Original scientific paper
https://doi.org/10.33180/InfMIDEM2024.204

Informacije MIDEM
Journal of Microelectronics, Electronic Components and Materials
Vol. 54, No. 3(2024), XX-XX

Optimization of Mobile Ad-hoc Networks Communication Using Ad-hoc On-demand Multipath Distance Vector With Novel Aging Multi Population Strategy for Effectual Energy Utilization

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Abstract: In today's world, wireless technologies play a vital role in numerous real-world applications, particularly Mobile Ad-hoc Networks (MANETs), which offer bidirectional transmission capabilities through intermediary nodes. However, packet collision poses a significant challenge in MANETs due to the random movement of nodes at unpredictable speeds, leading to degraded throughput, increased routing overhead, and higher end-to-end delays. Moreover, frequent node mobility causes topological shifts and link instability, further lowering data delivery rates. Limited possible routes to the destination network also contribute to traffic congestion at intermediary nodes, hindering successful packet delivery, especially in real-world MANET applications. The proposed approach introduces a novel strategy utilizing the concept of "age" to evaluate each particle's local area search capacity within the MANET environment, termed Aging Multi Population Optimization (AMPO). Particles are categorized into distinct age groups based on their ages to maintain population diversity during the search process. Particles within each age group can only select younger particles or those within their own clusters/groups as preferred neighbors. To determine the optimal route to the destination, multiple pathways returned by the Adhoc On-demand Multipath Distance Vector (AOMDV) mechanism are optimized, considering the route with the highest fitness value as the most ideal. Additionally, a parameter setting mechanism based on age groups is introduced to accelerate convergence, where particles in different age groups possess distinct parameters. Finally, the proposed approach is evaluated against existing methods such as AOMDV-TA and EHO-AOMDV, considering network overhead, throughput, delay, energy usage, and packet delivery range as crucial performance metrics.

Keywords: Fitness range, aging population, MANETs, AOMDV, optimization.

Optimizacija komunikacije v mobilnih omrežjih Ad-hoc z uporabo vektorja razdalje na zahtevo z novo strategijo staranja večje populacije za učinkovito rabo energije

Izvleček:. V današnjem svetu imajo brezžične tehnologije ključno vlogo v številnih aplikacijah v resničnem svetu, zlasti v mobilnih omrežjih ad hoc (MANET), ki omogočajo dvosmerni prenos preko vmesnih vozlišč. Trk paketov v omrežjih MANET je velik izziv zaradi naključnega gibanja vozlišč z nepredvidljivo hitrostjo, kar vodi do zmanjšanja prepustnosti, povečanja odvečnega usmerjanja in večjih zamud med koncema. Poleg tega pogosta mobilnost vozlišč povzroča topološke premike in nestabilnost povezav, kar še dodatno zmanjšuje hitrost dostave podatkov. Omejene možne poti do ciljnega omrežja prispevajo tudi k zastojem prometa v vmesnih vozliščih, kar ovira uspešno dostavo paketov, zlasti v resničnih aplikacijah MANET. Predlagani pristop uvaja novo strategijo, ki uporablja koncept "starosti" za ocenjevanje zmogljivosti iskanja vsakega delca na lokalnem območju v okolju MANET, imenovano Aging Multi Population Optimization (AMPO). Delci so razvrščeni v različne starostne skupine na podlagi njihove starosti, da se med postopkom iskanja ohrani raznolikost populacije. Delci v vsaki starostni skupini lahko kot prednostne sosede izberejo le mlajše delce ali delce znotraj svojih grozdov/skupin. Za določitev optimalne poti do cilja se optimizira več poti, ki jih vrne mehanizem AOMDV (Adhoc On-demand Multipath Distance Vector), pri čemer se kot najbolj idealna upošteva pot z najvišjo vrednostjo sposobnosti. Poleg tega se za pospešitev konvergence uvede mehanizem za določanje parametrov na podlagi starostnih skupin, pri čemer imajo delci v različnih starostnih skupinah različne parametre. Nazadnje je predlagani pristop ocenjen v primerjavi z obstoječimi metodami, kot sta AOMDV-TA in EHO-AOMDV, pri čemer se kot ključni kazalniki uspešnosti upoštevajo odvečno usmerjanje, prepustnost, zamuda, poraba energije in doseg dostave paketov.

Ključne besede:sposobnost, staranje populacije, MANET-i, AOMDV, optimizacija.

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How to cite:

1 Introduction

Mobile Ad-hoc Network (MANET) comprised of self-configuring wireless nodes. The Fig. 1 shows the mobility of networks, indicating the movement of data within the network rather than the networks themselves. Each Mobile ad - hoc device has a router that knows the necessary network activity and can forward messages reliably. The gadget can operate on its own or join a massive group. This feature has improved Mobile ad - hoc use [1]. The absence of centralized management in mobile wireless ad hoc networks causes several issues [2]. Because of mobile nodes, routing techniques respond to dynamic routing, increasing network congestion control [3].Maintaining effective networking and Quality of services (QoS) while taking appropriate broadband and power restrictions into account are still challenging. Hierarchical structures scale effectively because Mobile nodes have many mobile nodes [4]. Building node hierarchies enables network structure, which may solve Routing protocol challenges. Mobile ad hoc networks have a well-established technique called grouping [5].Numerous proposed algorithms take into consideration different measures and focus on different objectives. The bulk of existing techniques, however, are unable to produce stable cluster structures. They are crucially dependent on the continuous delivery of control messages, which raises internet usage and demands more power from Multi- Homing (MH). Spending extra money or time on ad - hoc networks is unnecessary. In a Mobile Ad-hoc Network, every network device serves as both the network and a typical host. Mobile node rechargeable batteries, periodic network connectivity, and bandwidth limitations imposed on node mobility are still problems for Mobile Ad-hoc Network [6,7]. Numerous clustering algorithms have been proposed to handle complex and dynamic environments [8,9]. For one-hop, multi-hop, and self-organizing networking, many routing techniques have been created [10,11]. Three sorts of routing exist: reactive, proactively, and mixed. Even when no content is sent, proactively protocols maintain the networks working and route knowledge available.

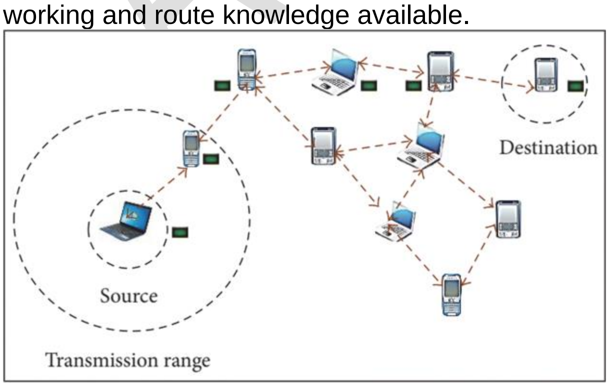

Figure 1: Basic Mobile Ad-hoc Network topology

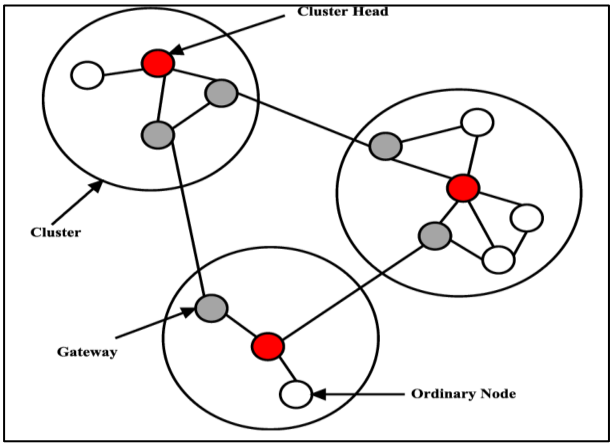

Figure 2: Clustering in MANET

The clustering technique is the most often used tactic in Mobile Ad-hoc Network, although figuring out what it needs and how successful it is still difficult [12]. The standard clustering algorithm in Mobile Ad-hoc Network is shown in Fig. 2. A CHs represents each substructure throughout the classification stage, while a gateway node mediates inter-cluster connectivity. The groups that have survived are regular nodes. A cluster's borders are determined by its transmission zone or Cluster Head (CH). Cluster-based forwarded networks are abnormal nodes. The proposed work has suggested a clusters coordinator-based Cluster head election mechanism.

Nodes in Mobile Ad-hoc Network are unaware of the structure of their networks and must determine it on their own because an ad hoc network's topology is changeable. The fundamental rules say that whenever a new node enters an ad hoc network, it must broadcast an indication of its existence as well as pay more attention to broadcasting of a similar nature received from mobile nodes already in the network. The proposed research takes into account the Adhoc On-demand Multipath Distance Vector routing mechanism, which is utilised to find numerous routes from the origin to the destination, in this regard. In this work, a brand-new fitness function is proposed as an optimization method. Adhoc On-demand Multipath Distance Vector (AOMDV) and Aging Multi Population Optimization (AMPO) combined, based on Fuzzy Logic – based Fairness (FF). For FF, the most important metrics to consider while choosing the most reliable and efficient route from origin to destination are data packet collision, queue length, and connection stability. Thus, the following are the primary contributions of this paper:

- The innovative aspect of Aging Multi Population Optimization (AMPO) lies in its utilization of age-based grouping to guide the selection of preferred neighbors, allowing particles to consider only younger particles or those within their own clusters/groups. This approach facilitates more efficient routing decisions by leveraging the knowledge accumulated over time within the network.
- Using the parameters alteration in the age-group based topological structure, the particle of the ageing multi population

approach converges at the local optimal threshold.

- Before to data transmission, all detected paths will be meticulously sorted, with the data load being distributed across the paths depending on path energy relative to all paths' capacity.

This research article is arranged in the following manner. Section 2 deliberates related works. Section 3 goes through the Aging Multi Population Optimization optimization algorithm in depth, as well as the proposed Aging Multi Population Optimization with Adhoc On-demand Multipath Distance Vector. The experimental procedure and performance assessment are presented in Section 4. Finally, Section 5 summarises the key conclusions and discusses potential future study.

2 Related Works

Adhoc On-demand Multipath Distance Vector (AOMDV) is a flexible multi-path routing Protocol that allows mobile edge computation. When a network received a request to transmit, then it first evaluates the fact that the route listing contains a route to the network it intends to communicate with.If no route exists, a route inquiry is issued. The least hop count determines the optimum route when there are several possibilities. Trust-Aware Adhoc On-demand Multipath Distance Vector (TA-AOMDV), which was proposed by researchers in [13], aims to lessen data traffic. This protocol would suffer in dynamic configurations when route safety and network diversity are required. In general, this strategy hardly boosts performance compared to alternative approaches, which often outperform it.

[14] proposed the energy-efficient, shortest path algorithm Fuzzy logic – based Fairness Adhoc On-demand Multipath Distance Vector (FF-AOMDV). In the case of a network outage or crash, AOMDV will automatically change to the next shortest distance in the route cache. FF-AOMDV performance is lower than AOMDV since it only considers energy and the shortest distance, thus network lifespan enhancement is limited. AOMDV directional conventions and the bio-enhanced computation known as Elephant Herding Optimization (EHO) were used to build an energy-efficient steering convention in their article [15]. The inventors' work streamlines hub energy use by dividing them into two kinds. A way from the test hub class with sufficient transmission energy might be selected, reducing the likelihood of routing disappointments and the growing number of disconnected hubs as a consequence of increased information retrieval .Following each transmission cycle, the EHO updating administration adjusts classes by an isolating administration that assesses hubs depending on the energy residual. The results obtained by the author demonstrate that EHO outcomes are preferable to those obtained by other techniques. As a result of the node's clan needing to be updated often, which drives up routing costs and introduces delay, there is, nevertheless, a significant amount of delays and communication expenses.

By switching to a different route when the primary one is stopped and allowing information to progress, the AOMDVs [16] networking strategy may provide a minimum QoS guarantee.But moving to other pathways results in a larger networking overhead since maintaining the path would need more data. [17] designed the QoS-AOMDV routing protocol to increase QoS. This technique gathers cross-layer statistics on remaining energy and queuing length to choose high-quality paths. The packet transmission ratio is low due to information collisions, which increases the latency. [18] suggests a MANET routing scheme. Migration causes random data stream loss & connectivity failures. The authors proposed an efficiency function that accounts for traffic volume, range among the source and destination nodes, and sustainable energy. Efficiency avoids crowded channels. AOMDV uses the efficiency function to choose the best routes. The number of data transmissions even if a networking connection is sometimes dropped, the quantity of energy used, and a short path length are a few elements to consider while selecting the best fitness approach. The dependability of the routes, as measured by the rate of information conflict and connection stability, was not taken into account by this technique. A multipath relay node based on link reliability is suggested by the approach in [19]. The simulation model and the size of the forwarding queue are used by the algorithm to estimate the confidence in the ability probabilities. This raises the likelihood that the relationship will remain stable. However, the power consumption of the network is significant since regular route modifications need additional nodes to ensure network stability.

AOMDV provide a congestion management method [20]. The technique uses a rate-based wireless data system with queue-based congestion management to progress the effectiveness of the system. The results showed better delivery of packets and less communication overhead. However, the system's utilization is relatively low because of the high network congestion brought on by collisions.One of the most significant difficulties with MANET is traffic congestion and connection breakdown. The network should have as little end-to-end latency as possible while delivering data packets from one place to another. But if there is overcrowding on the source nodes, it will be difficult to accomplish this because it will lengthen the queue, which will add to the delay. Consequently, [21] suggested a M-ary Quadrature Amplitude Modulation (MQAM) routing approach based on theMulti-Criteria Decision Making (MCDM) metric. Results reveal that MQAM routing is improved than Multi Protocol- Optimized Link State Routing Protocol (MP-OLSR) throughput. However, because of transmission errors, the delay is relatively high. [22] introduced anoriginal communication protocol Congestion-Aware Clusters & Forwarding to ease congestion and cluster in Wireless Sensor Network (WSN).

It was claimed in [23] that Transmission control Protocol (TCP) transmission over Time Division Multiple Access (TDMA) based MANETs might be utilized without interference with sender-side network congestion and prototype resource predictions. While together algorithms provide efficient congestion reduction networking techniques, they neglected to account for stochastic transmission errors, which would have unnecessarily reduced the traffic load. Wireless bandwidth transmission across mobile nodes must be managed and dispersed since MANETs lack a central organizer. MANET typically use Carrier sense multiple access/collision avoidance (CSMA/CA) and its alternatives. All of these Carrier sense multiple access collision (CSMAC) methods are, however, affected by the "secret terminal" problem [24]. Compared to standard communication networks, ad-hoc networks are more difficult. In [25], researchers advocated replacing hob count with link efficiency and impact frequency. This technique makes use of the single-path, antiquated interface AODV. The routing identification procedure must be started in the event of a connection loss, which will increase delay and routing expense.

In [26], a hybrid Gentic Algorthim -Hill Climb approach is employed in the (GAHC)route. A projected hybridization technique interpolates CHs and aggregating pathway attributes including throughput, latency, and node interconnectedness are utilized to pick routes. This suggested approach provides the highest bandwidth, detection accuracy, and ratio of packets delivered with the least amount of energy and latency. However, this approach is predicated on nodes with slow mobility. Authors in [27] investigated the route efficiency of the algorithm for WSNs. Two key experiment instances used Djekstra and a genetic algorithm. Depending on OLSR, [28] proposed an Artifical Immune System - Optimized Link State Routing Protocol (AIS-OLSR) approach that chooses the best path depending on base stations, node-accepting fuel qualities, and repository node proximity. This strategy could increase the network's capacity and end-to-end latency effectiveness. The significant amount of energy that must be used to calculate routes is one of the key concerns raised by this protocol.

A multipath high-quality of SR-MQMRs, according to [29], is reliable for the mobile ad-hoc network. This technique uses node signal power to pick the most reliable connections while considering throughput. The SR-MQMR protocol uses fewer specific times than MQMR, which boosts success. Additionally, choosing steady routes significantly increased dependability. The sudden change in system architecture and node stochastic velocities, however, have an impact on the network signal quality and reduce system performance by reducing the Packet delivery ratio (PDR).

When mobile networks are stationed at a steady speed and adopt a random path, the research [30] introduces novel Local Congestion Mitigation (LCM) and Personal digital Assistant (PDA) methodologies to evaluate the route dependability. Link expiration time, angular speed, connection, and reliability affect the LCM procedures of adjacent nodes, depending on the method provided. Both analytical and simulation findings that correctly forecast route integrity under dynamic topology, improving global network connection, demonstrate the LCM with the PDA approach's usefulness. The length of the connection expiration time generates additional latency, whereas a shorter duration increases routing overhead in the network.

Locating MANET adjacent nodes is the main goal of [31], which focuses on building multipath routing in varied mobility patterns. It efficiently manages congestion, data dissemination, and packet sequencing. The paper explains stable node forecasting, security evaluation, route finding, and package distribution. The optimum route is determined by linking stable connections between both the destinations and the source. A failed routing relationship activates path recovery. As a consequence, data packets are automatically dispersed along several paths. This approach has a very poor optimization performance owing to erroneous convergence, as revealed by an experimental investigation. Additionally, because each data packet is transmitted across numerous paths concurrently and only one of these channels is necessary, each node consumes a significant amount of energy.

2.1 Research gaps identified from the literature review

The following are some of the limitations that have been found, all of which will be addressed with greater depth in the subsequent research.

- An organised topology is inadequate for dealing with massive MANET systems.
- An ineffective monitoring system causes excessive network disruptions as well as failure of device.
- Existing approaches are ineffective when dealing with fluctuating topology.
- MANETs are consuming high bandwidth and energy.
- The lack of an effective procedure/protocol has a serious affect on PDR.

The proposed model overcomes the existing limitations with the concept of "age" in AMPO helps maintain population diversity, enabling more effective routing decisions in large-scale MANET systems. By categorizing particles into distinct age groups, the proposed approach ensures better adaptability to the dynamic and expansive nature of MANET. The novel routing strategy introduced by AMPO, coupled with the parameter setting mechanism based on age groups, enhances packet delivery rates by optimizing route selection and accelerating convergence. This leads to more reliable and efficient packet delivery within the MANET environment.

Overall, the proposed approach addresses key limitations of MANET by introducing innovative routing strategies based on age-based optimization, thereby improving network performance, reliability, and efficiency. Through comprehensive evaluations against existing methods, the proposed approach demonstrates significant advancements in overcoming the challenges associated with MANET, paving the way for more robust and scalable wireless communication systems.

3 Proposed Taxonomy: AOMDV with Aging Multi Population Optimization

AOMDV is a multihop protocol designed for network routing that supports MANET and is accessible on demand. Current research offers a system that uses a AMPO strategy to optimise routes in order to bypass unstable links as well as linkages that have traffic difficulties (such as linkages that are overcrowded or links with a higher collisions frequency). Several tribes of populations with younger men live under a head, whereas adult males prefer to keep apart but communicate through low-frequency influences. To imitate mature male populations leaving their tribes and to boost population diversification later on, two factors are employed. Population activity within tribes is tracked and updated using this method. The AMPO is divided into four stages,

- Stage 1) The clan-based split of the aging population
- Stage 2) The eldest male and eldest female for each clan are the matriarchs.
- Stage 3) The attitude of populations in herds may be modified according to the input of two operators Clan upgrading operator for adjusting the matriarch's location based on data from all clan populations.
- Stage 4) Based on the separation operator determined to use the upper and the lower limit of the location of the populations, the young males depart the clan. The departing adults may still communicate with the household female through minimum -frequencies vibes.

From the above, the explanation is that AMPO optimization addresses the problem of MANET network energy consumption. The MANET aging population, is separated into two clans, maybe with all interconnections. The division processes, based on nodal radiation, will establish each node's class, while the updates regulatory, that signal networks' reserves, will be changed for every transmission and is discussed in the next section.

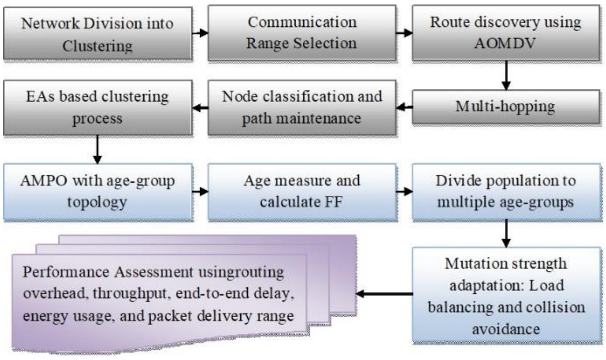

Figure 3: Working flow of the AOMDV-AMPO strategy

3.1 Routing Protocol using AMPO-AOMDV

AMPO-AOMDV, a spread spectrum load-balancing communication system based on both AMPO& AOMDV, serves as the basis for this system. By splitting node communities into two tribes based on nodal energy, also known as the division operation, AMPO is employed largely to minimize node electricity usage.Nodes that have more energy than is required to transport all of the messages via the network will be assigned to the clan, whereas the rest will be assigned to the second clan.The AOMDV protocol discovers T multilink disjoint pathways by Broadcasting Route Request Packet(RREQ) signals from origin node S to target D, creating numerous reverse paths at the relay node and the endpoint. Similar Source IP addresses and ID duplication output RREQs replace RREQs with lower central transmission power and higher usage. The pathway between S to D will be arranged by nodal efficiency.

According to the proportion of route energy compared to the total energy of all identified pathways, the data burden is distributed across the T-detected paths. If all paths fail or there is an upgrade in any part from the initial clan all access points in both the 2nd clan members would be inspected, and also the clans will indeed be revised by swapping clusters. We may break down the AMPO-AOMDVs into its four primary phases network classification, Paths Identification, Information Bandwidth Allocation, and Paths Maintenance—to provide more specifics.

Network Classifier:As noted earlier, the AMPO is identifying the endpoints based on the show's maximum alive nodes, which are employed as the automated update controllers, to decrease the number of extremities in use. Endpoints that have more minimum energy than is required to transmit all incoming packets PTEni across the ground station ni will be classified as belonging to the first clan; alternatively, they will be placed in the second clan.

Algorithm 1: Classifying the network
For i=1 to M (total nodes in network) do
$PTE_{n_i} = \mathrm{TP} * \beta(n_i, n_{i+1})$ // separation operator
If $E_{n_i} > PTE_{n_i}$ Then $n_i \in \mathrm{C}_1$ Else C_2
End If
End For

Algorithm 1 shows the pseudo-code of C1& C2clan nodes, where TPs is the total no. of frames, indicates the effort consumption in transmitter & receiver packages viewsin one hop, then PTEni is the strength desirable to carry all incoming packets over the single router.This stage reduces dead networks by ensuring that only networks with enough energy to broadcast will send.

Discovery of Path: The discontinuous trails investigation (shown in Figure 3) starts after categorizing the endpoints. This is accomplished by transferring RREQs from the S to D utilizing the AOMDV protocol. To retain the RREQ with both the maximum networkoriginalforce and the smallest hops, repetitive RREQs using the same source and Identity will be evaluated. It will ensure that the fastest pathway with the greatest quantity of energy was found for transferring the whole collected data.

Maintenance of Path: If all routes fail (Eq 4) or any detected paths lose energy, resume the nodes categorization process. The update operators evaluate all network connections in the two tribes to move the dead locations. The terminals had rotating inertia and initially had insufficient fuel for communications, but they assumed power and were able to communicate from the 1st clan to the next and it start the routes for a path.

Data load balances:The T-found pathways are ranked in decreasing order by their maximum nodal remaining energy Pet, determined from the minimum remaining power of all X vertices on a way.

Path: Approach on the path power % concerning all found path energies, as specified in algorithm.

The nodes in green in Fig 9 represent those that were classified into Category 1 because their remaining energy was larger than the energy required to transport all packets over a single hop, while the remaining nodes were classified into Category 2. RREQs are exclusively sent among nodes in clan C1—all nodes excluding node J, which has no predecessors in clan C1—as stated in portion (c) of the clarification. Only two identified pathways, t1D[S-A-B-G-D] and t2D[S-C-F-H-D] are shown in portion (d), and they will be arranged in decreasing order of nodal residual energy. Finally, the amount of information carried by every route will be calculated based on its frequency percentage concerning the combined power of all paths. For example, if there are 100 packages, 60 will be transmitted on t1 and 40 on t2.

Algorithm 2: Procedure for finding the routes
For j = 1 to R (for all nodes in Clan C_1) do
Flood RREQs from source S to destination D
Establishing numerous reversal routes at destination and intermediate nodes
Using the source and intermediate nodes as nodes, traverse the reverse paths back via several Route Reply (RREP) to build multiple forwards paths to the target
Maintain RREQs with the lowest hop count and highest nodal remaining energy
End For

3.2 Age-based Evolutionary Algorithms (EAs)

There are three aging operators, based on the techniques employed to calculate age: evolution age, static pure age, & genomic age. In evolutionary age, crossing or mutations children are given age 0, and each surviving individual's age increases by one per cycle. In static simple aging, a newborn's lifetime is 0 if its fitness is higher than its parents', or its relatives' ages. Unlike static pure aging, genetic variability overaged assigns generation 0 to offspring who have the same objective function value and differing coordination position than their parents. For a minimization issue, the three aging processors determine duration as in the following lemmas.

- Lemma 1: (evolutionary age). y age = 0.
- Lemma2: (static pure age). iff(y) $< f(x)$ then y · age = 0 else y · age = x · age.
- Lemma 3: (genotypic age). iff(y) ⩽ f(x) ∧ y ≠ x then y · age = 0 else y · age = x · age.

When a person's age is detected, the aging operation is utilized to replace any person whose age exceeds the maximum age with a brand-new, randomly generated person. whereas adaptive aging may optimize functioning with plateaus. This is thus because a person's fitness stagnation causes their static pure age to increase without affecting their evolving age. Genotypic aging recognizes optimum solution and peak because it enables random stroll on the level. [32] describes age as the population's genetic evolution. Depending on this age measurement, an Application Layer Protocol for Subnetworks (ALPS) is suggested to limit large inter-individual competition and procreation. Age 1 plus the oldest possible parent's age is the starting point for individuals produced via mutation or crossover. In ALPS, the majority are divided into multiple agelayers according to their ages, and each member may cross across with just another member of that layer or the one before it.

3.2.1EAs-based clustering

A collection of M unidentified objects in the d i/pgap is represented by $\mathbf{O} = \{\mathbf{o}_1, \mathbf{o}_1, \dots, \mathbf{o}_n\}$. The j[th] real-value characteristic of the i[th] object (i=1,2,...,n) is represented by each member of the vector o_{ij} (o ij=1,2,...,d). When faced with such a collection, a region-based segmentation clustering algorithm must choose a separation$C = \{C_1, C_2, \dots, C_k$ | $\forall k: C_k \neq \emptyset$such that the similarity of the items within the same clusters is maximized while the items within separate clusters are as dissimilar as feasible. The relationship among any two objects, $\mathbf{o}_i$ and $\mathbf{o}_j$ is described as follows in the most widely used correlation-based technique known as Euclidean distance:

$$D(o_i, o_j) = \sqrt{\sum_{m=1}^{d} \left(o_{i,m} - o_{j,m}\right)^2} = \|x_i - x_j\| \qquad (1)$$

This statistical method defines the cluster analysis issue mathematically [33]:

$$\text{Min} \sum_{k=1}^{K} \sum_{i=1}^{n} w_{it} D(o_i, z_k) \qquad (2)$$

where$\sum_{i=1}^{K} w_{ik} = 1$ for $i = 1, \dots, n$ and $\mathbf{z}_k$be the center vertex Cₖkth node. The Euclidean distance

$C_k . D(\mathbf{o}_i, \mathbf{z}_k)$between an object's center and the kth cluster's (C_k) center is shown. Even K=2 is NP-hard [34]. The traditional K-means method and its various variations were regularly shown to be susceptible to being caught in a local optimum.

EAs were introduced to clustering because of K-means' local optima difficulty. An early use of EA for clustering produced cluster centroids using an evolution method [35], which were subsequently partitioned as in standard K-means algorithms. Although a genetic algorithm rather than an evolution technique has been used to evolve cluster centroids, this approach has continued to be refined. Ant colony optimization, different evolution, artificial bee colony, and particle swarm optimization are recent examples of population-based global optimization approaches that have been employed for clustering. Some studies develop cluster centroids and find the ideal number of groups. The EAs increase the likelihood that the clustering algorithms will converge to an optimum solution, albeit at the sacrifice of convergence rate. Local search techniques, such as the K-means algorithm, were often used with EAs to refine the solutions found by EAs and speed up convergence to provide a thorough analysis of the EA-based clustering methods.

3.3 PSO with age-group Approach

Particle Swarm Optimization Age Group (PSOAG) improves Particle Swarm Optimization (PSO) in situations with multiple local optimums. It is planned to add three additional features. First, a particular age description for PSO is suggested to determine how old each particle in the swarm is. Additionally, a topological architecture for age groups depending on this new metric is created to control swarm variety. The variable adaptation approach adjusts inertial weight, acceleration parameters, and mutation intensity periodically.

3.3.1 Measure of Age

The pbest location of a particle has not changed till predicting the optimal exploration.

The following describes the new age.

Indication 4:if $f(\mathbf{x}_i) < f(\mathbf{p}_i)$ then $\mathbf{x}_i \cdot$ age $= 0$ else $\mathbf{x}_i \cdot$ age $= \mathbf{x}_i \cdot$age $+1$.

Each randomly generated particle in the first basic aspect is off at age 0, if it is unable to locate a position that is superior to the current pbest, its age is increased by one in one iteration. Additionally, a difference like a mutation does not change the particle's age.If a particle's lifespan surpasses the preset maximum age, it is eliminated from the existing population as well as a new element is produced at random in the state space.

Particle age is calculated using the quantum state pbest origin and present situation. PSO does not modify particle positioning if it overlaps with a local solution. However, if it oscillates about a locally optimal, its real location likewise oscillates while the pbest position is held constant. Here, we refer to the two circumstances as fitness fluctuation and immobility. The pbest data may be utilized to identify the two phenomena since it stays constant in each of them. Because only performance in the current and preceding iterations is taken into account for calculating time. Therefore, the age of every particle is determined using the pbest position. If the particle's pbest location is not altered during the new age test, the particle's age will increase by one with each iteration if the position is not changed. This growth procedure goes on until the component finds a more suitable pbest site or exceeds its maximum age and gets picked up.

3.3.2 Age-group topology structure

The people are divided into age groups to effectively use data from particles of various ages. Particles may be mapped to various age groups using a variety of mapping techniques, including Fibonacci, logarithmic, and polynomials processes. For example, using a mathematical equation, the age requirement within every age group is 1, 2, 4, 9,16,& the equivalent age limit is 1, 2,3 4,5 9,10 16, Age groups are shown in broad strokes in Fig. 1.

We define age-group topology from the age-grouped swarm. A random architecture is applied in the proposed circuit to determine neighbors for each particle. Instead of selecting k neighborhoods from the whole community, choose the neighbors from its groups together with the other older ensembles.The youngest group's nanoparticles are limited to choosing neighborhoods solely within their groupings. If age-group gi and gi-1have fewer nanoparticles than k, the current gbest component will be its only neighbor. Nevertheless, if the number is not lower than k < 1, k neighbors are randomly picked among them, and the element with a superior pbest placement is chosen as its best part of town for the current implementation.

3.4 Adaptation of Parameter: x & ci adaptation

Acceleration constants c1 and c2, which are utilized to maintain a balance between exploiting and exploring in the query, have a substantial impact on PSO's performance. PSOAG automatically adjusts the three parameters for each particle based on its agegroup. The three components are adjusted to make the search better selective if a particle is old sufficient to be allocated to an older age group. This change is intended to help antiquity nanoparticles upgrade their pbests by enhancing their local search capabilities.

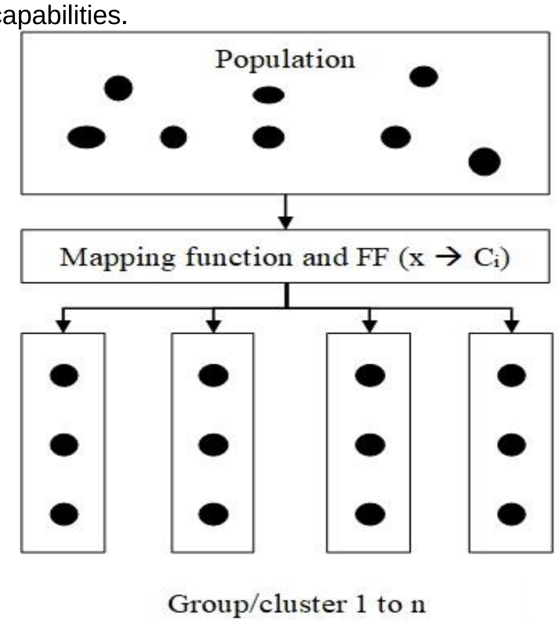

Figure 4: Segregating populations into several age groups via mapping functions. (The terms "x and ci" is particle age and target node)

Furthermore, every particle aged 0 is allocated the average range of,$\omega, c_1$and c_2, with 0.730,1.430 & 1.438. Putting a component in an older age group changes the three components[34]:

$$\omega_i^t = \omega - \theta \cdot g_i^t \quad (3)$$

$$c_{1,i}^t = c_1 - \theta \cdot g_i^t \quad (4)$$

$$c_{2,i}^t = c_2 + \theta \cdot g_i^t \quad (5)$$

where$g_i^t$is particles i's age-group in the t[th] repetition and influences. Based on these EQs, if input in an older group, and ω and c_1 are decreased by θ and c_2 goes up. They have chosen the value ofg_i^t.which is a very tinyθ variable that makes sure the three factors vary within a reasonable range.

3.5 Mutation strength alteration

An essential operator in this work is the mutation operator. Unlike typical individual line or stochastic length modification in PSOs, the proposed evolutionary scheme employs element lifespan to determine mutation intensity.This operator increases ancient particles' pbest updating chances. Mutation frequency (ms) for component i:

$$ms_i = \begin{cases} \left\lceil \dfrac{D}{2^{s-z_i^l+1} - s + g_i^l} \right\rceil & \alpha_i <= \tau \\ \dfrac{D}{2} & \alpha_i > \tau \end{cases} \quad (6)$$

where the mapping function determines the population's maximum agegroups. If $\alpha_i = 0$ just one dimension of the particle i will be altered, much as with one point mutation. The mutation length l_i, which ranges from one to half of the dimension of the particles, grows along with the growth in α_i.If $\alpha_i > \tau$, PSOAG's maximum size is D/2. PSOAG's architecture is Algorithm .

Algorithm 3: Particle role in AMPO

1. Initialize the variable limit $\mathbf{x}_{\min}$&$\mathbf{x}_{\max}$;
2. Produced an original swarm S utilizing range P;
3. evaluate these count intervals $= 0$;
4. initialize the swarm particles $\alpha_i = 0 (i = 1,2, \dots, P)$;
5. when the halt condition is not met, progress
6. The aging operator age groups ($(S, \alpha,$) are used to remove atoms $\alpha > \tau$ and replace them with new ones. The age-group topological structure is constructed using the () function.
7. end if
8. for $i = 1 \colon P$ do
9. A w_i alteration (S, ω, α); B inertial weight adjust
10. C_i adaptation (S, c_1, c_2, α); velocity remains constant
11. Inform the position & velocity
12. if the mutation form is fulfilled then
13. ms_adaptation(S, α).
14. end i
15. fitness calculate (S, fevals);
16. Update age accordingly.

In this instance, the sender network greets the nodes along a specified path that AOMDV has returned. We suggest that if no CTS is generated, then F_c= 0, which indicates the presence of a collision.

$$F_c = \begin{cases} 1/\text{RTT}, & \text{CTS is received} \\ 0, & \text{No CTS is received} \end{cases} \quad (7)$$

Data packets may be dropped throughout a route if $Q \le N$because of anticipated traffic congestion at one node. It is preferable in this instance to avoid excluding this method from the suggested alternatives.If $Q \le N$, the calculated route may join the pool of optimal routes dependent on the other fitness operating characteristic. The proposed model offers a method for the fitness functional where the overloaded efficiency functional element F_q will either have any values or be restored to 0, depending on the condition $Q \le N$. Equation (8) is used to calculate the value, and B is the reservoir size. If $Q \le N$ is true, which denotes that the route may receive packets for transferring data, then the value is computed. If not, the route probably has traffic at one or more of its endpoints, so we can modify the value of F_q to 0.

The currentmethod providesthe fitness service where another overloaded fitness functional portion $F_q$either has some values or restores to 0, depending on the condition $Q \le N$. Equation (8) is used to calculate the value, wherein B is the buffering size. If $Q \le N$is true, which denotes that the network may receive packages for the transmission of data, then the value is computed. Otherwise, the route probably experiences congestion at individual or many of its terminals, so we simply change F_q to 0.

$$\boldsymbol{F_q} = \begin{cases} \mathbf{1} - \dfrac{\boldsymbol{Q}}{\boldsymbol{B}}, & \boldsymbol{Q} \le \boldsymbol{N} \\ \mathbf{0}, & \boldsymbol{Q} > \boldsymbol{N}. \end{cases} \quad (8)$$

where F_c: collision, F_q: queue length and F_s: stability. All routes between the origin and the target FFs are sorted from greatest to lowest, and the path with the greatest FF ratio is chosen. As shown in Fig 12, shows the connection S& D.The threshold value is calculated by averaging each component. (I.e. F_{cavg} ,F_{qavg} and F_{savg}) using equation (9). We construct this mean amount as our predefined threshold and determine if every element have a larger value than the normal range in equation 9 by evaluating it to the overall average[35].

$$F_{xavg} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} F_{xij}}{n \times m} \quad (9)$$

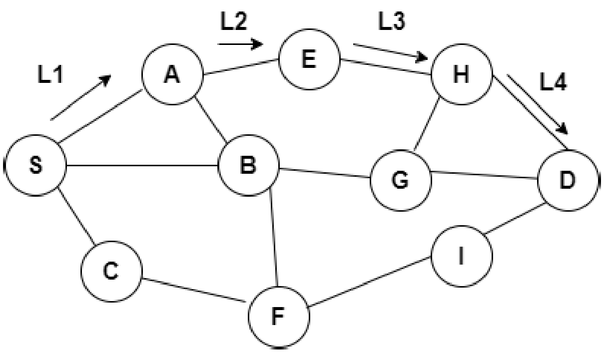

Figure 5:AOMDV-routing mechanism

3.6 Path Stability Probabilities (PSPs)

When a packet arrives at an RREPs from the target address, the PSP value can be obtainedeq (10) [21] this computes the LBPs values between both networks and the optimization algorithm of the link security F_s.

$$\begin{aligned} \mathbf{PSP_i} &= \prod_{l=1}^{L} (\mathbf{1} - \mathbf{LBP_l}) \\ \mathbf{F_s} &= \mathbf{PSP_i} \end{aligned} \quad (10)$$

PSPsare computed for route I for every connection l in the collection of links L. To calculate the new PSPs number and modify the PSPs, utilize eq(11). Lastly, eq (12) chooses the most reliable AOMDV method pathway.

Algorithm 4: Fitness evaluation for every router

1: I/p: For every routerdata retrieved from AOMDV-AMPO
2: O/p: Array of Function data
3: for every (i=0; i<= n; i++)
4: F_c evaluation in eq 7
5: F_qEvaluation
6: F_s Evaluation
7: Fxavg evaluation
8: if (Fc >Fcavg)
9: if (Fq>Fqavg)
10: if (Fs >Fsavg)
11: FF = Fc + Fq + Fs
12: end all

4 Experimental Results and Discussions

For the proposed model, the FF values has to be equalized to their defined average as per the aging population strategy. The performance of BCSMT scheme is analyzed by using NS2. The nodes have to be configured as mobile nodes by using the node-config command in NS2. The radio waves are propagated by using the propagation model two ray ground. The nodes are distributed in the simulation environment. The parameters used for the simulation of AMPO scheme is described in Table. The simulation of AMPO has 100 nodes deployed in the simulation area 500×500. The nodes are communicated with each other by using the communication protocol User Datagram Protocol (UDP). The nodes are moved randomly within the simulation area by using the mobility model Random waypoint. All the nodes receive the signal from all direction by using the Omni directional antenna. The traffic is handled using the traffic model Constant Bit rate (CBR). The performance of AMPO scheme is evaluated by the parameters PDR, routing overhead, end to end delay, throughput etc.

Table 1: Simulation setup

Parameter	Value
NumberofNodes	100
SimulationArea	500×500m^2
ChannelBW	1Mbps
Sizeofdatapacket	1 kB
Initialenergy(NormalNodes-77)	1J
Initialenergy(AdvancedNodes-23)	5J
ProcessingDelay	50μs
ε_{fs}	10pJ/bit/m^2
ε_{mp}	0.0013pJ/bit/m^4
E_{elect}	50nJ/bit
E_{DA}	5nJ/bit/signal

Packet Delivery Ratio assessment

Fig 6 & 7 compare the PDR to the number of networks and simulated period. The simulated duration increases, routing protocol monitoring the much more packets. It increases network traffic, which causes congestion at the relay nodes or collisions at connections. That results in much more lost or colliding bits and hence impacts the system severely. AOMDV-AMPOs and AOMDV-FFs provide more packets than AOMDV-TAs and EHO-AOMDVs. Congested networks or accidents will consequence the low FFs ratings, therefore pathways were to be kept away from it. Other methods don't utilize this approach. Table 2 shows that AOMDV-AMPO increases PDR by 4.5%, 10.29%, & 15% compared to AOMDV-FFs, AOMDV-TAs, & EHO-AOMDVs.

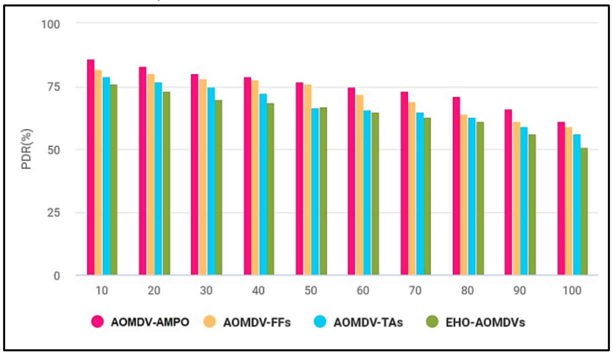

Figure 6: Computation of PDR vs network nodes

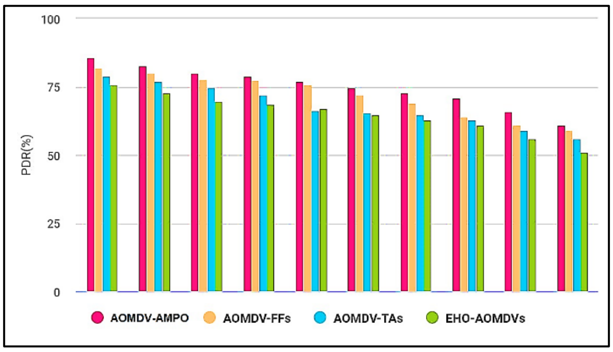

Figure 7: Computation of PDR vs simulation time

Table 2:PDR computation

No. of Vertices	AOMDV-AMPO	AOMDV-FFs	AOMDV-TAs	EHO-AOMDVs

10	86	82	79	76
20	83	80	77	73
30	80	78	74.9	70
40	79.13	77.53	72.3	68.8
50	77	76	66.6	67
60	75	72	65.6	65
70	73	69	65	63
80	71	64	63	61
90	66	61	59	56
100	61	59	56	51
Sum	742.13	709.53	673	641.8
Gain %		4.5	10.29	16

B. Throughput assessment

The number of nodes, percentage of defective endpoints, mobility speed (m/s), loss of packets (%), and simulated duration are used to measure throughput (s). Figure 8 shows how network performance depends on node count. With additional nodes available for packet data transfers comes the risk of traffic congestion and even more conflicts at the network's intermediate nodes. This will lower throughput. Our suggested protocols, AOMDV-AMPOs, and AOMDV-FFs concentrate on selecting the route with the greatest network reliability and least unreliable, which lowers the likelihood of traffic issues like congestion and conflict.

Fig 9 shows throughput vs malfunctioning nodes. We assume malfunctioning nodes in AOMDV networks and test each protocol in different circumstances. There may be a variety of causes for malfunctioning nodes, including battery drain or collisions between mobile nodes. We are concentrating on four distinct scenarios for malfunctioning nodes. Networking performance degrades as the frequency of defective networks increases and more node failures mean that less incoming information will reach the target, which lowers the transmission speed.This is because routes with problematic nodes will be ignored since the Round Trip Time (RTT) is in formulae (1) and (2).

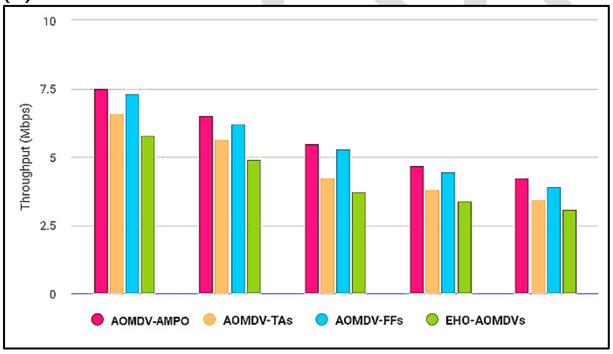

Figure 8: Computation of throughput vs node numbers

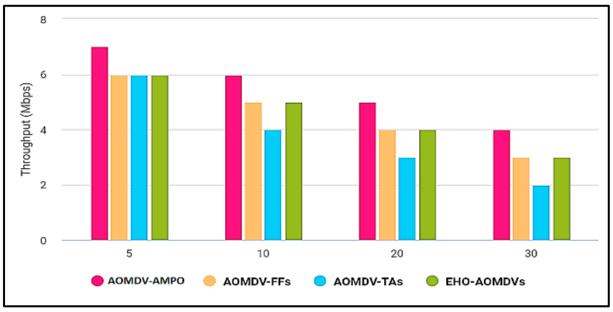

Figure 9: Computation of throughput vs faulty nodes

The efficiency is shown against mobility speed in Fig 10. Links are often unstable as a result of the nodes' constant movement. Our program chooses the most stable path with the fewest velocities and node motion. At high node speeds, when such unstable pathways are avoided by our algorithms, this system performance becomes more apparent.

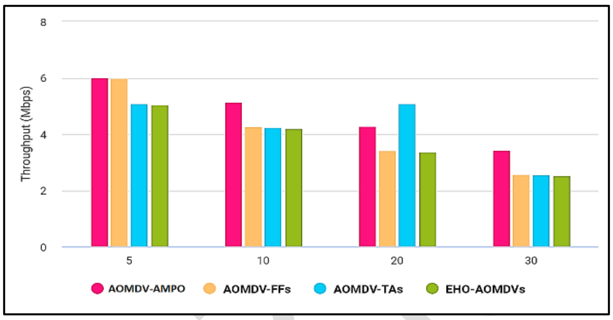

Figure 10: Computation of throughput vs speed of mobility

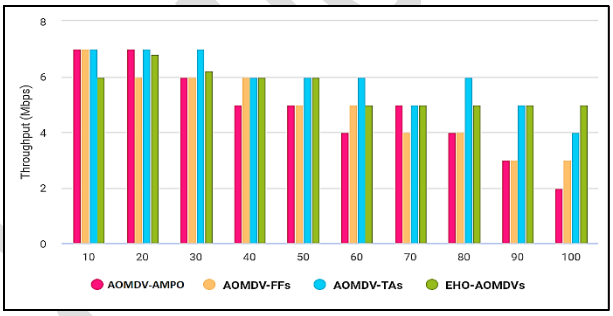

Figure 11: Computation of throughput vs loss of packets

Fig 12 shows how packet loss impacts network performance. The total quantity of packets not acquired at the target is multiplied by the amount of data packets from the source to get the packet loss rate. Data collision, insufficient node energy, and excessive node mobility are all potential causes of packet loss. Because we are concentrating on lowering the frequency of collisions in a certain network, our suggested protocols AOMDV-AMPO and AOMDV-FF are performing better than AOMDV-TA and EHO-AOMDV. According to Table 3, AOMDV-AMPOs increase throughput evaluation to AOMDV-FFs, AOMDV-TAs, and EHO-AOMDVs by 4.38%, 20.19%, and 35.70%, correspondingly. The stochastic network of nobilities, such as data latency and collision rises with time, and hence throughput decreases. Our methods, therefore, keep clear of these risky pathways, which improves throughput performance in comparison to other procedures.

Table 3: Throughput vs Packet Loss Range

Packet loss	AOMDV-AMPOs	AOMDV-TAs	AOMDV-FFs	EHO-AOMDVs
0	7.51	6.61	7.31	5.81
1	6.51	5.64	6.25	4.91
2	5.51	4.21	5.32	3.74
3	4.71	3.81	4.46	3.41
4	4.22	3.43	3.92	3.11

Sum	28.5	23.64	27.22	20.94
Gain %		20.19	4.38	35.68

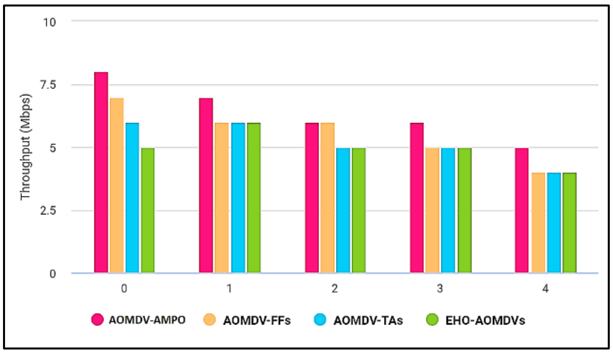

Figure 12: Computation of throughput vs simulation time

End 2 End Latency assessment

Data retransmissions rise as a result of the traffic difficulties in Fig. 21 and as the total number of nodes rises. This requires more nodes and time to identify the optimum paths. These factors will extend the process.The time required by our suggested techniques decreases as the quantity of packet forwarding decreases.

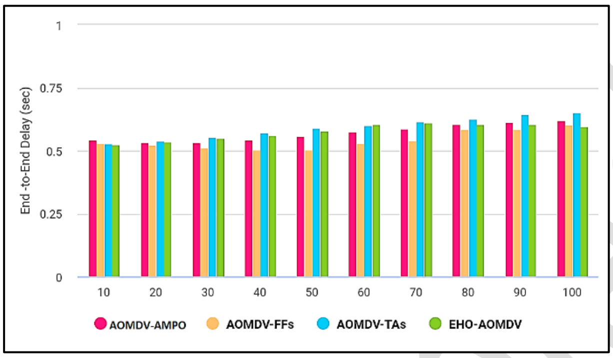

Figure 13: Computation of latency vs node numbers

Fig 13 shows how broken nodes affect end-to-end latency, similar to Figure 13. Before or during information transfer, the network might malfunction. If this happens while data is being sent, a time delay is needed to alert the transmitters of the route connection, an alternate route is investigated, and information restoration is started. The end-to-end latency would therefore decrease. If a network fails before data transmission, our methods will eliminate specific pathways.

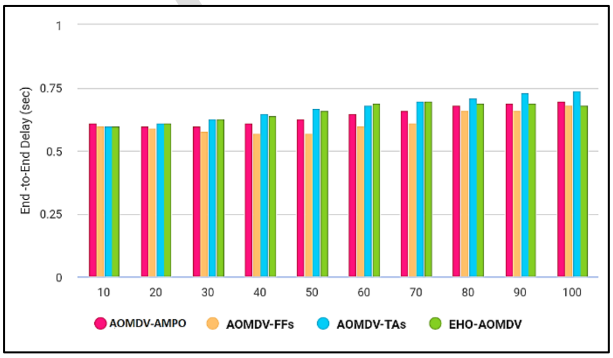

Figure 14: Computation of latency vs faulty nodes

Routes would probably be lost due to the movement of nodes, which might lead to packets dropping. Repeated data transfers would lengthen the end-to-end latency. This procedure performed then the rivals as they eliminate those problematic routes

Energy consumption assessment

Fig 15 & 16 show how our procedures cut down on the nodes' efficiency use by reducing the number of times packets have to be sent again. As nodes or time advance, computational time and energy increase. According to Table 4, AOMDV-AMPO saves fuel evaluate to AOMDV-FFs, AOMDV-TAs & EHO-AOMDVs by 10.76%, 61.97%, and 32.33%, respectively.

Routing Overhead assessment

Fig 17 & 18 shows the no. of computational cost progression boosts the quantity of RREQs packets floods in the system, increasing the latency in the 132960 VOLUME network. The route discovery procedure is activated more often due to node migration and route instabilities, which increases this overhead. As mentioned previously, our algorithms base their route optimization on the FF.

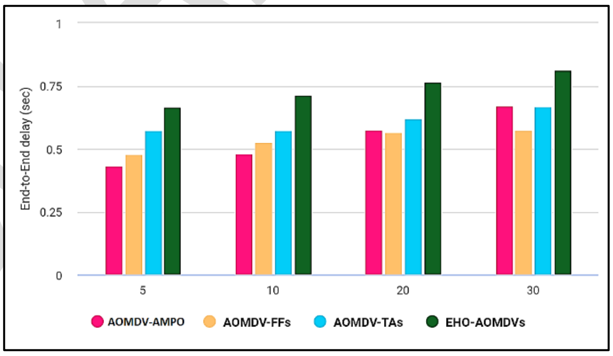

Figure 15: Computation of latency vs speed

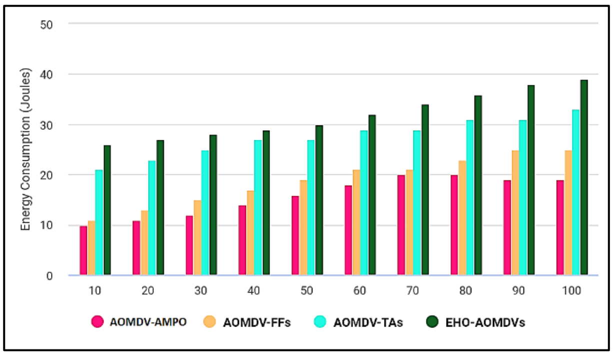

Figure 16: Computation of energy utilization vs node number

Table 4: Energy utilization

No. of Vertices	AOMDV-AMPOs	AOMDV-FFs	AOMDV-TAs	EHO-AOMDVs
10	17	18	32	27
20	19	20	32.3	27.3
30	19	22	7434	27.10
40	22.13	23.53	7236	28.2
50	22.9	24.5	6639	28.9
60	24	27	6540.3	32.6
70	26	29	42.8	33.8
80	30	30.9	46	35.6

90	32	33.8	47.3	36.8
100	33	35	47.5	38
Sum	235.9	254.10	380.4	310.8
Gain %		10.78	62.97	33.33

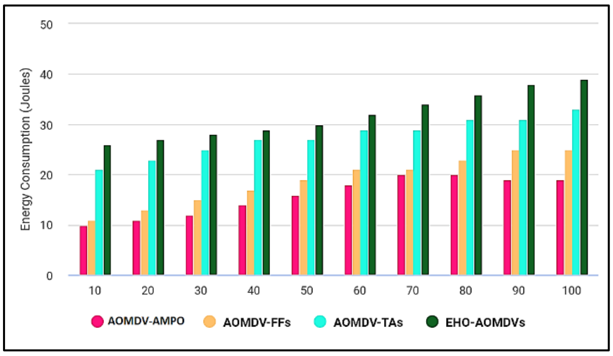

Figure 17: Computation of energy utilization vs node number

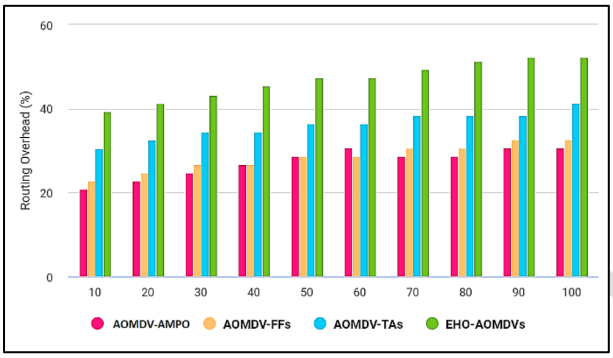

Figure 18: Computation of routing overhead vs node number

As a consequence, our methods have less complexity than conventional methods. AOMDV-AMPO decreases network loops by 12.55%, 33.35%, and 74.45%, respectively, when compared to AOMDV-FFs, AOMDV-TAs, & EHO-AOMDVs, as shown in Table 5.

Table 5: Routing overhead

No. of Vertices	AOMDV-AMPOs	AOMDV-FFs	AOMDV-TAs	EHO-AOMDVs
10	27	28	35	47
20	27.3	31	37	49
30	27.30	32	38.91	49
40	28.2	34	38.61	50.7
50	32.7	35.82	41.8	53
60	33.8	37	43	57
70	34.6	38.37	43.8	59
80	37	41	45.6	60.3
90	5.2	42.54	48	61.2
100	39	43	50	61.9
Sum	310.8	350.70	416.4	543
Gain %		13.55	33.36	75.45

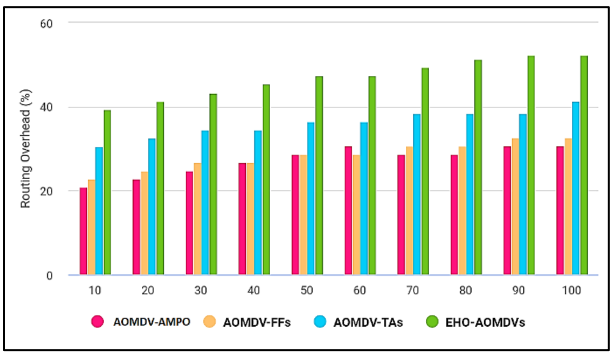

Figure 19: Computation of routing overhead vs simulation period

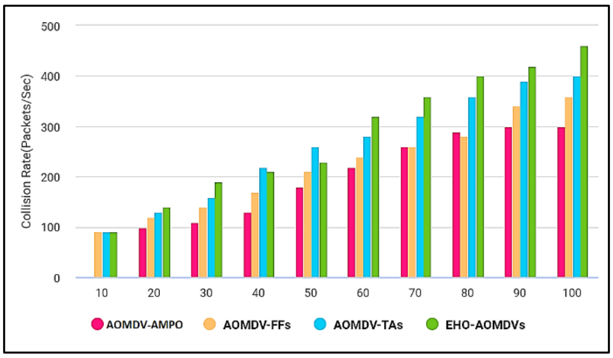

Figure 20: Computation of collision rate vs node number

Rate of Collision assessment

Fig. 20 displays this frequency at packet headers lost. With more nodes, more information must be sent so that the likelihood of a collision grows. Utilizing the equation's RTT algorithm our procedure chooses the path with the lowest likelihood of a collision.

Broken nodes cause the routers to terminate much more often. By increasing the number of RREQ frames broadcasting in the network. Thus, data conflicts commonly occur in the three-way handshake phase, as shown in Fig. 21 and 22. Our methods provide more dependable routes, which lowers the number of RREQ messages and Request To Send / Clear To Send (RTS/CTS) exchanges while also reducing collision rates.

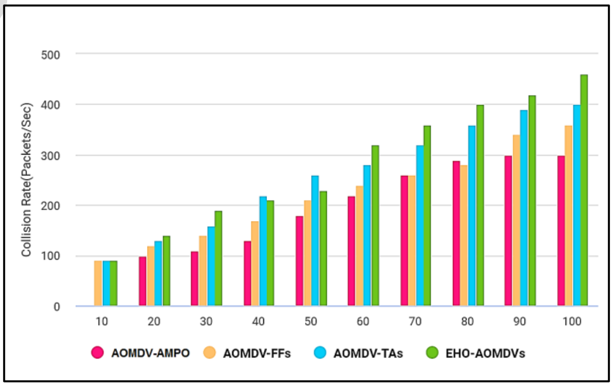

Figure 21: Computation of collision rate vs speed of mobility

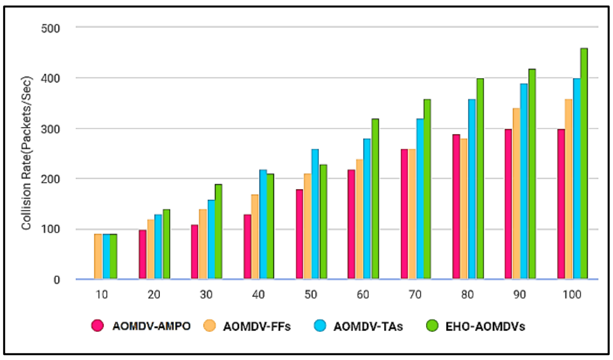

Figure 22: Computation of collision rate vs faulty nodes

5 Conclusions

The rapid rate of mobility of nodes produces data collision, which ultimately results in the loss of packets and has a devastating effect on the performance of the network by reducing its throughput. Random node movement produces unstable linkages and topological change. Additionally, the bottlenecks of the intermediary nodes may experience traffic congestion, which results in data dropouts. Packet retransmission is induced in certain circumstances, which increases the network overhead and overflows the network, exacerbating the traffic issues. As a result, the network's overall lifespan is decreased and the end-to-end delay increases. In this study, we make use of and improve the routes the AOMDV technique returns. The focus of the suggested AMPO technique is on establishing reliable connectivity with minimal PDR and energy consumption to fix the flaw of ineffective cluster system monitoring. We introduced the FF concept, and the communication as a whole is built on FF. The comparison results show that the suggested optimization outperforms the current approaches across the board.

Security must be taken into account in futuristic work with the usage of a confidence aware secure efficient energy navigating model in MANETs by utilising hybrid techniques, and the effectiveness of those algorithms will be analysed by enforcing higher number of security vulnerabilities.

6 Conflict of interest

The authors declare no conflict of interest.

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Arrived: 6.1.2024
Accepted: 22.04.2024