Optimization of Intelligent Transportation System using Biologically-Inspired Vehicular Ad hoc Networks for Achieve the Desired Performance

V.M.Niaz Ahamed[1], Dr.Sivaraman K[2]
[1]Research Scholar
Department of Computer Science and Engineering
Bharath Institute of Higher Education and Research
Chennai-73, India
e-mail: msajce.niazahamed@gmail.com
[2]Assistant Professor
Department of Computer Science and Engineering
Bharath Institute of Higher Education and Research
Chennai-73, India
e-mail: sivaraman2006@gmail.com

Abstract— Many innovations made possible by the Intelligent Transportation System (ITS), such as media apps, encrypted financial transactions, and effective traffic management, rely heavily on vehicular ad hoc networks (VANETs). Using bio-inspired methodologies, This study looks back at the past and forward to the future to examine all of the routing challenges in VANETs, whether they are associated with a chain of related routing tasks or are aimed at a group of distinct approaches to routing. The high node mobility and unpredictable vehicle distribution (on the road) lead to major issues for VANETs, including the design of a network's physical architecture and unstable connections. VANET's provision of reliable and appropriate vehicular contact in situations requiring good service is crucial. As a result, effective means of navigation are desperately needed in VANET. Hence, in this paper, we examine the Bio-Inspired vehicular ad hoc networks (Bio-VANETs), wherein, should a suggested algorithmic network fail at any given node or vehicle, the remaining vehicles may be able to take over the task of relaying the data to the necessary nodes to achieve the desired performance. Route lifetime increases, and connection failures are decreased when the shortest way is selected using the fewest possible hops over highly connected links. In addition, the received signal intensity fluctuations due to vehicle density and speed are assessed. Packet Delivery Ratio, Optimal Performance, Accuracy and Efficiency of Bio-VANET are discussed and simulated against other methods that are existing models.

Keywords- VANET, vehicle distribution, Application of systems, vehicle density and speed, lifetime and routing optimization.

I. INTRODUCTION (AN OVERVIEW OF VANET)

More recent years have seen a rise in driver safety awareness, resulting in the development of tools, cutting-edge technology, and the modification of vehicles. The growth of wireless and mobile networks has been crucial to the success of the Intelligent Transportation System (ITS), which aims to improve road traffic and safety data [1]. Transferring information within source and destination (requester) nodes can be optimized in several ways to increase quality of service (QoS) metrics, including forwarding delay (end-to-end delay), percentage of packet transportation, and many others. This is known as the routing problem in VANET [2]. Due to the dynamic nature of VANET nodes, it might not be easy to define the actions of routing techniques in generating routing pathways that would result in optimum data distribution [3].

To reduce the likelihood of accidents, ITS is often used to monitor traffic conditions, track traffic volumes and congestion, and provide drivers with up-to-the-minute route information. The initial bio-meta-heuristics established a lucrative ad hoc network routing foundation, notably in VANETs [4]. This led to the widespread usage of algorithms drawn from nature for routing throughout the last decade. Customers are informed of security measures and amenities like gas stations, toll booths, and public Wi-Fi access points [5]. Virtual wireless local area networks (V-WLANs) and virtual cellular networks (VCNs) are two networks used in ITS [6]. The first method uses WLANs to link vehicles to the internet. In contrast, the second uses 5G mobile networks to accomplish the same thing by letting vehicles connect to the cellular networks already in place to gain utilization of previously mentioned offerings; in this situation, the geographical area of the base station is marked in Cubicles (cells) [7]. New applications are conceivable in the disciplines of VCN and V-WLAN thanks to packet transmission optimized for low latency and high bandwidth base stations; nevertheless, these systems are underutilized owing to the

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expensive cost of their devices and infrastructures and their less-than-ideal placements [8].

For VANET (vehicular ad hoc network) communication to be successful, many moving elements must cooperate. However, keeping everything in mind while practicing it isn't easy. VANETs are a transition to a multi-hop network architecture. The plan is to install mobile transceivers in vehicles so that they can exchange information with one another. These communications are the lifeblood of vehicular ad hoc networks (VANETs) and are called V2V interactions [9]. The term "vehicle-to-infrastructure" (V2I) describes the exchange of information between moving cars and fixed structures along roads. Scheduling and transmission methods in VANETs have been the subject of extensive research [10].

In a VANET setting, a vehicle may try to alert an approaching vehicle by sending a broadcast packet to every node in the network. Therefore, a reliable transmission algorithm is crucial in VANETs [11]. Energy is not a limiting factor with VANETs because of the big battery, as moving vehicles may top off their power supplies. Topology-based, geography-based, and cluster-based protocols are only a few examples of the many types of meta-heuristics used to categorize VANETs [12]. Given the current trend toward using optimization methods inspired by nature to solve np-hard challenges, our survey provides a snapshot of the current state of the art in bio-inspired VANET routing as a starting point for predicting the active research topics into which greater investigation could lead to advancements in routing excellence. After addressing the proliferation of bio-inspired routing implementations and classifying their current state, this research deduces which routing problems have reached a saturation point [13].

The network's efficiency declines due to these inconsistencies, and the connected vehicles' range, latency, and connection is substantially impaired. Fast-moving vehicles (on highways) can degrade network performance and even break radio connections [14]. This is the case since handoffs, message dropouts, and poor communication between vehicles reduce the transmission range. Since every vehicle in a V-WLAN or VCN needs to be connected to an access point, the overall cost of an ITS system is significantly increased. Wireless nodes provide cost-effective solutions with the operator's data transfer packages [15]. Since broadcasting to every car at once is more difficult due to the constraints of the vehicular network, unicast and multicast communications are viable. A new type of network, the vehicular network, was developed in response to the limitations above and the need for enhanced reliability and mobility [16,17].

There are many vehicle communication apps, and they all affect drivers' safety and convenience in different ways. Both geo mode and broadcast transmission may be utilized for vehicle-to-vehicle communication using ITS security systems, with the former being the more secure option. Traffic management, accident reporting and prevention, and ecological control are only some ITS services offered by organizations that don't focus on mobile technology [18,19,26]. Businesses often employ unicast mode in their VRC (Vehicle-to-Roadside Communication) ITS program when transferring sensitive information. For instance, ITS-enabled cars may have enhanced capabilities for detecting and avoiding crashes, assisting other drivers, and providing location descriptions. People are better able to avoid possible crashes and take other precautions when these vehicles are transported and handled securely. Correctly transmitting a broad range of security warnings requires up-to-date, accurate, and useful data. Drivers might make better decisions or choose other routes if they had early notice of heavy traffic, a catastrophic occurrence, or a fire.

The following are the most significant results of this research:

- Biologically inspired vehicular ad hoc networks (Bio-VANETs) allow for data relay by other vehicles in the event of a node or vehicle failure in the original algorithmic network.
- Selecting the shortest route utilizing the fewest possible hops over highly linked links increases route lifespan and reduces connection failures.
- Bio-VANET's optimal performance, accuracy, and efficiency are simulated versus other approaches, and the success ratio is reviewed.

The paper's outline looks like this: VANET is introduced in Section 1, and then research on its environment is covered in Section 2. Bio-VANETs propose the possibility of data relay by other vehicles in the event of a node or vehicle failure in the original algorithmic network, which is given in Section 3. Sections 4 and 5 wrap up this research article with visual representations and conclusion

II. BACKGROUND RESEARCH

Cognitive sensor networks are supported by artificial neural networks, genetic algorithms, and even virtual agents to help create programs and well-informed judgments. This is a major progress in the last few years. No unified node- and app-agnostic architecture for incorporating intelligence into IoT-enabled sensing devices exists.

Previous work by Azzoug, Y. et al. [20] is summarized in this paper to provide a future overview of all routing problems (RP- VANET) in vehicular ad hoc networks (VANETs) that concern either closely related routing tasks or aim to achieve a set of diverse techniques in this area by drawing inspiration from biological systems. We propose a grouping for major VANET routing complications based on their nature, investigated range, and metaheuristic types used for their optimization, and we use this to serialize, in a concurrent investigation, the evolution and tendencies of the solution to the VANET routing issue together with the development of different classes of nature-based meta-heuristics.

Husnain, G. et al. [21] demonstrated the presence of cluster formation (CF) in vehicular communication by using a bio-inspired, cluster-based algorithm for routing, especially the bright, probability-based, and nature-inspired whale optimization algorithm (p-WOA). The level of uncertainty was reduced by adjusting the fitness function to consider the probability of certain factors. These variables were network size, node count, trip time, and direction. Packet Delivery Ratio (PDR) calculations and average throughput and delay measures show that the suggested method is preferable to the status quo.

Joshua, C. J. et al. [22] put forward that as the number of nodes [NN] in a VANET grows and their distribution of vehicles (on the road) becomes more uncertain, the network's adaptability and speed decrease and serious problems arise. Due to these obstacles, it is hard to have robust, dependable, and scalable vehicle communication, especially in urban traffic networks. Several studies have found that problems associated with VANETs can be nearly eradicated by employing strategies borrowed from nature and evolution. This delves into using evolutionary algorithms for MANETs and VANETs (vehicular ad hoc networks).

According to the research of Aggarwal et al., [23] VANETs, or vehicular ad hoc networks, are an inspiring tool for attaining the inter-vehicle communication required by the Intelligent Moving System [IMS]. VANET is useful because it connects drivers with the reliable vehicles, they need to give high-quality service. Therefore, reliable methods of navigation are very important in VANET. More than 400 bio-inspired algorithms exist to address the many challenges ad hoc networks present. Expertise networks like the Vehicular Ad Hoc Network use moving two- or four-wheeled vehicles as nodes to generate random network traffic. The path may be made available with minimal downtime, and performance can be evaluated using various biologically inspired techniques.

Ramamoorthy, R. et al. [24] implemented an improved bio-inspired routing algorithm (EBIRA) to ensure stable communication. Based on distance, received signal strength meter, hop count, and evaporation rate, improved ant colony optimization (EACO) in EBIRA discovers the ideal long-life short-distance routes with the fewest hops. Short distance and high link-level connectivity with the fewest possible hops characterize the EBIRA-selected path. If you want your route to last as long as possible and have fewer interruptions in communication between cars, prioritize short hops on well-connected lines. According to the simulation results, EBIRA outperforms RDACO and RAGR regarding the proportion of packets delivered, throughput, and delay.

The use of conventional techniques such as RP-VANET, CF, NN, IMS, and EBIRA exacerbates the problems with the current model. Bio-VANETs have been offered as a secure and efficient way for optimizing success ratio and other criteria; details on energy usage are supplied. In this article, we will briefly go over the proposed model.

III. BIO INSPIRED VEHICULAR AD HOC NETWORKS(BIO -VANET)

Optimization solutions for addressing hard, np-hard, and np-complete optimization issues may be found in the bio-inspired approaches of metaphor and nature-based metaheuristics. When there are too many alternatives to find the global optimum in a practical period, we have an intractable issue in optimization. When there are many different solutions to a problem, picking the best one is difficult since solving such a problem takes an exponentially increasing time as the issue's dimension rises.

Instead of being tailored to a particular issue, bio-inspired approaches and metaheuristics draw inspiration from natural or human-created events. As these methods make no assumptions about the optimization problems they are attempting to solve, they apply to various np-hard optimization problems. With its clever stochastic search techniques, metaheuristics may approach an ideal solution quickly. Remember that some metaheuristics perform better on certain optimization problems than others.

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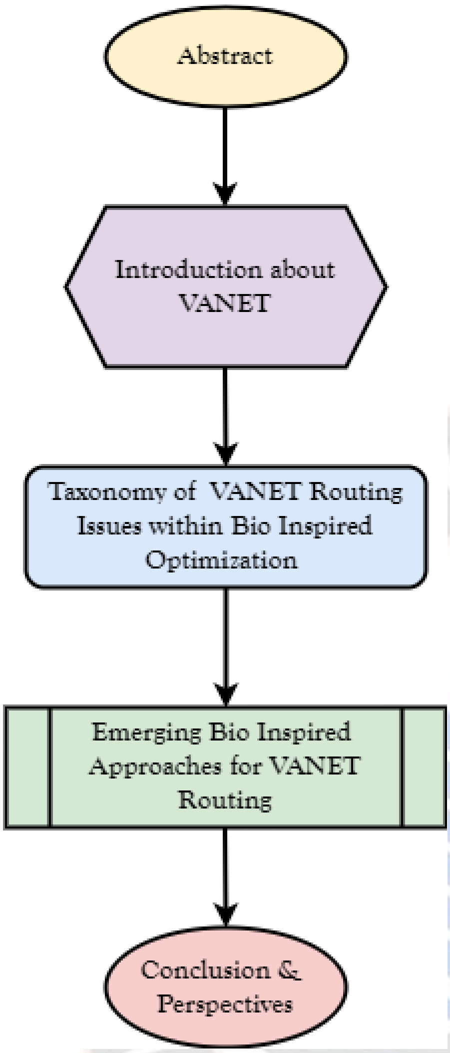

Figure 1. Methodology flowchart

The development of this survey is depicted in Fig. 1, an organizational flowchart. After addressing the proliferation of bio-inspired routing implementations and deducing which ones have reached a saturation point, this research identifies which routing issues are most heavily challenged. This sheds light on how bio-inspired techniques can be implemented in VANET routing. In this paper, we present our proposed system for categorizing VANET-based routing problems, dividing them into classical and modern subcategories according to their historical development as shown by realized contributions and the progress reported by carried-out metaheuristics, and elaborating our proposal with notable contributions. This section explains why swarm-inspired optimization techniques have recently gained popularity as a means of improving VANET routing. A suggested taxonomy of bio-inspired optimization methods is presented to classify the many approaches to address routing challenges in VANETs.

$$O_{VM} = \sqrt{(a_y - b_y)^2 + (c_z - d_z)^2} + \frac{a_y}{c_z} - \frac{b_y}{d_z} + VR \qquad (1)$$

Optimal vehicle management O_{VM} is represented by (1), where VM is defined as $(a_y, b_y), (c_z, d_z)$, and where VM is the vehicle management, and VR is the vehicle ratio. The above Equation allows for more accurate data analysis than most other models.

$$I - b_1 + b_1F_1 \geq 0 \qquad (2)$$

$$VD = \begin{cases} a < b_1 - \emptyset_1F_2 \\ a < log\ \frac{b_1+\emptyset_2F_2-\emptyset_1F_1}{1-b_1} \end{cases} \qquad (3)$$

Equation (2) collects the biological data sets of the correction factor for the vehicle terminal in the development learning system for the network, and Equation (3) shows the variable parameter for vehicle development. User input is represented by I, the biasing condition by b_1, and the fuzzified outputs by F_1 and F_2. Each time interval's waiting factor is designated by the subscripts 1 and 2. The symbol for the standard deviation is $\emptyset_1$.

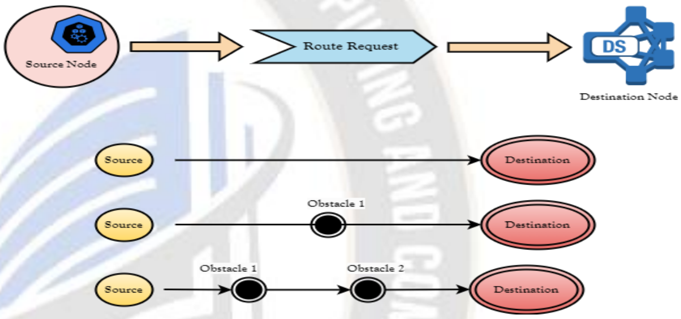

Figure 2. Route in a VANET

Fig 2 depicts one of the initially developed bio-inspired addresses to maximize VANET routing assistance. It is inspired by the source's ability to trace adaptive pathways from its nest to reports, and this inspires the use of request packets to locate optimal routes between data sources and destinations while accounting for the mobility of nodes. Bio-inspired metaheuristics sought to alleviate some of the issues associated with ad hoc routing by using many mobile nodes to provide stable and reliable routing pathways with decreased dissemination delays and packet losses. The obstacles 1 and 2 are shown as source to destination is specified. The source node to the destination node is mentioned per the route request.

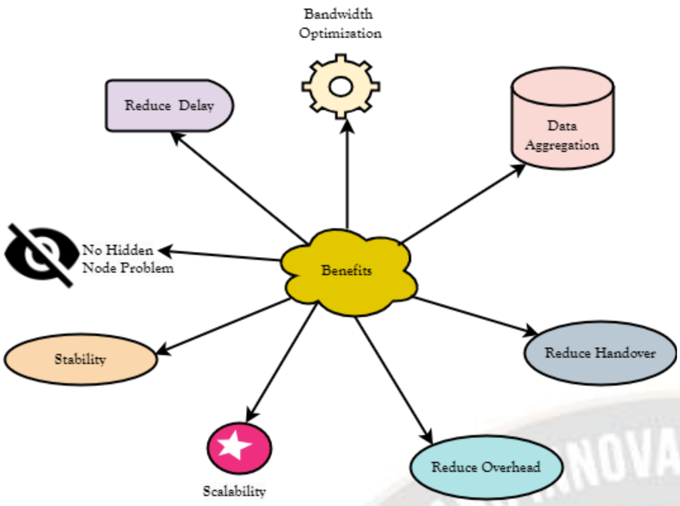

Figure 3. Benefits of Cluster Optimization for VANETs

As shown in Fig 3, clustering optimizations have many advantages, such as ensuring a steady network topology, collecting and organizing data, reducing the number of clusters, increasing bandwidth, and facilitating smooth handovers. The in-vehicle network clustering optimization problems are NP-hard; however, bio-inspired techniques like metaphor and natural metaheuristics can help. However, the metaheuristics processes or biologically inspired techniques are 100% accurate. The methods presented here are inspired by phenomena observed in the actual world. Many NP-hard optimization problems can be tackled with these methods, and expert knowledge of the underlying subject is unnecessary. When combined with effective search algorithms, metaheuristics can rapidly determine the best solution. The problem of routing in a VANET has been proven to be NP-hard. Several CBR strategies rely heavily on clustering algorithms. These optimization efforts become less necessary as cluster stability improves. Despite being an NP-hard problem, cluster stability can be improved using metaheuristics, particularly bio-inspired optimization techniques.

$$E_{CF} = E_{CF}(\,TPC * (E_{Tx})) - \log\,(E_{Rx}) \qquad (4)$$

In above Equation (4), where E_{CF} is the cost function for energy usage, showing that most energy bills are attributable to data transmission. The transmitted packet count (TPC), the energy needed to send those packets ((E_{Tx}), the received packet count (R), and the energy used to receive those packets (E_{Rx}) are all displayed.

$$N_{\emptyset,t} = V_{\emptyset_{a,t}} + TVB_t + r_{U\emptyset,t} - \frac{WR}{2} + RF \qquad (5)$$

Equation (5) yields navigation as$N_{\emptyset,t}$, where $V_{\emptyset_{a,t}}$ stands for velocity, RF stands for the reference frame, $r_{U\emptyset,t}$ stands for reusing, TVB_t stands for time-varying basis. When the above Equation is used up, security is greatly improved.

$$A_{\emptyset,t} = (\,N_{a_t} - N_{b_t}) + D_t + s_{b,t} \qquad (6)$$

Accelerometer readings are represented by $A_{\emptyset,t}$ where ($N_{a_t} - N_{b_t}$) from the navigation part a to the sensor part b are given by the Equation above (6). D_t is the distance of the vehicle moved apart, $s_{b,t}$ be the speed of the vehicle taken into consideration.

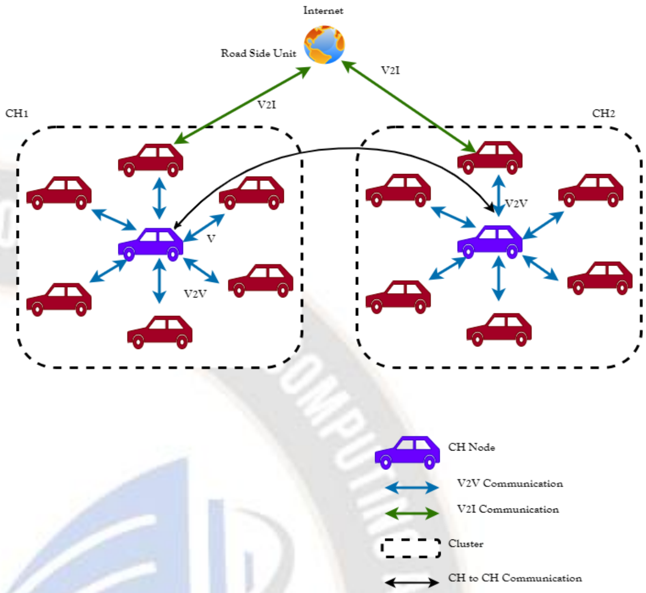

Figure 4. Assembly of VANET Clusters

The assembly of VANET Clusters is depicted in Fig 4 as shown above**.** The presentation was made more convincing according to the 1/5 Principle's input of the annual rate of population increase, which led to gradual adjustments in areas such as assembly precision, velocity, and control. It's a more sophisticated routing technique for QoS-equipped vehicular networks. This method is based on the most significant traits of pride and improves vehicle QoS pathfinding by movement from local to stronger networks. It was proposed as a solution for routing in VANETs. The best path was found by modelling water-wave properties and factoring in QoS needs, collision risks, and network congestion. It was a failsafe backup routing system deployed exclusively in extreme circumstances, and it bolstered the integrity of communications between individual nodes and between individual networks. Imitating bee behavior has been suggested to boost VANET multicast routing efficiency. The Algorithm found the best multicast tree between the sender and the recipient by existent paths that make the most efficient use of bandwidth while keeping costs and time to a minimum. This algorithm solved the scalability problem of VANETs. It reduces the number of clusters while keeping CH stable, putting less stress on the underlying network. This method was previously used to ensure a long cluster lifetime and an optimal CH number, which are fundamental features of a resilient network. The moth's ability to follow its flight path by viewing

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the moonlight inspired this idea. A moth monitors the location of the fiery space object and reports any changes.

$$OMF = \sqrt{\frac{SF_n \sum_{x=0}^{N} e^{-V_2(W-\propto)^2}}{1-\log n * e^{-T_2(W-\propto)^2}}} \quad (7)$$

V_2 Represents the optimization variable of interest. SF_n is the symbol for the scaling factor. W stands for the weight function, while $\propto$ stands for the average value. The vehicle development learning system's regulating objective functions are optimized using a numerical optimization approach. The above Equation (7) shows the optimized function. The corresponding algorithmic structure for bio-inspired model has been given below:

Algorithm.1.BIO INSPIRED MODEL

Input $a_y, b_y, c_z, d_z, N_{a_t}, N_{b_t}, D_t, s_{b,t}$

Output $O_{VM}, VD, E_{CF}, A_{\emptyset,t}$

Step:1 $O_{VM} = \sqrt{(a_y - b_y)^2 + (c_z - d_z)^2}$

$$I\ difference\ b_1 or b_1 F_1 \geq 0$$

Step-2 $VD = \begin{cases} a\ lesser\ \ b_1 difference\ \emptyset_1 F_2 \\ a\ lesser\ log\ \frac{b_1+\emptyset_2 F_2 difference \emptyset_1 F_1}{1 difference b_1} \end{cases}$

Step-3 $E_{CF} = E_{CF}(TPC * (E_{Tx}))$

$$N_{\emptyset,t} = V_{\emptyset_{a,t}} + TVB_t$$

Step-4 $A_{\emptyset,t} = (N_{a_t} - N_{b_t}) + D_t + s_{b,t}$

- **Initial Step:** Superior Car Control VM is the vehicle management, and VR is the vehicle ratio, therefore O_{VM} is represented by (1), where VM is $a_y, b_y, c_z, d_z, N_{a_t}, N_{b_t}, D_t, s_{b,t}$
- **Step 2:** Compared to other models, the above Equation provides more precise data analysis. Above, we see that data transmission accounts for the bulk of energy costs (Equation 4), where E_{CF} is the cost function for energy.
- **Step-3:** The total number of packets sent (TPC), the total amount of energy expended sending those packets(E_{Tx}), the total number of packets received (R), and the total amount of energy expended receiving those packets.
- **Step-4:** using equation (5), we can derive the navigation as $N_{a_t} - N_{b_t}$ where the velocity and the reference frame is the time-varying basis. Increased safety results from using the following equation until it is exhausted.

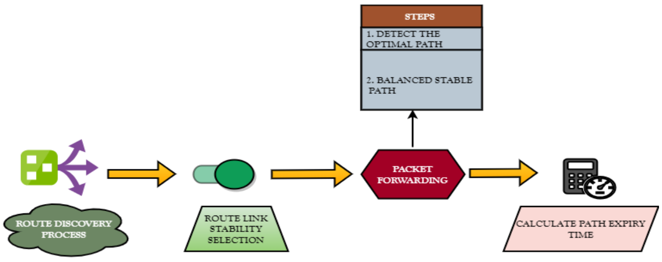

Figure 5. Path Optimization Procedures

Path optimization and its steps are depicted in Fig 5. The initial part of the process is called "route discovery," which entails looking for nodes along the path. After determining the overall stability of each node, packet forwarding proceeds to the next phase, route link stability selection. In essence, two additional processes are considered. Finally, the expiration time and the specified set of nodes are computed when they have identified the best route and achieved path stability.

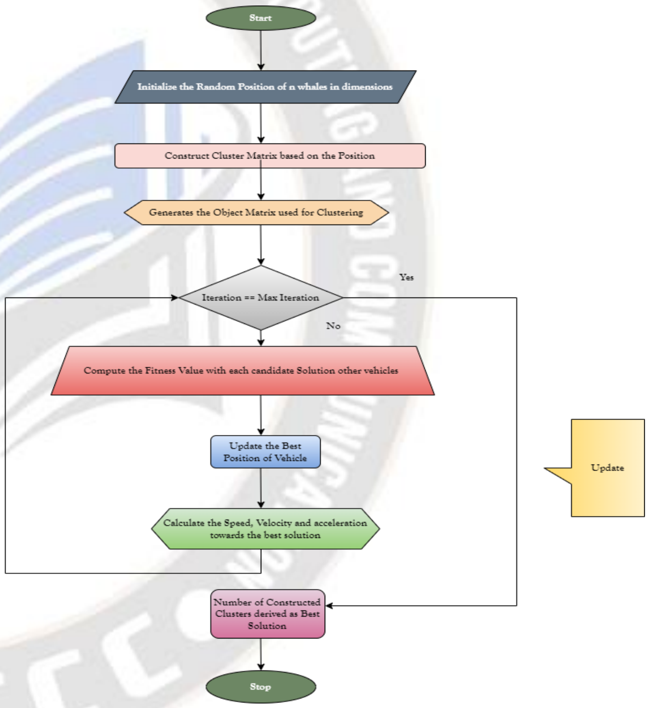

Figure 6. Methodology Construction Framework

To meet all the crucial needs for data transfer, routing protocols may need to focus on a specific region or depend on a small number of parameters. Considering the time and resources required to run such a simulation, this study proposes a smart cluster optimizing approach focusing on all these ITS provides by statistically placing roadways with one automobile and growing a maximum of vehicles to 100. Data messages' optimal pathways through the network were optimized using a clustering technique inspired by probability theory. The proposed framework, focusing on inputs and outputs, is depicted in Fig 6. The proposed structure functions as follows:

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Representation: The representation defines the individuals that make up an evolutionary algorithm.

Evaluation Function: Finding a fitness function, sometimes called a maximized function, is a crucial first step in facilitating progress. This cutoff value must be reached to validate a solution as valid.

$$S_T = ((1 - P_B) * (1 - F_T) * (1 - P_D)) \quad (8)$$

From the above Equation (8), S_T is the probability of a successful transmission over the channel, P_B is the probability of a packet being blocked, F_T is the probability of a failed transmission over the channel, and P_D is the probability of a packet being discarded after infinite retries.

Population: This set incorporates all feasible answers.

A System for Choosing Parents: These pinpoint answers can become the basis for future generations or act as parental figures.

Operators for Variations: Mutations and rearrangements, two types of variation operators, were utilized to identify and isolate the unique solutions.

Methods of Choosing: This operates similarly to parental selection, except it takes place in the next evolutionary cycle once the candidate solution has developed to a point where it can be evaluated.

Optimal Remedy: A cluster leader may be chosen by considering the impact of the fitness functions on the best Packet Delivery Ratio, the least latency, and the greatest average throughput.

Algorithm.2. Optimal Routing Data Transfer:

Initialization of freeway traffic by generating a random mesh of vehicle placements and speeds. The above mesh requires uniform settings for all car search agents.

Establish the appropriate distance between vehicles.

While I = I ≤ 300 , I -> Iterations

For Nodes j = 1 to 100, do

All Nodes in the Data Set Used for Clustering

(Nodes for clustering! =empty) while

Determine the probability that each node was chosen

CH = Picking a Roulette Number; it's feasible to use any node in a cluster

Tour, Append, and Node (CH)

Find CH neighbors = CH neighbors found.

(Cluster Nodes) = (Cluster Nodes) –CH

Cluster Heads (CH) = Cluster Nodes (Nodes) - CH Heads

End While

Nodes i. price = (Node i.tour) / 10

Only If (Nodes i. Price < Optimal Cluster. price)

Optimal Cluster = Nodes i

Nodes i++

End For

Output: CHs = Optimal Cluster

As inferred from the above algorithm.2 At the beginning of each cycle, the automobiles either use a specific vehicle to boost their standing or use a probabilistic strategy to find the best potential configuration. Dropping the "a" value from 2 to 0 is required to enable searching and identification of individual cluster heads. If the probability function |A| is larger than 1, it will choose the most erratic vehicle, and if it is less than 1, it will choose the best rearrangement configuration.

Tabulation 1:

No. of Dataset	RP-VANET	CF	NN	IMS	EBIRA	Bio-VANET
10	35.35	31.51	41.38	42.13	47.92	70
20	26.95	78.12	70.25	47.13	37.45	86.15
30	18.78	33.06	65.26	34.17	17.86	78.28
40	32.45	61.29	74.24	55.99	45.74	60.78
50	30.74	25.15	31.05	23.56	12.85	86.3
60	50.77	45.09	57.11	42.32	61.45	65.56
70	57.89	57.54	48.74	77.49	45.78	77.49
80	51.98	69.14	35.66	29.74	40.15	84.77
90	42.66	38.63	36.57	37.49	36.18	93.44

The above tabulation 1 compares existing methods with the proposed method for the different number of datasets considered.

This research uses a model of the Internet of Things optimized for protocol and security analysis to show how bio-inspired vehicular ad hoc networks (Bio-VANETs) work. Bio-VANET's optimal performance, accuracy, and efficiency are simulated versus other approaches, and the success ratio is reviewed.

IV. RESULTS AND DISCUSSION

Here, we provide numerical findings for variations in a given quantity of nodes across various configurations, network size, inter-node distance, and load distribution across nodes. It has been proposed that bio-inspired vehicular ad hoc networks (Bio-VANETs) can improve data privacy, routing, and security without resorting to the most circuitous route. Using this simulation analysis tool, the suggested Bio-VANETs scheme was evaluated. See how this section defends against several other popular models in the graph below (including RP- VANET, CF, NN, IMS, and EBIRA). The sampling procedures for this research are detailed in Table 1. And the experiments are analyzed based on the datasets [25].

Tabulation 2: The Analytical Data Set

No	Information	Content
1.	Sum of users	10,20,30,40,50
2.	For Clients	10,20, 30,…90
3.	The total amount of samples	90
4.	Instructional Material Samples	80%
5.	Initial Evaluations	70%

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Based on an Internet of Things perspective, this technique can be used to assess the safety of routing protocols. This research made use of information obtained from a for-profit organization. The entire data set is shown in Table 2.

4.1 Packet Delivery Analysis**:**

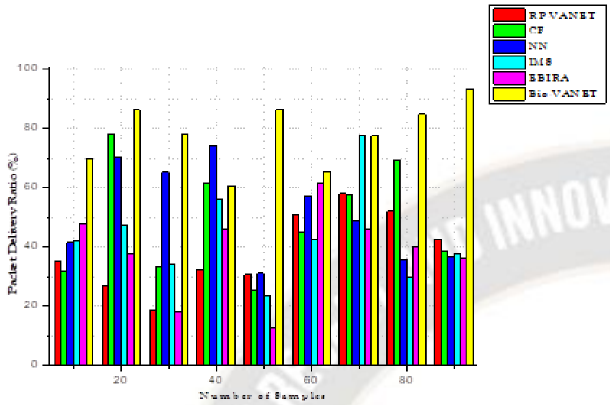

Figure 7. Packet Delivery Analysis

The above Packet delivery analysis ratio was used to examine the findings. Fig 7 shows the percentage of successfully delivered packets against the number of samples along the x-axis. Compared to sending fewer packets at a slower rate, sending more packets in a shorter time yields better results. Packets sent via a certain method must reach their destination within a specified time window. The proposed Bio-VANET model is superior to all existing approaches.

4.2 Accuracy Analysis:

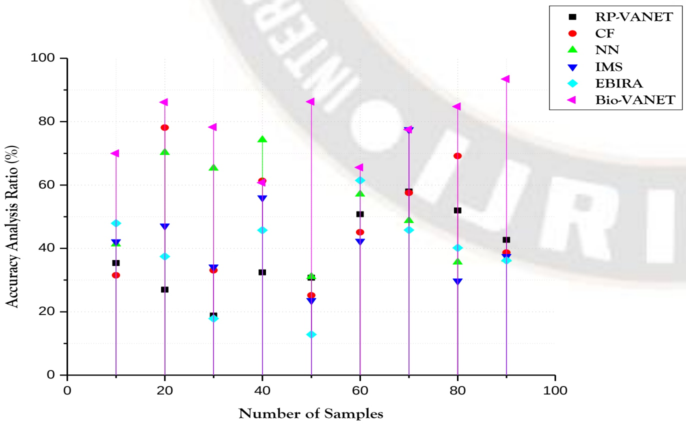

Figure 8. Accuracy Analysis

The safeguards against accuracy analysis ratios for samples are depicted in Fig 8. Data transmission accuracy is higher than any other method currently in use. To prevent data degradation caused by infiltration, the data must be transmitted via a network with minimal noise. Data transmission accuracy is improved over state-of-the-art methods.

4.3 Security Analysis:

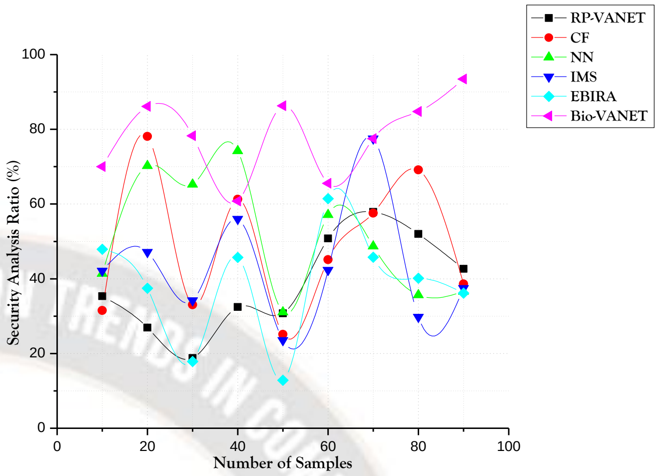

Figure 9. Security Analysis

Protecting samples from ratios used in security analyses is depicted in Fig 9. Bio-VANET transmits data more securely than any other technique now in use. For the data not to degrade as a result of an intrusion, it is crucial that the network it travels over be as noise-free as feasible. Data transmission security is improved over what is currently available. The x-axis represents the total number of samples, while the y-axis displays the percentage of secure data for each sample. Multiple methods compare the samples; Bio-VANET stands out as the most useful.

4.4 Efficiency Analysis:

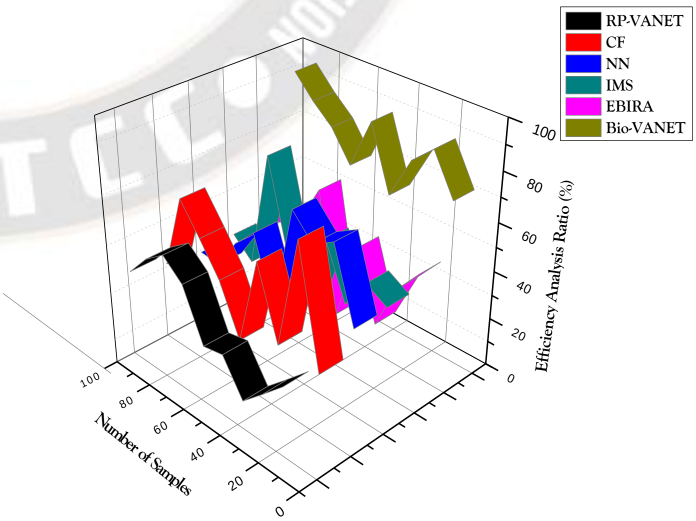

Figure 10. Efficiency Analysis

The data was analyzed for efficacy once samples were collected. Fig 10 displays the results of the effectiveness analysis. The efficiency analysis ratio is plotted against sample size on a graph. Using the dataset, data may be transferred more efficiently than ever before. An analysis of a content strategy for efficient data analysis associated with progress allows for producing outcome forecasts.

4.5 Performance Analysis:

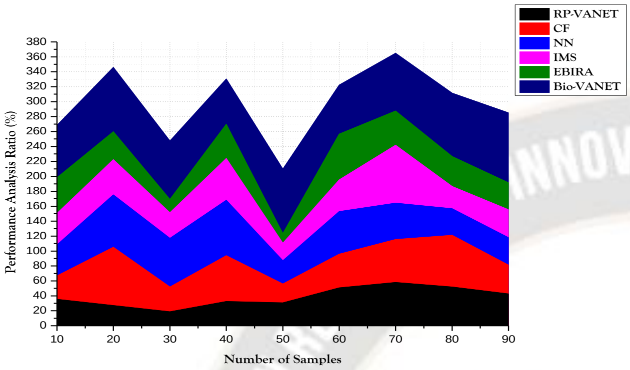

Figure 11. Performance Analysis

Figure 11 shows how useful performance reviews are taken into consideration. The x-axis shows a variety of performance analysis ratios, and the y-axis displays the total number of samples. Therefore, to put each hypothesis to the test, we gathered samples at varying ratios. With the assistance of Bio-VANET, this model transmits a higher standard of goods than existing ways.

4.6 Change in traffic:

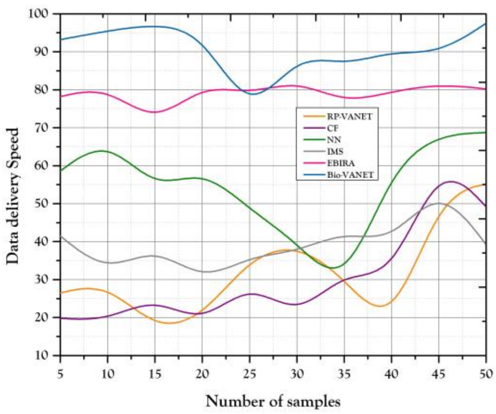

Figure 12a: Data delivery speed

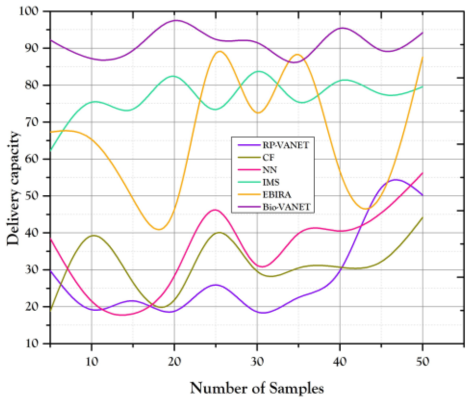

Figure 12b: Delivery capacity

This section of the speed research aims to maximize data delivery to the target using the five protocol routes: RP-VANET, CF, NN, IMS, and EBIRA. Still, we'll adjust the network's load to watch how the three programs respond to the new conditions. The quantity of traffic generated is compared across the five routing strategies in Figure 12a. RP-VANET, CF, NN, IMS, and EBIRA are all seen in Figure 12b, receiving comparable quantities of traffic. Bio-VANET once outperformed RP-VANET, CF, NN, IMS, and EBIRA regarding delivery capacity because of its superior adaptation to network mobility.

4.7 End-End delay:

Table 1: End-End delay

No of Samples	Bio-VANET	CF	NN	IMS	EBIRA	RP-VANET
5	39.3	49.3	60.6	61.3	65.5	82.2
10	49.4	39.3	56.6	64.2	71.2	81.3
15	46.3	50.3	65.3	43.8	64.2	81.4
20	44.5	42.2	60.7	52.9	68.9	89.6
25	21.5	15.8	29.3	42.1	69.3	90.2
30	28.6	24.9	36.2	58.9	69.5	84.3
35	19.3	29.3	39.4	58.7	62.1	89.6
40	49.3	39.5	45.8	64.4	77.3	87.2
45	56.3	29.7	39.5	59.3	65.8	86.7

50	42.2	62.2	59.4	69.7	72.5	89.6

The latency of a network connection from beginning to finish is known as the end-to-end delay. The whole time it takes for a packet to travel from its origin application to its destination application is known as its end-to-end delay. The total latency may be calculated by averaging the bit lifetime per Packet. End-to-end latency from the source node to the gateway is compared in Table 1 for RP-VANET, CF, NN, IMS, and EBIRA protocols. Bio-VANETs route state information aids nodes in making the most time- and resource-efficient path selections.

Compared to the current RP-VANET, CF, NN, IMS, and EBIRA, Bio-VANET outperforms them all. In light of the rivalry above, the article indicates that this Bio-VANET is being constructed to improve data security and efficiency.

V. Conclusion

In this paper, we suggest a Bio-VANET as a means by which VANETs can maintain stable lines of communication. In the suggested model, the number of pheromones is used to determine which of several possible short-distance routes has the fewest hops. Distance, received signal intensity, hop count, and evaporation rate are all considered to keep the pheromone count steady on short and high signal strength lines. An optimal route selection process selects the path with the fewest hops along links with a high connectivity level to maximize route lifespan and lessen the frequency of link breaks between vehicles. In this review, we shed light on the most pressing issues surrounding vehicular ad hoc routing and the protocols designed to address them, providing context for how these issues first arose and developed over time. The contributions to VANET routing that have been realized, from classical to bio-inspired works, are described in increasing detail, with the solutions achieved using nature-inspired metaheuristics being presented last. This paper provided a broad review and perspective on recently proposed metaheuristics from the field of artificial intelligence that may help improve VANET-born routing under certain conditions and presumptions. By shedding light on the pre-existing realizations crafted using bio-inspired approaches, this study may serve as a reference categorization of routing difficulties in VANETs. We classify these issues as either having been addressed previously or as being in the process of being addressed currently. The taxonomy of bio-inspired optimization algorithm combinations is laid bare for in-depth research to improve VANET routing beyond what is possible with conventional metaheuristics. Common uses include parallel optimization techniques and hybridized metaheuristics. This article provides a global guide to improving VANET routing quality by applying optimization methodologies inspired by nature by tracing the development of what has already been achieved and highlighting the remaining obstacles to be satisfied in developing vehicle routing systems influenced by biology. Through a review of the foundational studies conducted in this area, the most pressing challenges have been isolated. Implementing such systems within mobile ad hoc networks is still in its infancy. The rising computational power of interconnected digital systems will soon make more complicated and scattered development algorithms possible. In the future, VANET research geared toward environmental sustainability will be of the utmost importance.

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