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A SURVEY: ANT BASED BIO-INSPIRED ALGORITHM FOR AD-HOC NETWORK

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ABSTRACT

Ad-hoc networks are wireless networks where nodes communicate with each other using multi-hop links. Each node itself acts as a router for the forwarding and receiving packets to/from other nodes. There are some critical issues in wireless network as battery life, routing, mobility, interference, dynamic topology etc. Routing in ad-hoc networks has been a challenging task due to dynamic network topology because of high degree of node mobility. Swarm intelligence based routing protocol helps to solve the routing problem using the collective decentralized, self behavior to search optimal path. This paper presents a review on various ants based routing algorithms.

KEYWORDS: Ad-hoc, Swarm Intelligence, ACO, AntNet, AntHocNet, ARA.

INTRODUCTION

Ad-hoc network is self organizing wireless network which relies neither on fixed infrastructure nor on predetermined connectivity. The earliest wireless ad-hoc networks were "packet radio" network in 1970. Ad-hoc network is gaining popularity because of the characteristics such as decentralized mode of operation, self configuration, high node mobility, rapid deployment. Because of these characteristics these networks are best suitable for disaster management. Routing management is challenging task in these situations. The conventional routing protocols performance is well under various situations. But recent the research has proven that the swarm intelligence approach will make the ad-hoc network more useful in the disasters situation. Many desirable characteristics, such as scalability and robustness are exhibited in the biological systems. The global complex structures are typically flexible to adapt to a new environment and are robust to resist occasional individual failures. The Collective behaviours of the nature species (e.g., ants) provide a natural model for distributive problem-solving, without any extra central control or coordination.

CONVENTIONAL ROUTING PROTOCOL

Routing is difficult since mobility causes frequent network topology changes and requires robust and flexible mechanism to search and maintain routes. Routing protocols must also deal with other constraints such as low bandwidth, limited energy consumption, and high error rates etc. Mobile Ad-hoc networks (MANET) are self-organizing and self-configuring multihop wireless networks. The routing protocols in MANET are classified based on routing strategy and network structure. According to the routing strategy the routing protocols are categorized as Table-driven and source initiated, while depending on the network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing. Some of the routing protocols are Ad-hoc On Demand Distance Vector routing (AODV), Dynamic Source Routing protocol (DSR), Destination Sequenced Distance Vector (DSDV), Temporary Ordered Routing Algorithm (TORA), Associatively Based routing protocol (ABR), Location Aided Routing Protocol (LAR), Signal stability based Adaptive Routing Protocol (SSA), Optimized Link State Routing (OLSR) etc. These conventional routing protocols have some features and drawbacks too. The shortcomings can be eliminated considering the bio-inspired approach to the routing in Ad-hoc network.

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SWARM INTELLIGENCE

Wireless networks have difficulties arising from the dynamic nature of topology, node movement, radio interference, node failures etc. A variety of routing protocols have been offered and the best-performing schemes depend on the characteristics of the operating environment. Swarm based routing algorithms uses the operation of biological swarms, such as ants, honeybees, birds, termites, fish, frogs etc. These swarms perform complex tasks of global optimization and resource allocation using only local information from the collective of all its elements. Studies have shown that self-organization and stigmergy are two key ideas in the swarm systems. The basic concepts of self-organization include positive feedback, negative feedback, multiple interactions and fluctuation amplification.Swarm-intelligent routing methods will enhance the reliability and timeliness of data transfer within a heterogeneous multi-node wireless communication network. They will furthermore reduce the overhead in network growth due to their inherently scalable features. The collective decentralized, self-organized behavior of the network exhibits a great deal of global intelligence capable of dynamic near-global optimization of certain tasks.

ANT BASED ROUTING ALGORITHM

The ant based algorithm uses the principle as behavior of ant for searching the food. While searching for food the ant's secrets the chemical called pheromone. Based on the probability of pheromone ants finds the shortest path. The ants which travel the shortest path, reinforce the path with more pheromone that aids other ants to follow. This autocatalytic behavior quickly identifies the shortest path. Stigmergy is an indirect form of communication where individual agents leave signals in the environment and other agents sense them to drive their own behavior. In the 1991 M. Dorigo proposed the ant system for ad-hoc network. The various biologically inspired routing methodologies for ad- hoc networks are proposed like AntNet, Ant-colony Based Control, Ant colony optimization, AntHocNet, Ant based Routing Algorithm, Mobile Ant Based Routing, Efficient Ant Routing, ant-based routing algorithm using enhanced path maintenance, Emergent Ad-hoc Routing Algorithm with QoS. In this paper the different proposed algorithms are listed with their features.

- ***Ant Colony Optimization***

The Ant colony optimization is based on the foraging behavior of ants [8]. A colony of artificial ants cooperates in finding good solution to optimization problem. When ants search for food, they travel randomly and on finding food return to their colony while laying a chemical called pheromone. The ants, which travel the shortest path, reinforce the path with more pheromone that aids other ants to follow. Ants are simple autonomous agent that interact via indirect communication known as stigmergy.

- ***Ant-Based Control***

Ant-Based Control (ABC) is a routing algorithm for telephone networks which routes calls based on the local interaction of mobile agents i.e. ant [4]. This Algorithm uses only one class of ants and every node in the network has a pheromone table entry for every possible destination in the network, and each table has an entry for every neighbor. Routing tables consist of next hop probabilities for each destination. The algorithm is adaptive and exhibits robustness under various network conditions. It also incorporates randomness in the motion of ants, which increases the chances of discovery of new routes.

- ***AntNet***

AntNet algorithm in [1] uses ant colonies behavior to solve routing problems in wired networks. It is presented as a distributed, scalable, and responsive algorithm for routing in wired networks. The improvement in algorithm is explained in [2]. In the AntNet algorithm, routing is determined through complex interactions of network exploration agents, forward ants and backward ants which collect information about delay, congestion status and the followed path in the network.

- ***Mobile Ants Based Routing***

Mobile Ants Based Routing (MABR) in [3] introduced the first routing algorithm for MANETs inspired by social insects. The approach presented in AntNet is extended to ad-hoc networks by abstracting the network into logical links and nodes based on relative node location. To forward messages between logical nodes optimized greedy routing algorithm is used.

- ***Ant-Colony Based Routing Algorithm (ARA)***

The algorithm (ARA) in [5] describes a routing algorithm for MANETs using ant to setup multiple path, including route discovery and maintenance mechanisms. Route discovery is obtained by flooding forward ants to the destination while establishing reverse links to the source. Routes are maintained primarily by data packets as they flow through the network.

- ***Probabilistic Emergent Routing Algorithm (PERA)***

This [8] algorithm uses the probability in routing table to route the packets. The ants broadcast towards the destination at the start of a data session. Multiple paths are set up, but only the one with the highest pheromone value is used by data and the other paths are available for backup [8]. The route discovery and maintenance is done by flooding the network with ants. Data packets can be routed according to the highest probability in the routing table for the next hop.

- ***Ant Agents for Hybrid Multipath Routing (AntHocNet)***

AntHocNet provides good performance compared to ad hoc on-demand vector routing (AODV) in terms of data delivery ratio and end-to-end delay [9]. AntHocNet [9] is a multipath routing algorithm for mobile ad-hoc networks that combines both proactive and reactive components. It maintains routes only for the open data sessions. A reactive forward ant finds multiple paths towards the destination node and backward ants are used to setup the route. While the data session is open, paths are monitored, maintained and improved proactively using different agents.

- ***Efficient Ant-based Routing Algorithm (EAR)***

To overcome drawback of AntHocNet, an efficient ant-based routing algorithm (EAR) is proposed in [13]. EAR introduced several features in the route set-up phase to decrease the overhead introduced by ants and to efficiently update pheromone values in all the intermediate nodes along the path.

- ***Ant-based routing algorithm using enhanced path maintenance (EPMAR)***

In this paper, [6] an ant-based routing algorithm, EPMAR (ant-based routing algorithm using enhanced path maintenance), is introduce. EPMAR uses procedures of EAR for route setup and route maintenance phases. EPMAR proves to be more efficient for link failure more than AntHocNet and EAR. The EPMAR [7] increases the performance by choosing the best path for the data delivery and to reduce the critical link failures.

- ***Emergent Ad-hoc routing algorithm with QoS (EARA-QoS)***

This paper [10] presents a biologically inspired routing algorithm for mobile multi-hop ad hoc networks with QoS. For QoS provisioning, Diffserv based queuing scheme is implemented. The stigmergy is used to reduce the control traffic. The cross layer optimization is used to determine route from network layer and MAC layer. EARA originally proposed in [12], is a probabilistic multi-path algorithm inspired by the foraging behavior of biological ants.

PERFORMANCE PARAMETER

The performance of the above mentioned routing algorithm can be studied by analyzing the various below mentioned parameters.

- ***Packet Delivery Ratio***

Packet Delivery Ratio is defined as the ratio of the total number of data packets received by the destination node to the number of data packets sent by the source node. This ratio tells us how many data packets are successfully delivered at their destinations.

$$\text{Packet Delivery Ratio} = \frac{\text{Total number of packets recived at destination node}}{\text{Total number of data packets sent by source node}} \quad (1)$$

- ***Network Throughput***

The network throughput represents the numbers of data packets generated by the source node to the number of data packets received in the destination. A routing protocol should try to maximize this value.

$$\text{Network Throughput} = \frac{\text{Total number of packets generated at source node}}{\text{Total number of packets received at destination node}} \quad (2)$$

- ***Packet drop ratio***

Packet drop ratio is the average number of packets dropped by the network to number of packets generated by the network as given in equation. The percentage of data packets that are dropped because their time to live timer (TTL) value expired or the queue buffers were full.

$$\text{Packet Drop Ratio} = \frac{\text{Total number of packets dropped by network}}{\text{Total number of packets generated by network}} \quad (3)$$

- ***End to End Delay***

A good algorithm should be able to deliver packets with minimum delay. Average ETE delay reflects the total time needed to successfully deliver a packet by a source node till it is received by the corresponding destination node.

- ***Energy Loss***

The energy loss is an important parameter for analyzing the network performance. The energy loss takes place during the path searching and packet transmission.

- ***Routing Overhaed***

The ratio of the bandwidth occupied by the routing/control packets and the total available bandwidth in the network are routing overhead. In wireless ad-hoc networks, nodes often change their location within network. Some stale routes are generated in the routing table which leads to unnecessary routing overhead.

CONCLUSION

Ants-based routing algorithms are more robust, reliable, and scalable than the conventional routing algorithms. The research have shown that ant based routing protocols can remove several problems such as battery life, capability, maintainability, survivability, adaptability and so on. As such, ant based approaches are attracted by much researchers than other approaches.

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