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An analysis of the Manet node density-based ant colony routing algorithm

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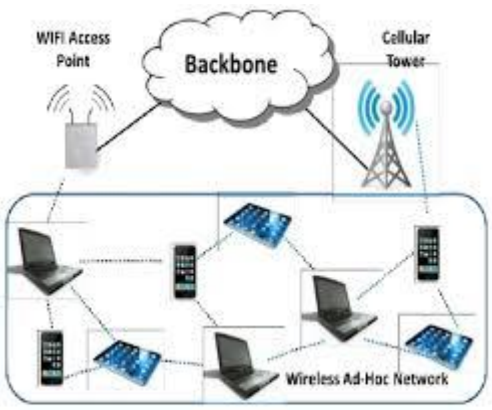
Abstract— The Manet node density-based ant colony routing algorithm is a routing algorithm specifically designed for ad hoc networks. This algorithm is based on the behavior of ants in finding the shortest path to a destination, and it considers the node density of the network to make routing decisions. Finding a path between the communication end points is the largest issue in these networks, which is made more difficult by node mobility. Mobile nodes, a router with numerous hosts, and wireless communication equipment make up a MANET. Mobile ad hoc networks are utilised for particular objectives. However, because it is more adaptable than other networks, ad-hoc networks are the most widely used networks.Data may be transferred quickly and simply between networks, enhancing flexibility and requiring less time.For mobile, multi-hop ad hoc networks, we introduce a new on-demand routing algorithm in this research. The protocol is based on swarm intelligence, specifically the meta heuristic based on ant colonies. With these methods, the ability of swarms to solve engineering and mathematical challenges is attempted. The new routing protocol is scalable, effective, and highly adaptive. The reduction of routing overhead was the primary objective in the protocol's design.

Introduction

The (MNDC-ACO) is an ant colony optimisation (ACO)-based routing method for mobile ad hoc networks (MANETs). ACO is a metaheuristic optimisation algorithm that draws its inspiration from how ants forage. Ants in ACO leave behind pheromones as they move around the ground, and the more pheromones are left behind in a path, the more probable it is that additional ants will follow that path.A network of autonomous, decentralised, and mobile nodes is known as MANET. It is an easy target for security-related concerns because of its distributive nature, lack of infrastructure, and dynamic structure. A mobile ad hoc network (MANET), also known as a mobile mesh network, is a wirelessly connected, self-configuring



network of mobile devices.Each device in a MANET is allowed to travel arbitrarily in any direction, changing its connections to other devices repeatedly. Each must forward traffic that is unrelated to its own usage, acting as a router in the process. Making each device capable of monitoring and maintaining the data necessary for traffic routing is the main problem in establishing a MANET.

various forms of vulnerability. A security system's vulnerability is a flaw [1]. Because it does not confirm a user's identity before granting access to data, a certain system may be exposed to unauthorised data access. Compared to wired networks, MANET is more susceptible. The following are some of the vulnerabilities:- (i) Inadequate centralization of management

There is no central monitor server for MANET. Attack detection becomes challenging in the absence of such management since it is challenging to monitor the traffic in a large-scale ad-hoc network. The trust management for nodes will be readily broken in the absence of centralised administration.

Resource accessibility

In MANET, resource availability is a significant problem. The creation of various security architectures that ensure user safety assaults is a result of providing secure communication in such a changing environment. We can create such security mechanisms in collaborative ad hoc contexts.

- Scalability

Because nodes are mobile, the size of an ad hoc network changes regularly. Scalability is therefore a significant problem in terms of authentication and security. A security system should be able to handle networks of any size and range.

- Cooperativeness

Routing algorithms for MANETs typically make the assumption that nodes are friendly and unintentionally good. Therefore, by violating the protocol standards, a malicious attacker can easily attack, displace the mechanism, and interfere with network operation.

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- Dynamic configuration

  The trust relationship between nodes may be harmed by dynamic configuration and fluctuating node membership. If certain nodes are found to be defective, the trust may be affected as well.With widely dispersed and area-adaptive security systems, this dynamic behaviour could be better protected.

- Limited Power Supply

  The nodes in a mobile ad hoc network must take limited power supply into account. When a node in a mobile ad-hoc network discovers that the power supply is restricted, it may act selfishly by using it for its own purposes.In MANETs, there are many attacker types that attempt to lower network performance by using up more energy.

In this case, our algorithm of interest is:Numerous combinatorial optimisation problems, including quadratic assignment, protein folding, and vehicle routing, have been tackled using ant colony optimisation [3] algorithms. Many of the derived methods have also been applied to dynamic problems involving real variables, stochastic problems, multi-targets, and parallel implementations. The travelling salesman dilemma has also been utilised to generate nearly ideal results.When the graph may vary dynamically, they have an advantage over approaches using simulated annealing and genetic algorithms because the ant colony algorithm can run constantly and adjust to changes in real time. Urban transit systems and network routing are both interested in this.

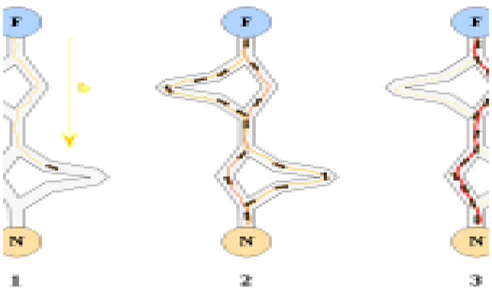


Figure Ant Colony Optimisation

Literature review

The Manet node density-based ant colony routing algorithm is a popular routing algorithm used in mobile ad hoc networks (MANETs). This literature review aims to provide a comprehensive insight into the existing studies and research conducted on this algorithm.

Using QoS Aware Approach" by Rajesh Verma and Sandesh Gupta. This research proposed a modified version of the algorithm that considers quality-of-service parameters like bandwidth, delay, and jitter. The authors conducted extensive simulations to compare their proposed algorithm with traditional routing methods and demonstrated its efficiency in terms of packet delivery ratio, end-to-end delay, and throughput.

Another notable study is "A New Ant Colony Optimization Algorithm for Routing in MANETs" by F.R. Yu, Hui Li, and Victor C.M. Leung. This research introduced a hybrid ant colony optimization approach that integrated with a table-driven routing protocol. The proposed algorithm considered factors such as node density, residual battery power, and network congestion to make routing decisions. The researchers evaluated the algorithm through simulations and revealed its superior performance in terms of packet delivery ratio, network throughput, and end-to-end delay compared to other routing approaches.

Furthermore, "SNMDAC: Secure Node Mobility Detection Authentication for Cellular Network Using MANET Node Density Based Ant Colony Routing Algorithm" by A.S. Manjunath and S. Ramachandramurthy explored the integration of a secure authentication mechanism with the Manet node density-based ant colony routing algorithm. The authors proposed a novel authentication scheme called SNMDAC and assessed its performance, including security parameters like authentication overhead and malicious node detection rate. The study demonstrated the effectiveness of the proposed scheme in terms of secure routing and node authentication in MANETs.Moreover, "Enhanced Ant Colony Routing Algorithm Based on Node Density for Mobile Ad hoc Networks" by Yuxia Zhong and Qi Han proposed an improved version of the Manet node density-based ant colony routing algorithm. This research integrated network coding into the routing algorithm to enhance data transmission efficiency. Through simulations, the authors demonstrated the benefits of their enhanced algorithm in terms of packet delivery ratio, network throughput, and end-to-end delay.

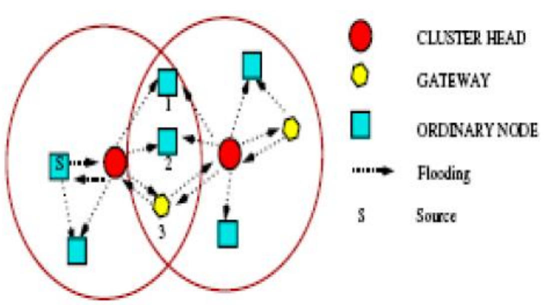
Overall, the literature review reveals that the Manet node density-based ant colony routing algorithm has been extensively studied and enhanced by researchers. The proposed modifications and integrations presented in these studies have shown promising results and improvements in terms of various performance metrics, including packet delivery ratio, network throughput, and end-to-end delay.

We create a system to dynamically identify each node's role (internal node or leaf node) in each spanning tree in a mobile context. When a node receives a routing message from a target node, it examines its position in the related spanning tree to decide whether or not to forward the message. The suggested approach is particularly well suited for mobile Ad Hoc networks with high node densities because it efficiently conserves the limited bandwidth resource by filtering out redundant routing messages at leaf nodes.

1.Hierarchical:Network scalability is a benefit that has long been associated with hierarchical approaches. Network nodes can save memory and link resources by condensing topology detail via a hierarchical network topology map. In the 1970s, a thorough investigation of the memory needs of hierarchical routing was conducted. However, there hasn't been much research published that analyses the communication costs associated with hierarchical routing.

2. Clustering: In the literature, the idea of segmenting geographical regions into small zones has been referred to as clustering. Fig. 1: Clustering Mechanism Route Establishment A physical network is essentially converted into a virtual network of connected clusters or groups of nodes by clustering. These clusters are linked by gateways or border terminals, as indicated, and are dominated by cluster heads (CH).

Image:1



In order to decrease the hello overhead messages, the frequency of greeting messages generated by a node to learn about its surrounding node whenever a new link is formed should be at least equal to the link generation rate. Any two nodes can be informed when a link is being established between them by sending hello messages, and each node can hear the hello message that the other node sends.

In the event that there are no nearby clustering heads, this occurrence forces the node to transfer clusters or take over the role of the cluster head. b) Cluster message overhead brought on by a linkbreak between a cluster's members and cluster heads. These kinds of link alterations result in cluster messages being sent out by the cluster members. To minimise the overhead of control messages, the ratio of such link breaks to total link breaks should be equal to the ratio of links between cluster members and cluster leaders divided by the total number of links in the entire network. c) Clustermessage overhead resulting from the loss of a cluster head role when a link is formed between two cluster heads. The clustering algorithm determines which cluster head role must be given up when a link is generated between two cluster heads. The amount of cluster messages created each time a link between two cluster heads arises is equal to the number of cluster nodes that require clustering.

d) Routing overhead: The routing storage overhead is proportional to the size of the cluster when a specific cluster node needs to be updated with the route to other cluster nodes.

3) Compression of the header

It has been documented in the literature that [8] about 50 percent of Internet packets are 80 bytes or less long. This percentage has risen over the past few years, in part because real-time multimedia programmes are so widely used. The packet size of a multimedia application is typically lower, and these little packets must be appended with numerous protocol headers while moving via networks. In IPv4 networks, each packet may have overheads of at least 28 bytes (UDP) or 40 bytes (TCP). The bandwidth used by these overheads, which is extremely constrained in wireless networks, is heavily used. Poor line efficiency results from small packets and relatively big header sizes. The portion of transmitted data that is not regarded as overhead is known as line efficiency.

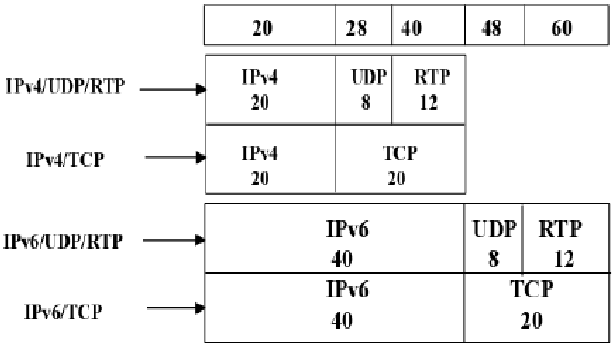


Figure shows Common Header Chains and their Sizes.

Ad hoc networks present extra difficulties like the cost of context initialization and problems with packet reordering brought on by node mobility. Ad hoc networks' dynamic nature negatively affects the effectiveness of header compression.

The first step in creating a context is delivering a packet with a complete, uncompressed header, which gives the sender and receiver a shared understanding of the values of the static field values and the initial values of dynamic field values. Initialization of the context is the name of this phase. The following compressed headers are then decompressed and evaluated in accordance with a previously defined context. A context label can be found in every packet. The context name in this instance identifies the context in which the headers are compressed or decompressed.

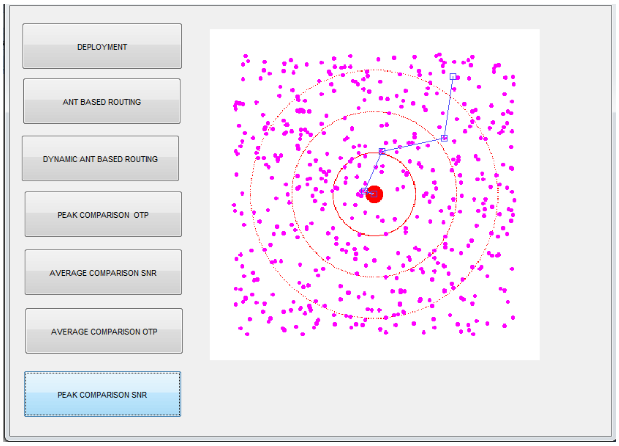
In [6], a brand-new hop-by-hop context initialization approach is put forth that relies on routing data to cut down on the overhead related to IP header context initialization and makes use of a stateless compression technique to cut down on the overhead related to control messages. Since each of the intermediate nodes needs to review the headers in an uncompressed state, context initialization of IP headers is carried out hop-by-hop. Context initialization overhead is decreased by caching the address data that is transmitted in routing messages and thereby reducing the size of the context initialization headers.

It is also suggested to use stateless header compression. It is stateless because the context's state is constant and does not alter over time. By taking advantage of the redundant header fields inside a single packet or between related packets belonging to the same stream, header compression boosts line efficiency. Overall, even in the presence of frequent path oscillations, there is a reduction in overhead and a gain in network capacity and line efficiency. Simulation Parameters

The nodes are dispersed at random over a 400 m x 400 m region. The area is divided into circular regions, and each hop is chosen based on its proximity to the region's border and the remaining energy of its cluster's sensor nodes. The population of nodes in this simulation is 100, or n=100.

To compare the effectiveness of proposed protocols with currently utilised ant colony-based protocols, many different terms are used.When evaluating the performance of various routing protocols, the following metrics are frequently used:

Figure shows Random deployment of nodes



The most typical transmission power for wireless ad hoc networks. The minimal transmit power necessary to maintain network connectivity has been established as the ideal common transmit power in particular. It is possible to construct an analytical closed-form expression for the ideal common transmit power. This is very helpful for network planning because it enables one to figure out how much power is needed to keep the network connected.

SNR

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Signal-to-noise ratio, often known as SNR or S/N, is a measurement of signal intensity in relation to background noise used in analogue and digital communications. Usually, the ratio is expressed in decibels (dB).When describing the ratio of true or irrelevant material to helpful information in a conversation or transaction, the term "signal-to-noise ratio" is occasionally used informally. The signal-to-noise ratio, S/N, in decibels is calculated using the formula S/N = 20 log10(incoming signal intensity, Vs), and ambient noise level, Vn, both expressed in microvolts.

PSNR

Peak signal-to-noise ratio (PSNR), which is sometimes shortened, is an engineering term for the comparison of a signal's greatest power to the power of corrupting noise that impairs the representation of the signal's fidelity. Due to the high dynamic range of many signals, PSNR is typically stated in terms of the logarithmic decibel scale.In this instance, the original data is the signal, while the error brought on by compression is the noise. PSNR serves as a proxy for the human impression of reconstruction quality when comparing compression codecs. Even though a greater PSNR typically denotes a higher-quality reconstruction, this may not always be the case. The range of validity of this metric must be carefully considered because it can only be used to compare results from the same codec (or codec type) and similar content.

1) SNR on average

Average SNR is the second parameter that may be calculated from the input signals.This programme calculates the average SNR of a file, where power is the Root Mean Square (RMS) of the signal across a 20-millisecond sliding window with a 10-millisecond scroll. After computing the noise and speech values, a histogram is made using the RMS values.

Reliability and network longevity can be traded off. There are both unstable and stable regions throughout a network lifetime. A smaller unstable region results in greater reliability but a shorter network lifetime for the same stable region.

Results of Simulation

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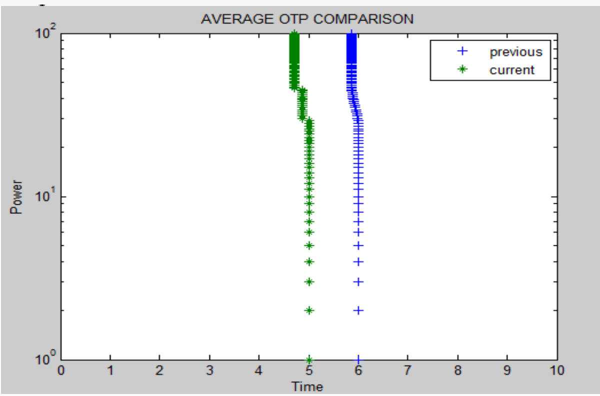
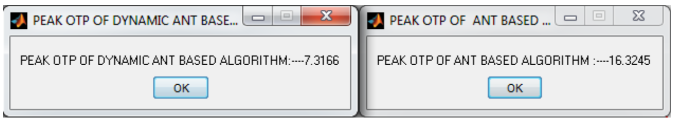
The MATLAB tool is utilised to obtain the simulation results. To examine the Average Optimal transmission power, Peak Optimal transmission power, Average Signal to noise Ratio, Peak Signal to noise Ratio, and Average OTP, an ant colony-based algorithm is used in contrast to a dynamic ant colony

$$\Psi \triangleq \left\{Q^{-1}\left[1-(1-\mathrm{BER}_{th})^{1/\overline{n}_{grid}}\right]\right\}^2$$

$$P_t^* = FkT_0R_b\left[\frac{2\alpha}{r_{link}^{\gamma}\Psi} - \alpha(1-e^{-\frac{\lambda L}{R_b}})I_{grid}\right]^{-1}$$



Average OTP Comparison



Peak OTP Comparison

Peak-to-peak OTP comparison demonstrates that less power is gradually needed to complete the same set of transmitting operations from source to destination. The proposed routing algorithm performs better than the current ant-based routing method, as seen by the 55% reduction in power.

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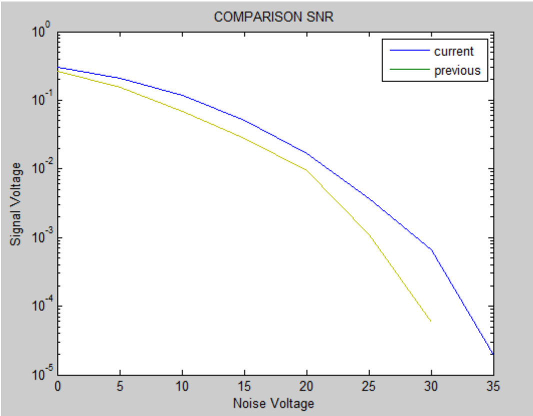
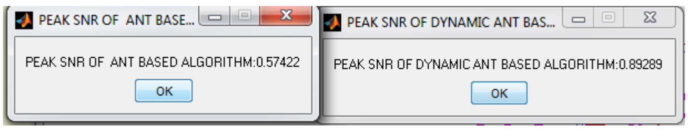


Average SNR Comparison

If the incoming signal strength is measured in microvolts (Vs), and the noise level is measured in decibels (Vn), the signal-to-noise ratio, or S/N, is calculated as follows: S/N = 20 log10(Vs/Vn).

The average Signal to Noise Ratio, however, can be defined as S/N = 20 log10(Vs/Van) if we consider the average of all noise voltage Van.The comparative graph demonstrates that Ant Colony Based Routing Algorithm has a smaller slope than Dynamic Ant Based Algorithm. Compared to the prior algorithm, better performance is obtained when more signal is conveyed than noise.

Peak SNR Comparison



Max SNR The PSNR increased by 56%, making the value of the present algorithm better than the old one.This demonstrates the Routing Algorithm's improved performance.

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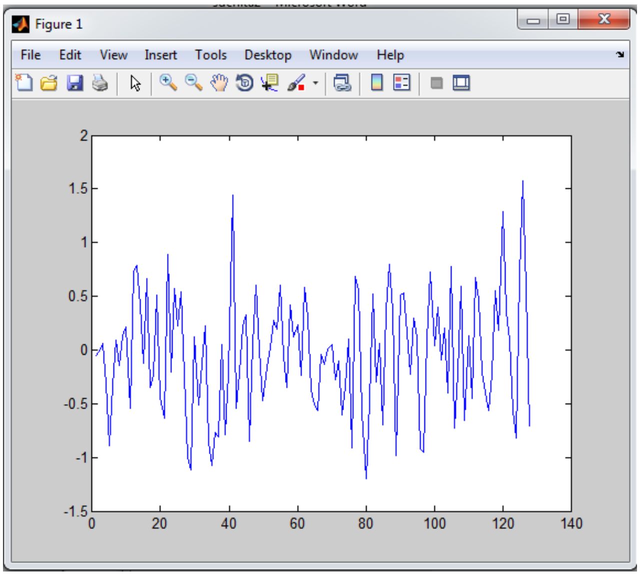

Gradient of ant based algorithm

This displays the gradient of an ant colony-based method that provides data on network connectivity. The graphic displays network connectivity between various nodes clearly.

This displays a simulation of an ant colony-based algorithm that provides information on the volume of data being transferred from source to sink. The diagram clearly shows the methods used to transfer data between network nodes.

Conclusion

In this work, a brand-new routing protocol for the MANET environment is put forth. It is based on the idea of Ant Colony Optimisation and other dynamic methodologies. The OTP, robustness, and SNR are all enhanced by the suggested dynamic method. The suggested routing protocol's efficiency is demonstrated to be superior to other demand Ant colony-based routing systems.The suggested Dynamic routing methodology makes use of quick route discovery and optimal path routing. The established pathways provide fast, efficient, and trustworthy communication. In comparison to the existing protocol, simulation results demonstrate that the suggested protocol offers reliable and energy-efficient routing by achieving high Signal to Noise ratios and low energy consumption.Through simulations, we demonstrated the method's capacity to function effectively in mobile multi-hop ad hoc networks and described how to adapt it to these networks. The performance for the simulated situations under consideration is quite comparable to the Ant-based algorithm's performance, but it produces less overhead.

In conclusion, an effective routing method for ad hoc networks is the Manet node density-based ant colony routing algorithm. It seeks to reduce energy usage, load balancing, and adaptability by taking node density into account. It does, however, have some restrictions on overhead and the precision of node density estimation.

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