Protocol For Routing In Mobile Ad Hoc Networks Based On Ant Colony Optimisation

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Abstract: This article will primarily use the AODV algorithm to investigate and clarify the concept of ant colony optimisation (ACO) as it applies to mobile Ad hoc Networks (MANETs). Here, we applied two optimisation methods, ACO and one based on swarm intelligence, extensively in network routeing. The potential, adaptability, and scalability of an on-demand routeing protocol are quite high. Swarm intelligence and ant colony optimisation methods will be used to engineering and mathematics mistakes in the final product. These networks may adapt to changing circumstances and can function independently of any preexisting central administration or infrastructure. Therefore, mobile ad hoc networks are networks that are entirely devoid of fixed infrastructure, operate in an AdHoc fashion (i.e., on the move), and are designed to facilitate short-term communication connections. The primary motivation for the development of these protocols was the need to reduce routing-related overhead. The nodes in mobile ad-hoc networks are constantly on the go, communicating with one another through radio waves.

Keywords: ant colony optimisation (ACO), mobile Ad hoc Networks (MANETs), communication, protocols

Introduction

Network communications is a rapidly expanding sector, and the internet's widespread use has increased the need for distributed multimedia. Many scientists are studying routeing technology because of its importance in distributed real-time applications. Routeing is the process of determining the best path for data to go from its origin to its final destination inside a network. Finding a path between communication nodes is a key challenge in Mobile Ad hoc Networks (MANETs). Due to the dynamic nature of the network's nodes and pathways, an architecture that was once viable often becomes untenable very rapidly. Therefore, it is more important than ever to locate the quickest route.

To identify the quickest route, nature provides a tried-and-true classical answer. The ants not only cover a lot of ground while foraging, but they also signal to their friends where they found food on the way back to the colony. Therefore, the ant colony method has been extensively used in routeing because to its robustness, parallelism, flexibility, lack of need for artificial interference, and accuracy. The concept of Ant Colony Optimisation (ACO) is inspired by nature and attempts to replicate the ants' ability to locate food sources while minimising travel time. The ACO is inspired by the ants' foraging behaviour in particular. To determine the quickest routes between their colony and food sources, ants rely heavily on chemical pheromone trails for indirect communication. Swarm intelligence (SI) is a subfield of AI that focuses on the collective intelligence of social insects like ants, bees, wasps, and termites, and ACO is one of the fields most fruitful applications of SI. Stigmergy, or indirect communication via the environment, is used by swarm intelligence. This study proposes alternative MANET routeing algorithms inspired by ant-based routeing. The gist of these methods is to continually sample pathways using ant-like agents, and then use fake pheromone variables to signal the quality of the paths.

The Ant Colony Optimisation technique is used in the first suggested method, AntHocNet, which ensures efficient routeing in MANETs. The suggested strategy has both reactive and proactive elements. This strategy employs ant-like mobile agents to set up several reliable pathways between the origin and destination nodes. The Modified Ant Colony Optimisation (ACO) provides the foundation for the second suggested method. The suggested method also includes the use of clone ants in addition to forwards and backwards ants. As a result, the clone ants allow this algorithm to find several solutions with little effort.

The Multiple Ant Colony Optimisation (MACO) method is the basis for the third suggested solution, which sidesteps the ants' tendency towards stagnation. Both efficiency and flexibility are improved by using this method. In addition, this method employs tabu search, which sidesteps the ants' blind alley issue. The effectiveness of these methods is measured by a number of parameters, such as delivery rate, average delay, etc. The optimal routeing method for multimedia communication in MANETs is determined by comparing the results of the many offered ways.

In an ad hoc network, users share data directly without the need of any central hub. A central data hub, either a physical device or a piece of computer software, is the conduit through which the data of the infrastructure networks flows. In most corporate networks, employees' computers link to a central server in order to access business data. Ad hoc networks, on the other hand, bypass this centralised server entirely. Ad hoc networks are often formed locally, without an external connection to the internet. However, if one of the participants creates a link to a public or private network, the link may be shared among the rest of the ad hoc network's participants. Because of this event, additional users on the ad hoc network will be able to access the internet as well. Ad hoc networks are widely used for wirelessly connecting gamers to play video games on handheld consoles like the Sony PSP and Nintendo DS. In wireless networking, an ad hoc network is analogous to a peer-to-peer network. The first Windows machines could connect to each other through peer-to-peer networks. This means that the first computers were able to connect to one other and share data, usually in a more contained office setting, without the need for domains and the associated administration and overhead.

ANTHOCNET Routing Algorithm to Support Multimedia Communication in MANETS

There have been several advancements in the tools and algorithms used to solve combinatorial optimisation challenges in recent years. Genetic algorithms, ant systems, and neural networks are all examples of such algorithms. These groups of adaptive routeing algorithms provide a replacement for conventional methods of routeing. The biological processes were the initial inspiration for the ACO routeing approach. It uses the ACO framework for optimisation, which is based on principles found in the foraging behaviour of ants in nature. Algorithms for ACO routeing provide adaptability, resilience, and scalability, and they perform very well in a distributed setting. The approach discussed in this thesis draws heavily on the field of ACO routeing. The AntHocNet method is proposed in this chapter. Based on the Ant Colony Optimisation framework, AntHocNet is a routeing method designed to facilitate multi-media communications in wireless ad hoc networks. The ant system, also known as Ant Colony Optimisation (ACO), mimics the workings of ant colonies. The methodology is a multi-agent method for solving the travelling salesman problem and other combinatorial optimisation issues. The ACO might be used for several combinatorial optimisation issues thanks to the ant-colony metaheuristic framework. Based on studies of actual ant colonies, "ant colony algorithms" have been developed. The social behaviour of ants is geared more towards the survival of the colony as a whole than to the survival of any one member of the colony. Ant colonies' foraging behaviour is both unusual and fascinating. Ants' capacity to locate food sources with the least amount of travel time is a particularly notable trait of ant colonies. There have been improved solutions to the travelling salesman issue thanks to the application of ant colony optimisation methods. Since the ant colony method works constantly and adjusts to changes in real time, it outperforms other techniques like simulated annealing and genetic algorithms when the network undergoes dynamic changes. This method is very useful in routeing networks.

Ant Colony Optimization Metaheuristic

Researchers in the field of Artificial Intelligence (AI) have found significant motivation in the method used by foraging ants to choose the route of least resistance. It was the starting point for creating the ACO metaheuristic, in particular. In order to solve optimisation challenges, this framework may be utilised as a basis for creating appropriate algorithms. ACO's central tenet is the deployment of a network of synthetic pheromones much to those used by real ant colonies. The algorithms used by ACOs are iterative in nature. Using the synthetic pheromone matrix, all the robotic ants devise a plan to solve the issue. The solutions are recorded in a new version of the pheromone matrix. Good solutions that have been developed may then be reflected in the pheromone matrix.

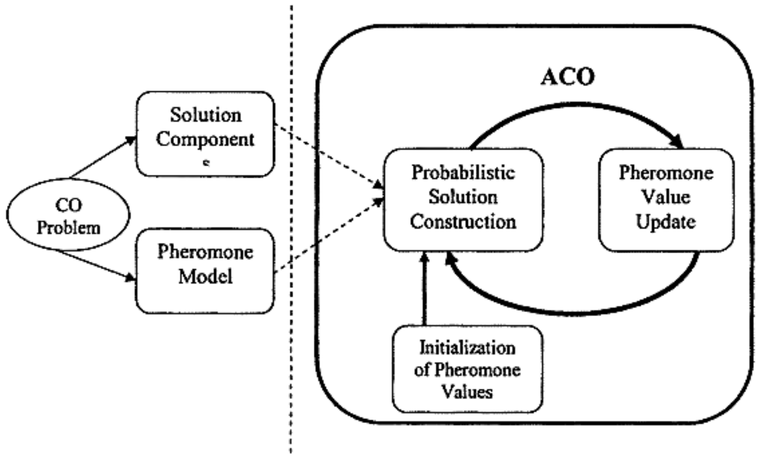

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Figure 1: The Working of the ACO Metaheuristic

In [12], the use of "smart ant-like agents" to perform routeing in Telecommunications networks is considered. Among the algorithms, Ant-Based control (ABC) and AntNet stood out as particularly useful. In 1996, we saw the debut of the ABC algorithm. The method relies on pheromone updates, which are best suited to symmetric networks and were employed in the circuit-switched networks. Dicaro and Dorigo first released their AntNet algorithm in 1998. AntNet's pheromone update method works well with both symmetric and asymmetric networks and is optimised for packet-switched networks. These two algorithms both originated in the context of wired networks. The most well-known distributed ant algorithm is AntNet. As can be seen in Figure 2, each node in AntNet maintains two separate data structures: a routeing table and a local traffic statistics table. The synthetic pheromone is stored in the routeing tables, which are also known as pheromone tables. There is one entry per outgoing connection in the pheromone tables for each and every destination vector. The pheromone value Ttj, represented as a floating point integer, indicates the relative merit of taking the outgoing link leading to destination d and is stored in the entry Tfj of node i's pheromone table Tj. The values of pheromones are standardised for each final location..

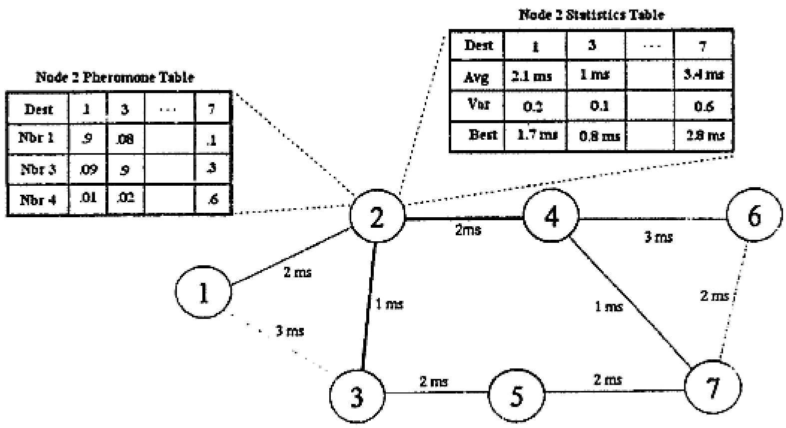

Figure 2.: AntNet in Telecommunication Network

There are three entries for each location in the tables of local traffic data. The first two record an estimated mean and standard deviation of travel time to the destination, while the third records the quickest travel time recorded during a certain observation window. Insect travel times are used to update the data, which are then used to the assessment of travel times on alternative routes. Each network node, denoted by the letter s, periodically broadcasts brief control packets to some unknown receiver, denoted by the letter d. The control packets, which perform the job of fake ants, are referred to as forwards ants. Their primary objective is to locate a viable route to the final destination and assess its merits. The forwards ant keeps track of the time it takes to go from one node to the next on its way to destination d. These delays are comparable to those encountered by data packets since the forwards ants are put in the same queues.

Literature Review

Mani Bushan Dsouza et.al(2020) Mobile ad hoc networks (MANETs) often have limited bandwidth and power, both of which might hinder routeing. One of the ant colony routeing (ACR) protocols, Simple Ant Routeing Protocol (SARA) finds the best route between two communicating nodes. However, network congestion and remaining node energy are not considered throughout the route selection process. Nodes along the route will die off sooner if they have less remaining energy. Because of this, communication between the nodes breaks down. In addition, the packet delivery rate will be decreased since the node will discard it if it encounters too much traffic. Therefore, the protocol's performance may be improved by factoring in remaining energy and congestion at the time of route selection. Results from simulations have shown that this change may improve network performance in regards to packet delivery and throughput.

Subhrapratim Nath et.al.,(2020) In this work the capacity to circumnavigate the sky in a hovering Unmanned Aerial Vehicle (UAV) is a technical marvel. A flying ad-hoc network (FANET) system must be implemented for a multi-UAV system developed on an efficient but complicated network. FANET confronts a significant difficulty in routeing optimisation because of the greater degree of mobility and more processing capacity.

S. K. Nivetha et.al (2019) The purpose of this study is to investigate the use of ACO, PSO, and GA metaheuristic approaches for route optimisation in Mobile Ad Hoc Networks (MANETs). The simulation results showed that using metaheuristics improves MANET routeing performance.

In this chapter, we describe the results of an assessment study of several suggested ant-based routeing algorithms for multimedia data transfer. The outcomes of several simulated tests are presented, each of which compares the suggested routeing strategies over a broad range of conditions. Analytical studies and experimental studies are both viable techniques for assessing network algorithms. Analytical performance assessment is a well-studied issue for conventional telecommunication networks. In addition, there have been a lot of fascinating analytical research for AHWNs, such as looking at the physical aspects of a MANET or the connection between the number of nodes and their connectivity. Analytical studies have been utilised to examine the scalability of AHWN routeing algorithms and to evaluate the load balancing features of single path and multiple path routeing. Such research is valuable because it sheds light on certain aspects of algorithms, but it is inevitably narrow in its focus. This is due to the high degree of complexity present in AHWNs. It is consequently necessary to conduct analytical investigations with restrictive assumptions (such as no mobility or faultless MAC mechanisms) that might have a significant impact on the outcomes.

Various simulators are used for testing and simulating the suggested methods. Finding an efficient routeing technique for multi-media communication in MANETs is a primary focus of these methods. Each of the three methods is unique from the others. The simulations are run to test how well the strategies work. The experimental work presented in this paper makes use of the NS2 simulator.

NS2 SIMULATOR

Models for the protocols and underlying technologies must be developed before a computer network can be simulated. Models of physical phenomena, such as radio wave propagation and interference, and the motion of network nodes are also required in the case of AHWMNs. Tests comparing different models have demonstrated that these changes may produce notably different outcomes. For this reason, it's crucial that every model be as precise and comprehensive as possible. Several distinct network simulator software packages give such precise models in an integrated fashion to the academic community. Wire- and wireless-network behaviours may be simulated using Network Simulator. This was created at UC Berkeley and is an event-driven network simulator for modelling IP networks. NS2 is a network research-oriented discrete event simulator. Transport Control Protocol, User Datagram Protocol, File Transfer Protocol, Telnet, World Wide Web, Constant Bit Rate, Variable Bit Rate, Queue Management Mechanism, Routeing Algorithms, and More Are All Implemented. For LAN simulations, NS2 additionally includes support for multicasting and various MAC layer protocols. The core of the system is UNIX. The scripting language it use is called TCL. The suggested methods are simulated in NS2. In this scenario, mobile hosts all have a channel capacity of 2 Mbps. As the media access control (MAC) layer protocol, IEEE 802.11's Distributed Coordination Function (DCF) is used. It can detect when a connection has been broken and provide that information to the network layer. In this scenario, mobile nodes have 50 seconds to cover a rectangular area of 1000 metres by 800 metres. The starting positions and directions of the nodes are determined using NS2's random waypoint (RWP) model. Each node is thought to be moving at a constant, independent rate. The 250-meter transmission range is standard across all nodes. In this mobility paradigm, a node will choose a location on the ground at random. It travels in the direction of the target at some speed between the minimum possible and the maximum possible. The node reaches its target, waits some amount of time before moving again. Constant Bit Rate (CBR) is used for the simulated traffic. For each case, ten simulations were performed using a variety of random seeds, and the average was taken.Table 1 provides the comparison results of delay for various routing approaches. The table provides information about the average delay obtained when the multimedia data flows are varied from 1 to 5.

Multimedia Data Flows	AVERAGE DELAY (m/s)			
	AODV	AntHocNet	Modified ACO	Multiple ACO
1	2.7	2.5	2.1	1.5
2	6.2	6	5.6	4.2
3	9.3	9	8.5	5.2
4	9.7	9.2	8.7	5.1
5	10.8	9.3	8.6	5

Table 1 .Comparison Of the Delay Results

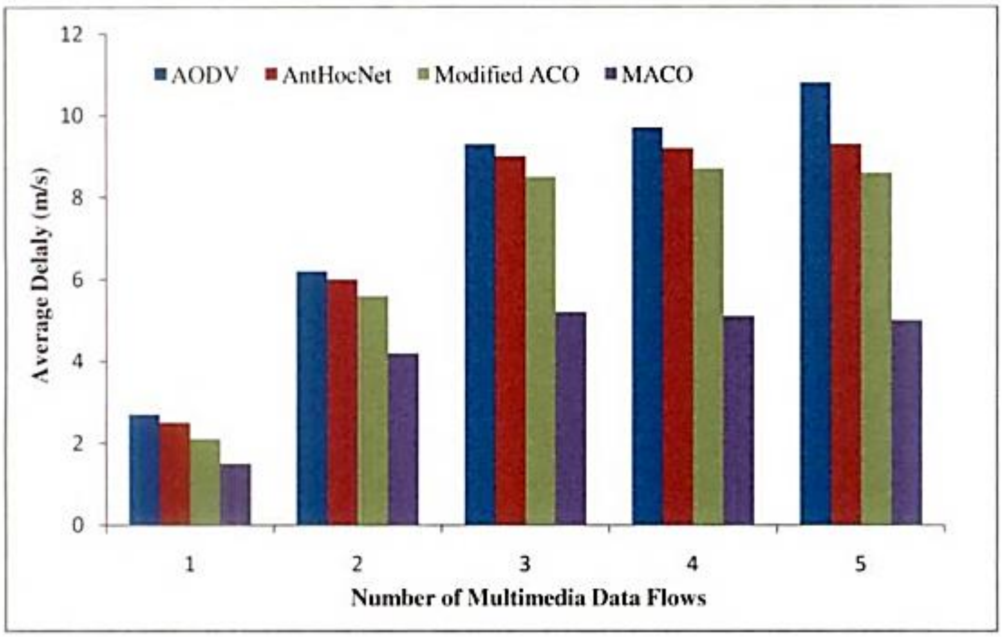

Figure 2: Flow Vs Delay

Figure 1 depicts a comparison of the average latency for distinct multimedia data flows across the various routeing approaches. Figure 2 shows that the suggested MULTIPLE AGO method significantly outperforms the different methods. It is also observed that the Multiple AGO technique has the shortest average latency.

Outcomes Table 3 compares the percentage of dropped packets across different data flows and routeing strategies. When multimedia data flows are changed from I to 5, the average loss of all the methods is calculated. This includes AODV, AnlHocNet, Modified AGO, and Multiple AGO.

Multimedia Data Flows	PACKETS DROP			
	AODV	AntHocNet	Modified ACO	Multiple ACO
1	0	0	0	0
2	2400	2000	1700	1200
3	3700	3500	3000	2400
4	46000	40000	35000	30000
5	66000	60000	57000	50000

Table 3 Comparison of The Drop Results

The relationship between data flows and packet loss is shown in Figure 3.The suggested Multiple ACO strategy shows extremely little decrease compared to previous methods, as seen in the graph.

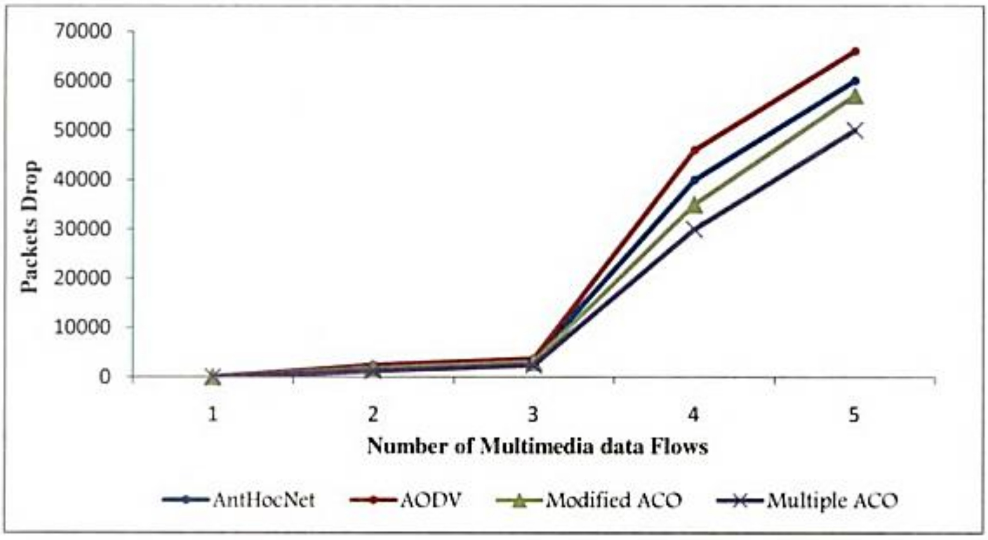

Figure 3: Flow Vs Drop

Conclusion

The article provides a detailed account of the observed outcomes of the experiments.Various routeing strategies, including AODV, AntHocNet, Modified ACO, and Multiple ACO, are tested, and their respective outcomes are summarised. The performance of the suggested methods was measured against parameters including average latency, delivery ratio, average packet drop, and jitter value, and the results were shown graphically as bar charts and pie charts. The suggested MACO method outperforms the alternatives.

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