |a_1 - a_2|^2 + |b_1 - b_2|^2 \quad (1)$$

The distance among the MANET nodes at any time *l* in the new positions is calculated as follows,

$$d(l) = |a_1' - a_2'|^2 + |b_1' - b_2'|^2 \quad (2)$$

Where (a_1', b_1') *and* (a_2', b_2') are the new locations obtained via the nodes n1 and n2, respectively

3.2 CH selection using MACO algorithm

MACO algorithm is used for the selection of CH node selection in this research. Distance between MANET node and cluster forms the base for selection of CH node [13]. Also it depends on the remaining energy of the node in given network decreases the overhead of clustering process. It is used to reduce the load over CH, avoiding re-clustering and therefore lessen the power utilization within the cluster in large-scale.

Clustering is one among the essential technique for extending the network lifetime in MANET. It consists of grouping of the nodes into clusters and then selecting CHs for every cluster. CHs gather data from nodes of corresponding cluster and forwards data aggregated to main node (Information center).

Process of selecting head of a cluster from nodes present in the cluster is termed as Election of CH. In intra- and inter cluster communication, important role is played by head of cluster in hierarchical structure. For member of cluster, local coordination is maintained by CH and also cluster members are managed by this. Node connecting intra and inter cluster communication is termed as gateway node. Inter cluster communication path is provided by distributed gateways. Cluster head's next immediate neighbor corresponds to a ordinary node.

Behaviour of ant colonies is inspired by an algorithm called ACO algorithm. Ant system also represents ant colony. By traversing pheromones or footprint of paths, best food sources and CH are computed by an ant. Following describes the process used by ACO algorithm in computing CH.

Algorithm is initialized with following parameters, constant control visibility (β) where, β ≥ 0, constant intensity controller ant trail (α),constant cycle of ants (Q), source and destination node, evaporation constant trail of ants (ρ), where ρ > 0 and <1 distance between nodes (dij), nodes n with coordinates x and y, number of ants (m), intensity of inter-node ant trail and changes (τij), , visibility between nodes = 1/dij (ηij),maximum number of cycles (NCmax) and it is a fixed value. In every cycle of an algorithm, update costs (τij) until reaching maximum iteration count.

In the tab_u list, first node is charged. Between nodes, information of visibility is contained by Tab_u list in a table format. In Tab_u list, first element is filled by a first step of ant in every node's first initialization result. Particular index node, tabu list's first element is filled by this result of this step. Every tab_uk(1) can contain node index between 1 and n as the initialization in step (a).

To all node, compose route from every node. Every node is distributed in ant colonies. Origin node corresponds to first node and nodes starts to travel from this node to destination node. Then they start from second node. Nodes are chosen randomly based on tabuk. Until reaching all nodes, journey of ant colony continuous.

$$p_{ij}^k = \frac{[\tau_{ij}]^\alpha . [\eta_{ij}]^\beta}{\sum_{k\epsilon\{N-tab\,u_k\}}^{n} [\tau_{ik}]^\alpha . [\eta_{ik}]^\beta} \quad (3)$$

for j ∈***{N-tabuk}*** and = 0, for other j

After all ants completing one cycle, closed route length or Lk is computed. With following equation, every

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tabuk is used to perform computation. Distance between node i and j is represented by dij,

$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \qquad (4)$$

On path between nodes, footprints are registered by ant colonies. Intensity value of inter-node ant footprints can be varied by difference in number of ants and evaporation existence. Price intensity parameter of ant footprints defines iteration count of algorithms.

The ACO algorithm is modified to allocate a best local guide to every particle via lower angular distance information data. The fitness function calculation is performed based on the nodes residual energy, bandwidth availability and delay time between the nodes.

3.3 DSR protocol

DSR is a source routing protocol which is an on-demand and beacon-less protocol. Route is discovered from source to destination, when cache route does not contains this as it is an on-demand protocol. For MANET, it is termed as reactive routing protocol. Route maintenance and discovery are the major functionalities included in DSR. Ina given network, submerge Route Request (RREQ) packets are used to make a direction in route discovery stage of this protocol.

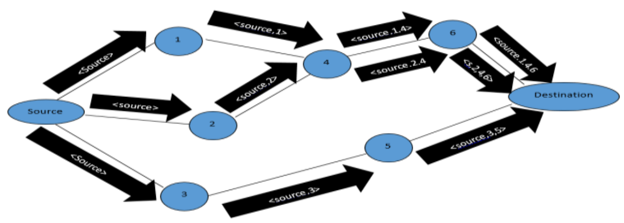

Fig 2 Route discovery phase

Route direction cache is looked by source node, when information packet is send to destination by it. The message is transmitted if destination's route information is contained by the route collection [4]. PREQ packets are send to initiate route discovery procedure, if route cache does not have the information of route.

Route Reply (RREP) message is transmitted to source after receiving RREQ packet in receiver side. In RREQ Packet, stored route information data is overturned to do this. If intermediate node has a route for destination node, it transmits a RREP to source node after receiving PREQ.

Figure 3 shows the dealing of breakage of links in the phase of route maintenance. Movement of intermediate node out of range of broadcast in packet forwarding leads to breakage of link. To source node, route error (RERR) message is send by node if a node is capable of transmitting data packets. From cache, route is isolated and packet is resend.

In path of route, if an link breakage is identified by upstream node when forwarding a packet to next node, to source RERR message is transmitted to update about breakage of link. Alternate path is selected by source node or route discovery process is initiated by it.

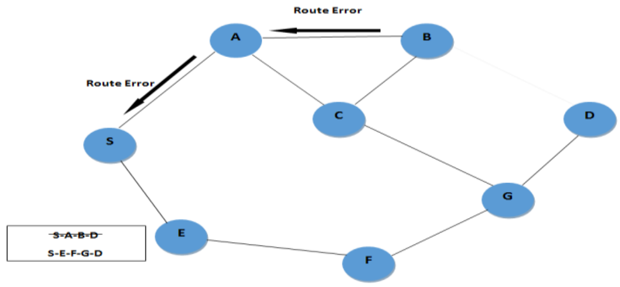

Fig 3 Route maintenance phase

Algorithm 2: DSR protocol

If source node
Begin the source node to transmit data
Apply route discovery process
Generate RREQ packet and broadcast
Send packet with source id, destination id, unique id, path, RERR
Data packets count is intimated to destination node.
Transmit data block packets by the route chosen via discovery of route procedure
Else if destination node
Data packets received with data count intimated is evaluated and it is done through source.
PD is computed which corresponds to probability of packets received at destination node.
RREP initiation process
If PD<TEL, PL (where TEL, PL is energy loss and packet loss threshold in the given network)
To source node, positive acknowledge is send
Else
Best energy consumption node and lower packet loss node are initiated
End if

Main benefit of this protocol is that it is beacon-less, therefore bandwidth utilization is lower and every packet takes full routing information data. Broken link is not locally patch by maintenance of route method. This is a major issue of it. Old route cache data could result in contradiction during the route reconstruction phase.

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4. Simulation Settings

Proposed MACO+DSR method's performance is evaluated in this section. AODV and PSO methods are used to make a comparison of performances. Lifetime of a network, packet delivery ratio and consumption of energy, throughput and end-to-end delay are the parameters used for making performance comparison. Table 1 shows the parameters setting used for simulation.

TABLE 1: PARAMETERS OF SIMULATION

Parameter	values
Nodes Count	100
Size of Area	1100 X 1100 m
Mac	802.11
Range of Radio	250m
Time of Simulation	60 sec
Size of Packet	80 bytes

Performance Evaluation

1. End-to-end delay

End-to-end delay is defined by standard period occupied through a packet to send to destination from source nodes over system.

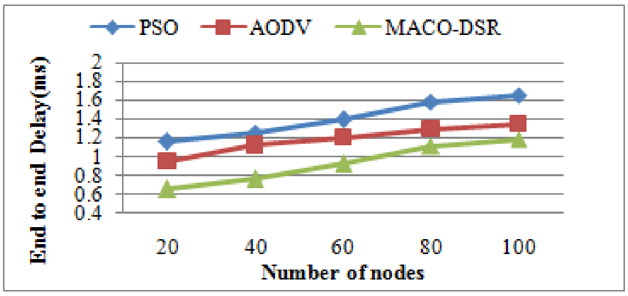

Fig 4 Comparison end-to-end delay

End-to-end delay of proposed MACO-DSR is shown in Figure 4. It is compared with existing AODV and PSO algorithms. Number of nodes are represented in x axis and end to end delay is represented in y axis of a graph. When compared with existing method, better end to end delay performance is exhibited by a proposed MACO-DSR algorithm.

2. Throughput:

The speed in which the information data is effectively sent across the communication links or system defines throughput and it is measured in bits per second (bit/s or bps). A unit of packets processed in given period indicates it.

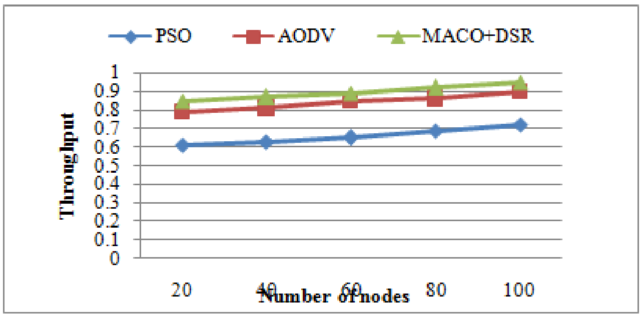

Fig 5 Throughput comparison

Throughput of proposed MACO-DSR is shown in Figure 5. It is compared with existing AODV and PSO algorithms. Number of nodes are represented in x axis and throughput is represented in y axis of a graph. When compared with existing method, better throughput performance is exhibited by a proposed MACO-DSR algorithm.

3. Energy consumption

In the system, standard power required sending and receivepacket functions to a node in a given time slot corresponds to energy consumption.

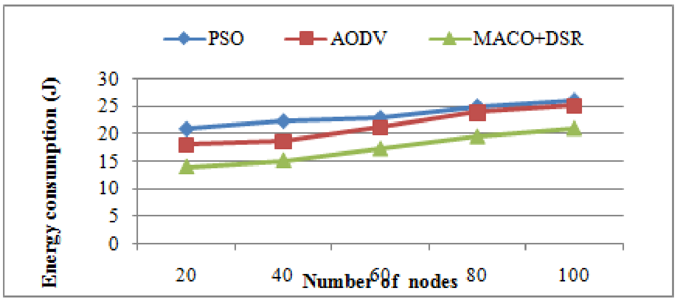

Fig 6 Comparison of consumption of Energy

Consumption of energy performance of proposed MACO-DSR is shown in Figure 6. It is compared with existing AODV and PSO algorithms. Number of nodes are represented in x axis and consumption of energy is represented in y axis of a graph. When compared with existing method, better consumption of energy performance is exhibited by a proposed MACO-DSR algorithm.

4. Network lifetime

The system is called better when the proposed method provides higher lifetime of a network.

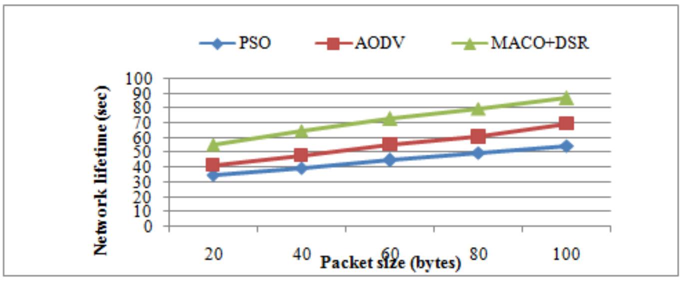

Fig 7 Lifetime of a Network

For a given size of a packet, lifetime of a network is shown in Figure 7. Size of a packet is represented in x-axis and lifetime of a network is represented in y axis of a graph. Lifetime of a network is enhanced largely by a proposed MACO-DSR algorithm where, low performance with respect to lifetime of a network is exhibited by existing methods like AODV and PSO. When size of packet increases, repeated node usage is avoided to enhance the lifetime of a network.

5. Conclusion

In this work, proposed MACO+DSR algorithm is used for finding best CH nodes and routing path over MANETs. To determine the optimal CH nodes MACO algorithm generates best fitness values using objective function. Energy efficiency of a network is improved by using this algorithm, when there is an increase in number of nodes. Also the MACO algorithm focused to develop the optimal values for improving the energy efficiency and network lifetime. Then the DSR protocol is used for efficient routing path over the given network. The result concludes that the proposed MACO+DSR algorithm provides higher throughput, lifetime of network, lower end to end delay, and consumption of energy than existing PSO and AODV approaches. In future work, the hybrid optimized algorithm along with the multipath routing should be enhanced for detecting the attacks over larger network.

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