OPTIMIZATION ROUTING ALGORITHMS FOR MOBILE AD HOC NETWORK

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Abstract

Mobile Ad hoc Network (MANET) is a collection of mobile nodes that are arbitrarily located in the network environment. The interconnections between the nodes are dynamically changing. Mobile nodes form a temporary network without the use of any existing network infrastructure or centralized administration. A routing protocol is used to find routes between the mobile nodes to facilitate communication within the network. The limited battery power of each node in the MANET requires the optimum use of energy.. Ant colony optimization (ACO) Algorithm has shown to be good techniques for optimizing the solutions for energy constrained problems. The Ant Colony Optimization (ACO) routing technique is adaptive and reliable approach to find the path in routing for MANETs. In ACO algorithms the ant as agent traverses across the network to find the shortest path from the source to destination. The high probability of pheromone is chosen as the optimized path to transfer data packets between the source and destination. The selection of the optimal path is based on the residual energy of the nodes in that path. This algorithms highlights the ability to use ant as an agents to perform foraging activities to communicate between the nodes and to achieve the robustness of an energy efficient shortest path in MANETs. This paper describe the detailed survey of energy based ACO algorithms in MANET.

Keywords:

Mobile Ad Hoc Networks, Energy Efficiency, ACO routing algorithm.

INTRODUCTION

Mobile Ad Hoc Network (MANET) is a self-configuring, self-organizing and infrastructure less network of mobile node which allows the systems to be communicated without any wires. Each device in a MANET is free to move independently in any direction and will therefore change its likes to other devices frequently. Ad Hoc Network have many challenges in MANET's are asymmetric links, Dynamic topology, routing overhead, inference, limited power supply and routing range, energy, consumption, mobility induced changes, security. In MANET energy efficiency directly affects the network lifetime, it is important as general performance measures such as delay, remaining energy, and packet delivery ratio. The network under investigation is a set of wireless energy limited transceiver processors. Each transceiver processors is energy limited in the node where its battery operated and unattended, once its battery energy has been depleted, the transceiver processors can no longer support packet transport.

The nature inspired algorithms such as Ant Colony Optimization (ACO) algorithm have shown to be good techniques for developing routing algorithm for MANETs. The Swarm intelligence (SI) is to design algorithms inspired by collective behavior of insects such as bees, termites, ants and other animal societies that exist in decentralized, self organized systems. These insects live in a hostile, dynamic environment and co-ordinate and co-operate to survive. They communicate directly with one another or indirectly through the environment to accomplish their tasks such as foraging, brood sorting, etc. the ACO is one of the SI techniques inspired by the foraging behavior of ants. In nature, ants always determine the path from their nest to food by following the trails they create using a chemical substance known as pheromone. The ACO technique for routing in MANETs uses

this stigmergy process to determine the best possible routes from a source node to a destination node. Artificial ants are placed at each node and they mark their trails with pheromones as they move within the network. ACO algorithms the ant act as an agent traverses across the network to find the shortest path from the source to destination. The high probability of pheromone is chosen as the optimized path to transfer data packets between the source and destination. The selection of the optimal path is based on the residual energy of the nodes in that path. A roust route with minimum energy path cost with short hop count is select for pheromone deposition. This algorithm highlights the ability to use ant as agents to perform foraging activities to communicate between the nodes and to achieve the robustness of an energy efficient shortest path in MANETs.

The paper is organized as follows: section II present the suitability of ACO in Ad Hoc Networks. Section III presents a detailed description of various ACO routing algorithm. and finally concludes the paper in section IV.

DEFINITION OF ANT COLONY OPTIMIZATION (ACO)

The Ant colony optimization is based on the foraging behavior of ants. When ants search for food, they wander randomly and upon finding food return to their colony while laying a chemical substance called pheromone. These pheromones are dropped at regular intervals to act as a trail. Also the pheromones slowly disappear over time. So they act as a guiding trail to other ants which begin to follow this path. In the same way, ants which trace a particular path strengthen the scents of pheromones on the path. In this way, a number of paths might exist from the nest to the food source. Also the shortest path will be the one with the highest pheromone scent and also naturally the path with the highest concentration of ants. Subsequently more ants are attracted by this pheromone trail, which reinforces the path even more. This autocatalytic behavior quickly identifies the shortest path. It is shown in Fig 1

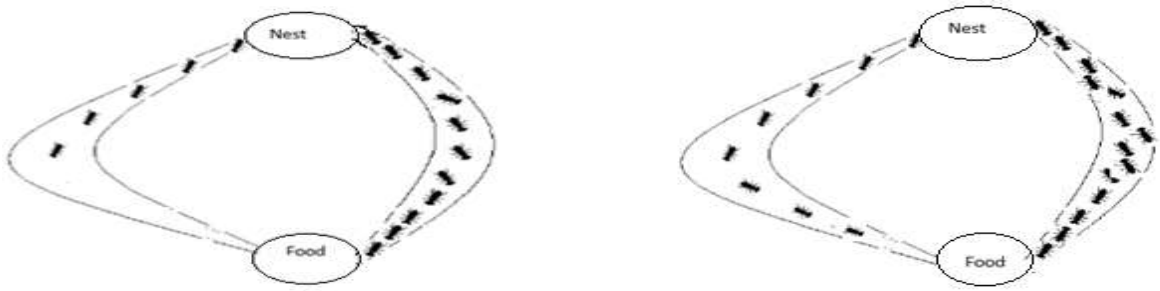

Fig. 1 Ant Colony Optimization.

CLASSIFICATION OF ACO ALGORITHM IN MANET

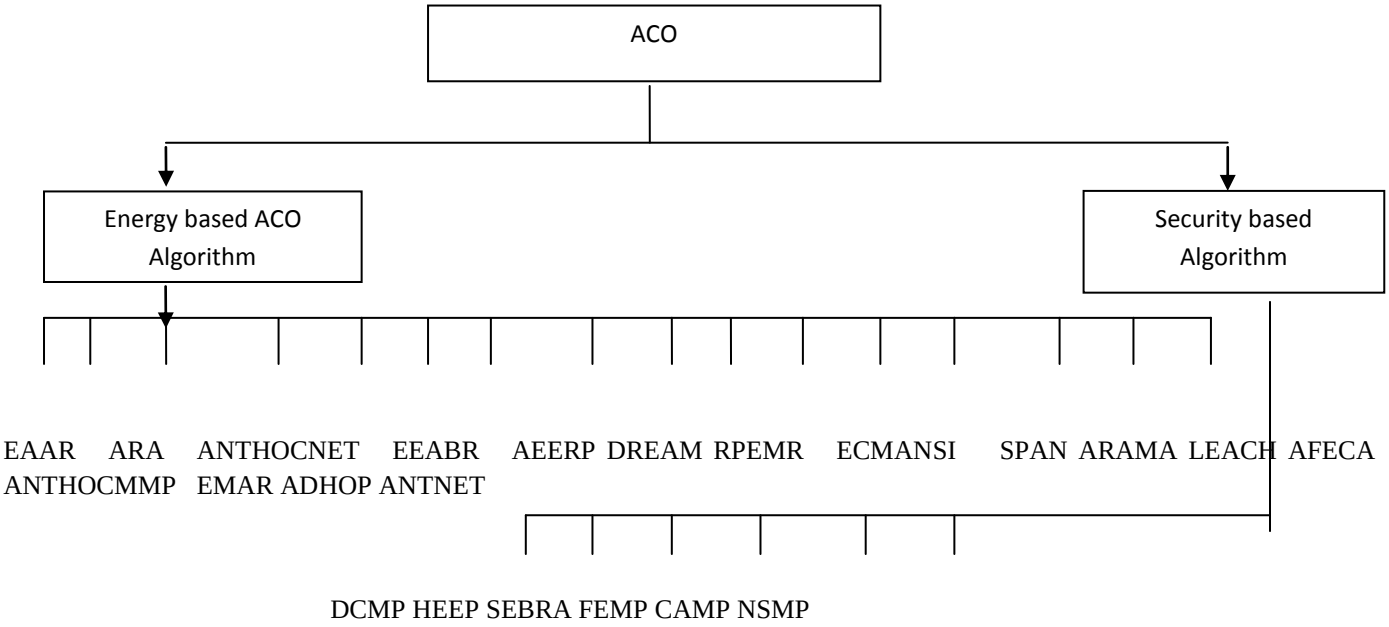

Fig. 2 Classification of Energy based ACO algorithms

The classification of ACO algorithm on MANET is mostly based on the type of protocols used. This paper classifies the algorithm in into two such as Energy based ACO algorithm and Security based algorithm. Fig 2 shows the above classification and Table 1 gives the analysis of energy based ACO algorithm. The following section elaborately explains the energy based ACO algorithm in detail.

SURVEY OF ENERGY EFFICIENT ACO ROUTING ALGORITHAM

A. EAAR (Energy Aware Ant based Routing)

EAAR algorithm proposed bySudipMisraa, Sanjay K. Dhurandher in 2010[1]. EAAR is multipath ACO routing protocol it calculate the energy by transmitting a packet and the residual battery capacity of a node to increase the artery life of the node so that they can increase the battery life of the node. To considered the minimum battery energy remaining from the weakest node of the route and the hop count in consideration as the number of hops.

B. ARA (Ant colony based Routing Algorithm)

ARA algorithm proposed by Gunes in 2002[2] [4]. Ant Colony based Routing protocol called ARA is an ACO based routing scheme using distance vector routing. It is a very simple and sophisticated algorithm for Ant Routing Algorithm (ARA). Route discovery in ARA is done by broadcasting forward Ants, similar to forward ant in AntNet, and similar to Route Request (RREQ) packets in AODV. The FANT set up a pheromone trail pointing back to the source node as it is broadcast through the network. When a route is found to the destination node a (BANT), similar to backwards ant in AntNet and ROUTE reply (RREP) packets in AODV is created. The BANT follows the pheromone trail create by the FANT back to the source nod, and set up a pheromone trail pointing to the destination node.

C. AntHocNet

Jipeng Zhou, Haisheng Tan, [22] have proposed in 2016 a hybrid multipath ant colony based routing protocol for MANETs called AntHocNet. It uses FANT to find routes and BANT to build routes from the source node to the destination node. The power problem in MANET has been receiving significant attention in mobile nodes. The power management schemes have two objectives to minimize the total power consumption in the network and to minimize the power consumption per node. [3] AntHocNet is a hybrid multipath algorithm for mobile Ad Hoc networks that combines both proactive and reactive components. AntHocNet design is based on a self organizing behavior of ants, shortest path discovery in ant colony optimization. Especially the algorithm is reactive that it does not try to maintain up-to-date routing information between all the nodes in the network, but instead concentrates its efforts on the pair of nodes between which communication sessions are taking place. It is proactive in the sense that for those ongoing communication sessions, it continuously tries to maintains and improve existing routing information.

D.EEABR (Energy Efficient Ant Based Routing)

EEABR algorithm is proposed by Camilo et al. in 2006[5]. Energy Efficient Ant Based Routing (EEABR) algorithm is maximizing the network lifetime. This algorithm main aim to reduce the energy consumption related to the ants. EEABR algorithm carries only the last visited node information. Each node keeps the information of the received and send in its memory. Each memory record contains the previous node and the forward node. A forward and arrived, a node looks up in its memory. The node record the information restarts the timer, and forwards the ant to next hop node.

D. AEERP

AEERP algorithm proposed by Jipeng Zhou, Haisheng Tan, in 2016[22]. An ant based energy efficient routing protocol (AEERP) is proposed in MANET. Where the path selects is dependent on not only the number of hops between nodes but also the energy consumed in transmitting packets and residual energy of nodes. AEERP can balance the energy consumption of node in the network and increase the network life time.

E. DREAM (Distance Routing Effect Algorithm for Mobility)

Distance Routing Effect Algorithm for Mobility (DREAM) algorithm proposed by Basagni S in 1998 [7]. DREAM the current node c forwards the packet to all neighbors in the direction of the

destination d. A node is considered to be in the direction of d if it is located in a 2D cone that starts at current node and ends with a circle centered at d, the circle radius equal to vmax * (t1 − t0) where t1 is the current time, t0 is the time stamp of the position information that c has about d and vmax is the maximum speed of the node in the network.

F. RPEMR (Reliable and Power Efficient Multicast Routing)

RPEMR proposed by Sabari and K. Duraiswamy in 2010[8] [6]. RPEMR protocol Reliable and Power Efficient Multicast Routing, by attaining high packet delivery ratio and energy. RPEMR protocol uses swarm intelligence to calculate reliability metric that is calculated by each node individually, based on the bandwidth, mobility factors and power. The intermediate nodes forward the data packets between the reliable nodes and the reliable support the multicast operations. A best path is estimated connects the reliable nodes with the intermediate node. This path can be considered to be the backbone for multicasting which is created using the swarm‘s forward and backward agents. These established paths provide shorter, reliable and faster communication

G. ECMANSI (Energy Conserving Multicast for MANET with Swarm Intelligence)

ECMANSI proposed by ChaipornJaikaeo and VinaySridhara in 2005[9]. Energy Conserving Multicast for MANET with Swarm Intelligence (ECMANSI) the evaluation of an energy conserving multicast routing protocol for ad hoc networks. The protocol uses the MANSI framework that is applies to ad hoc multicast routing, the idea of swarm intelligence. ECMANSI decreases the overall energy consumption by regulating the transmission power of each individual forwarding node dynamically.

H. SPAN

SPAN algorithm proposed by B. Chen, K. Jamieson in 2002[10]. SPAN algorithm is multi-hop wireless ad-hoc networks. [21] This algorithm power saving technique for multi hop ad hoc wireless networks and reduces energy consumption without connectivity of the network. [10] SPAN works on the principle that only a small number of nodes need to be powered on to forward data on active connections, from a sufficiently large density of nodes in the network. SPAN maximizes the lifetime of wireless ad-hoc network by switching off the nodes for as long as possible. This algorithm save the energy of the network and the data transfer between the nodes takes place with minimum delay as compared to every node being awake. This protocol makes decisions locally and creates a network without considerable increase in latency or decrease in capacity.

I. ARAMA (Ant routing algorithm for mobile ad-hoc networks)

ARAMA routing algorithm proposed by O. Hussein in 2003[12]. A node needs to establish or maintain a path to the destination node; it sends a forward ant to a neighbor node rather than flooding. Intermediate nodes IDs are appended to the forward ant. The ARAMA value is calculated by the backward ant and saved in nodes. The formula of the grade relies on the link information such as energy. The path information of the forward ant is also appended or changed. ARAMA defines the concept of the grade. The value is calculated by the backward ant and saved in nodes. The formula of the grade relies on the link information such as energy. When an intermediate node receives a backward ant, the pheromone is updated according to the path gradient of the ant. Pheromone of link which is passed by the backward ants is increased, and the other link pheromone volatilizes. The purpose of volatilization is to make nodes forget the old path quicker. The backward ants are deleted when they reach the source node. The data transmits along the best path. When the best path is destroyed, another path can be used to send data packets immediately.

K.LEACH

LEACH (Low Energy Active Clustering Hierarchy) [23]. In LEACH and ant colony applied on the basis of the death of first node wireless sensor networks. The ant colony algorithm is applied on existing LEACH protocol, the network lifetime has improved. LEACH all nodes are organized into clusters on based on distance. Cluster heads are used for transmission of data from cluster to base station. The cluster head is selected by rotations one by one to balance the load of energy in the way that most of nodes get small distance to transmit and cluster only cluster head are responsible for long transmission to base station. LEACH protocol is a cluster-head selection, and introduces an improve clustering

algorithm. LEACH in balancing node energy consumption; improve the efficiency of data transmission and increasing the network life.

J. AFECA (Adaptive Fidelity Energy Conserving Algorithm)

AFECA algorithm proposed by Benjie Chen, Kyle Jamieson [21].AFECA algorithm to maintain a count of the number of nodes. These AFECA algorithm approaches use dynamically switching the nodes between active listening and sleeping states. The net effect is the number of listening nodes is roughly constant regardless of node density. The density increases the more energy can be energy saved. [15] The mobile node switch between the states with fixed intervals and in order to ensure the successful forwarding the messages. The active node may have to transmit messages a number of time before the receiving node is listening or active.

K. AntHocMMP

AntHocMMP algorithm proposed by a p.vijayalakshmi in 2015[17]. AntHocMMP algorithm enhances the performance of Max-Min-Path (MMP). Therefore, it is a challenging task in MANETs to construct the reliable path that is likely to be disconnected for a long period of time. The AntHocMMP algorithm is meant to achieve robustness of paths for reliable communication with adaptive re-transmission delays in MANETs. This is MMP approach by using ant as agents to find the optimal path in the network. The selection of the optimal path is based on the residual energy of the node in that path. Therefore to keep the paths connected in dynamic topology. The AntHocMMP algorithm effect of re-transmission delays spent in reliably delivering the packets to the destination nodes.

L. EMAR

EMAR algorithm proposed by Mengjun Tong, Yangli Chen in 2015[11]. Energy efficient ACO – based Multipath Routing algorithm (EMAR) is a hybrid multipath algorithm is reactive in path discovery and proactive in route maintenance. EAMR average energy consumption and congestion of path find pheromone update more reasonable mechanism which becomes more multipath between source node and destination node. The algorithm achieves an improvement in energy efficiency packet delivery ratio and end-to-end delay.

M. ALEEP

ALEEP algorithm proposed by R. Vallikannu and A. George, in 2015[13]. An Autonomous location based energy efficient routing protocol (ALEEP). In mobile ad hoc network and if they find shortest path which increases the computation energy. Most of the location based algorithm Benchmark mobility model use GPS for location determination. To increase node complexity and most fails in indoor and disaster area environments. ALEEP under two different mobility model. Since our routing algorithm is location based, geographic restrictions and temporal and spatial velocity mobility model.

N. DBACRA

DBACRA algorithm proposed by H. Wang and N. Luo in 2010[26]. DBACRA proposes a pheromone diffusion mode of the ant colony algorithm based on routing protocol DBACRA. The protocol is divided into two types, the actual and virtual pheromones, which guide the ant packet and data packet to the path search, when the actual pheromones of the backward ants are from the destination node, releasing the link of the pheromone. Data transmission also needs the actual pheromone to be completed. Virtual pheromones are spread by the destination node; the whole network forms the preliminary virtual pheromones by the certain amount of time. They can guide the forward ants to reach the destination node. The forward ant can guide the actual and virtual pheromones to reach the destination node. As a result of the virtual pheromones being propagated by the diffusion method, in a mobile or relatively large network, the virtual pheromones are also very easy to fall into the loop.

O. ABEBR

ABEBR algorithm proposed by Xuepeng Jiang and Bei Hong in 2010[24]. Energy-Balance Routing Algorithm (ABEBR) was presented to balance the energy consumption. a new pheromone update operator was designed to integrate energy consumption and hops into routing selection. In order to optimize of the routing quality and the energy consumption, it is need to achieve the tradeoff between route hops and the energy

consumption. The Ant Colony Optimization is a heuristic bionic evaluative algorithm, which has good positive feedback and parallel computing. Low energy consumption and long lifetime are the most basic conditions for good performance.

A. ACECR

ACECR algorithm proposed by JipengZohou, Haisheng Tan, in 2016[22]. The ant colony-based energy control routing (ACECR) protocol to find an optimal route by using the positive feedback character of ant colony optimization (ACO). In our ACECR protocol, the routing choice depends on not only the number of hops between nodes and the node energy, but also the average and the minimum energy of the routes. ACECR routing protocols is evaluated in different mobility models. The efficient foraging behavior of naturally occurring small-sized and energy-constrained ants is studied in the theory of ACO pheromone content is used to choose the best paths out of a given network. It can be used to forward data stochastically. Data for the same destination can be spread over multiple paths with more data transmitted on higher quality paths, which results in load balancing.

B. ADHOP

ADHOP algorithm proposed by ArlionesHoellerJr, in 2015[25]. Ant based Dynamic Hop Optimization Protocol (ADHOP) is a routing algorithm based on ant colony optimizations that target such small size and low cost platforms, consuming small amount of memory and processing power. EA-ADHOP is an energy efficient version of the ADHOP routing protocol for mobile wireless network. It is algorithm uses energy related information to achieve to homogenize energy consumption among node. The energy related heuristic metrics are used in the ant colony optimizer. The EA-ADHOP algorithm target lifetime, eliminating failures due to battery depletion and raising packet delivery rate is more energy efficient as is spend less energy per delivered packet.

ANTNET

ANTNET proposed by Di Caro and Dorigo in 1998[28]. ANTNET inspired by the foraging behavior of ants and is applied for wired networks. The main aim of this routing technique is for optimizing the performance of the network. ANTNET is based on a greedy stochastic policy according to the following rules: forward ants randomly search for destination, after arriving at the destination, the ants travel backwards on the path; to visited all nodes are updated the most adjective information for the destination. The goodness of a path is influenced by the travel time of forwards ants, the selections probabilities of path updated by backward ants travelling in the forward rather than backward direction.

TABLE 1. ANALYSIS OF DIFFERENT ACO BASED ROUTING ALGORITHMS

Algorithm	Path Type	Type of Ant's	Main focus
EAAR	Multipath	Forward ant and backward and.	To reduce the energy capacity of a node to increase the battery life time.
ARA	Multipath	Forward ant and backward ant.	This is highly adaptive, efficient, and scalable and provides less overhead.
AntHocNet	Multipath	Reactive forward ant and Backward ant, proactive Forward ant and Backward ant.	Power management scheme to objectives in minimize the consumption per node.
EEABR	Single path	Proactive, Reactive and Hybrid, Forward ant.	To reduce the energy consumption related to the ants. To calculate the

			delay of that packets in the network.
AEERP	Multipath	Forward ant and Backward ant.	Energy consumption of nodes in the network and extends the network lifetime.
SPAN		Forward ant and Backward ant.	Maximizes the lifetime, minimum delay as compared to every node.
DBACRA	Multiple path	Forward ant and Backward ant.	Releasing the link of the actual pheromone, network forms the preliminary virtual pheromones by the certain amount of time.
EEABR	Single path	Forward ant.	EEABR algorithm is maximizing the network lifetime and to reduce the energy.
AntHocMMP	Multipath	Forward ant and Backward ant.	The AntHocMMP is meant to achieve robustness of path for reliable communication with adaptive re-transmission delay.
RPEMR	Multipath	Forward ant and Backward ant.	This algorithm by attaining high packet delivery ratio and energy to find the best path.
ECMANSI	Multipath	Forward ant and Backward ant.	ECMANSI decreases the overall energy consumption by regulating the transmission power of each individual node
AFECA	Multipath	Forward ant and Backward ant.	The density increase the more energy can be saved.
LEACH	Multipath	Forward ant and Backward ant.	Cluster head is selected by one to balance the load of energy consumption and increasing the network life.
EMAR	Multipath	Forward ant and Backward ant.	An improvement in energy efficiency packet delivery ratio, and end-to-end delay.
ALEEP	Multipath	Forward ant.	Performance analysis of energy efficient routing protocol with different high density of needs stable scenario due to

			slow speed in a small area under disaster area model.
ADHOP	Multipath	Forward Transport Ant and Exploratory transport Ant.	The EA-ADHOP algorithm target lifetime, eliminating failures due to battery depletion and raising packet delivery rate is more energy efficient as is spend less energy per delivered packet.

CONCLUSION

The Ant Colony Optimization (ACO) based routing algorithms effectively utilizes the energy of the nodes and enhances the lifetime of the network. We presented a survey of addressed various ACO based routing algorithms to solve the energy and find the optimal path in MANETs. ACO algorithms tend to provide features such as adaptively and robustness which essentially deals with the challenges of MANETs. The agents in ACO routing algorithms communicate indirectly through the stigmergy and provide positive feedback to a solution by laying pheromone on the links. Moreover, there is negative feedback through evaporation and aging mechanisms, to avoid stagnation.

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