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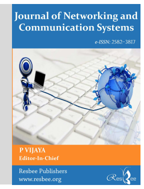


# Hybrid Butterfly Optimization and Particle Swarm Optimization Algorithm for Video Transmission in VANET

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**Abstract:** In Vehicular Ad Hoc Network (VANET), the communication amid the vehicle plays an important role in the enhancement of security in dangerous circumstances of road cases. The video transmission to other vehicles with the VANET implementation is performed in an enhanced manner. In this work, a novel hybrid method named the Butterfly Optimization (BO)- Particle Swarm Optimization (PSO) algorithm is adopted in order to decide the optimal multipath for the video transmission from one vehicle to another in the VANET network. At first, VANET has experimented as well as the optimal multipath is selected and it is performed by exploiting the adaptive geographic routing model on basis of fitness metrics. The adopted model performance is calculated using the measures namely, Packet end-to-end delay, Packet Delivery Ratio (PDR), as well as throughput. The proposed method yields the least end-to-end delay, as well as utmost PDR and throughput that exhibit the advantage of the proposed technique in efficient video transmission.

**Keywords:** Optimization, Packet Delivery Ratio, Routing Model, VANET, Video Transmission.

***Nomenclature***

| Abbreviations | Descriptions |
|---|---|
| **VANET** | Vehicular Ad Hoc Network |
| **BO** | Butterfly Optimization |
| **PDR** | Packet Delivery Ratio |
| **PSO** | Particle Swarm Optimization |
| **MIMO** | Multiple Input Multiple Output |
| **DSR** | Dynamic Source Routing |
| **ACO** | Ant Colony Optimization |
| **FMO** | Flexible Macroblock Ordering |
| **AODV** | Ad Hoc On-Demand Distance Vector |
| **MDC** | Multiple Description Coding |
| **En-AODV** | enhanced model of AODV |
| **g-MMDSR** | game theoretic-Multipath Multimedia Dynamic Source Routing |
| **DYMO** | Dynamic MANET on demand |
| **FEC** | Forward Error Correction |
| **GA** | Genetic Algorithm |
| **MAC** | Medium Access Control |

## 1.Introduction

VANETs are amid the up-and-coming network paradigms that aid secured measures and improve data transfer with improved effectiveness. VANET applications comprise warning of collision, warning of pre-crash, warning of an emergency vehicle, and warning of traffic circumstance and notification of hazardous position. For VANETs the important suggestion is illustrious to offer verification and trust. It is required to describe the routing as well as data dissemination approaches to enable the VANET applications. The routing problem is a challenging task although vehicles travel within set lanes. For a vehicle to enhance the safety metrics on highways, method named customizing channel access probabilities was presented [1].



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To improve video streaming quality by VANET issue, it is required to present an appropriate routing protocol for the VANET. Few routing protocols namely DSR, DYMO, and AODV were presented for the MANET routing were exploited to the VANET routing. Although these protocols have ensued in a better performance they possess unsuccessful to alter to delay happening because of data packets transmission. For the VANET, in order to develop the appropriate routing protocol, it is necessary to connect the topology beside network factors [13]. In some recent works, the Particle Swarm Optimization [14] and ACO were used to develop for the VANET, and few pieces of research were adopted for communication the Geographic Routing Protocol in VANET [2].

In mobile video streaming applications, there is a current trend to exploit MDC in few studies. In multi-source video streaming, the MDC is considered via VANET. Hence, spatial decomposition was exploited by means of the checkerboard's FMO, an H.264/AVC error resilience approach. MDC on the basis of H.264/AVC was combined with MIMO transmission exploiting numerous antennas to improve train to wayside video transmissions in tunnels. For a wavelet coded multi-stream video transmission, a cross-layer method over multihop wireless networks [3].

The main contribution of this work is to propose an effective method for video transmission in VANET from one vehicle to other vehicles to protect the vehicles from dangerous circumstances which happen on highways. At first, VANET is experimented with to decide the count of routes for video transmission with adaptive geographic routing models. By exploiting the newly adopted method, the multiple paths are revealed that are attained from the combination of PSO and BOA technique. Using the proposed model, the fitness metrics are computed based upon several metrics like distance, delay, as well as QoS parameters. To transfer the videos, the optimal multipath having the least distance, delay, and fulfilled the QoS is chosen. By exploiting the HEVC encoder, the video is encoded as well as the transmission packet is performed using the multipath which is optimally chosen.

## 2. Literature Review

In 2018, Shivaprasad More and Udaykumar Naik [1] focused on both the multi-hop routing and urgent data dissemination by means of choosing the optimal data disseminator as well as the trustworthy forwarder. For a user request, this paper comprises effective video transmission.

In 2018, Shivaprasad More and Udaykumar L. Naik [2], proposed a multipath routing technique for video transmission by exploiting the optimization method. To encode the HEVC, the encoding method was used because the video files were large to make a bitstream. Subsequently, the probable paths among the sender and receiver were identified. For video transmission, this paper uses the GA method to choose the optimal multipaths from the path. The bitstream was transferred subsequent to the optimal multipath recognitions via the multipath to attain the destinations.

In 2019, Shivaprasasd More et al [3], worked on the VANETs multipath routing. Here, the routing protocols such as distance-based routing as well as location-based routing were strongly exploited. To recognize the optimized path amid the multipath environment was an important monotonous task to finish. By exploiting few meta-heuristic approaches, multipath routing optimization was attained. Hence, this work exploits the multi-hop environment to choose one path between numerous paths by exploiting the GA.

In 2011, Mónica Aguilar Igartua et al [4], developed a method named called g-MMDSR that comprises a game-theoretic model with a cross-layer multipath routing protocol to attain a dynamic selection of the forwarding paths. The proposed method searches to enhance the individual advantages of the users when by exploiting the general scarce resource effectually. Here, the video frames' significance was considered in the decoding procedures that were better than the received video quality.

In 2017, Boubakeur Moussaoui et al [5], developed an En-AODV protocol it was exploited to tackle the routes unsteadiness problem in VANETS. In the link, En-AODV leverages cross-layer information was integrated by means of ultimate destination knowledge of destination vehicle to set up high stable routes. The attained experimentation outcomes verify the En-AODV effectiveness and spotlight its superiority against AODV in several measures and cases.

In 2019, Mohamed Aymen Labiod et al [6], proposed an innovative cross-layer system to enhance attained video quality in vehicular communications. In an MDC technique, the system was minimum complex. Finally, it was on the basis of an adaptive mapping model and it has experimented with in the IEEE 802.11p standard MAC layer.

## 3. VANET system model

For stipulation of V2I as well as V2V communication, VANET is considered an extraordinary example of MANET. One of the most important applications of the VANET is to present safe, secure as well as pleasant drives for the travelers who ride on the road in vehicles. Hence, every vehicle is presented with an individual electronic device in order to connect the vehicle with the VANET. No fixed server communication and infrastructures are present in the case of VANETS. The VANET architecture model is exhibited in Fig 1, in that all vehicles comprise of a VANET device, which performs as a node in VANET. By means of the wireless network, the whole vehicle communicates with each other [7] in the network. Moreover, multimedia and internet facilities are offered to the passengers.

If any accidents or an unexpected braking issue happen in any of the vehicles, the VANET system will transfer the emergency signal. In the VANET model, one of the main enhancements is the advancement in the driver supporter system. From this system, the driver is permitted to help event which occurs beyond his eye-sight. The driver accepts the information by exploiting this security system about the events like a traffic jam, accident, traffic signal information which outcomes in high safety and effectual driving.

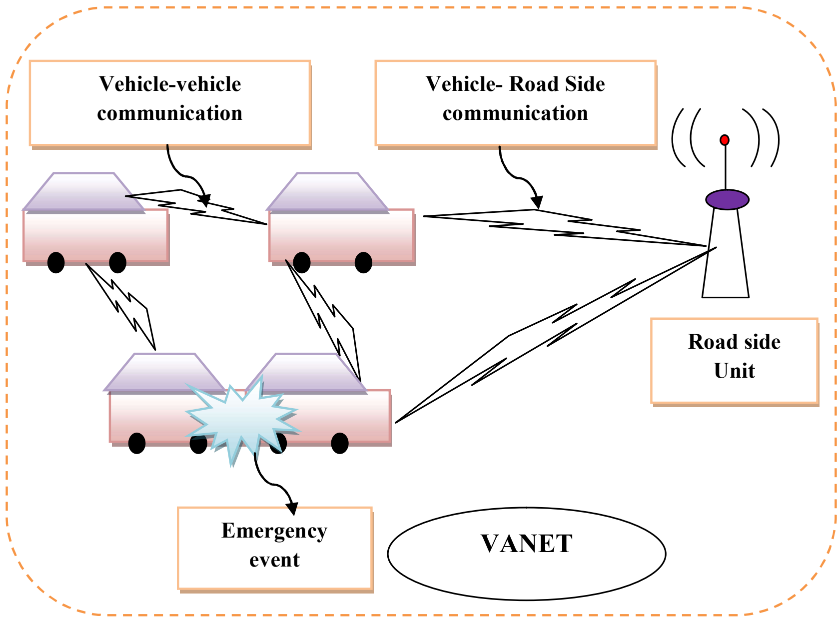


***Fig. 1*** *System model of VANET*

## 4. Adopted model for multipath routing in VANET

The main objective of this work is to propose a routing protocol to achieve multipath routing in order to transmit the videos with an optimal path selection in VANETS by using an optimization technique. At first, by exploiting the adaptive geographic routing model, the VANET has experimented as well as a number of routes to transfer videos from the source to the destination [8]. On the basis of the several metrics like delay, distance and QoS parameters the fitness metrics are developed, and the optimal paths with the least delay, distances as well as fulfilled QoS are chosen for video transmission. Subsequent to the encoding, video by use of HEVC, via the multipath the packet transmission is performed, which is chosen optimally for the video transmission from the source to the destination. Fig 2 depicts the architecture model of the developed multipath routing in VANET.

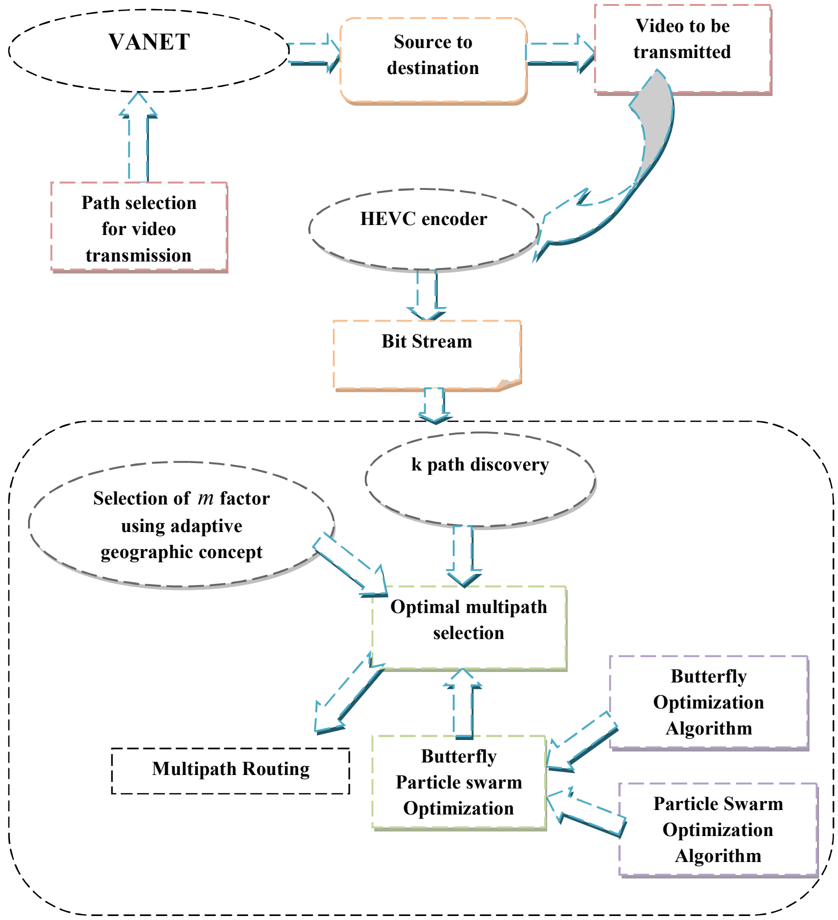


***Fig. 2*** *Architecture model of multipath routing in VANET*

## 4.1 HEVC Encoder for Video Compression

For the video compression, the High-Efficiency Video Coding (HEVC) [9] is considered as the current standard method, which represents as a substitute of the Advanced Video Coding, called H.264/MPEG-4 AVC.

While comparing with the present de-facto video standard called H.264, the HEVC guarantees a half-bit rate with the similar quality video exploited in several kinds of video applications which ranges from cell phones, broadcast, video conferencing, automotive, and etc. In compression, because of the attendance of maximized effectuality in compression, the HEVC set up the Super HD resolution which enables the transparency quality as minimum as 20 Mbps. On the basis of the application area, the performance of the HEVC video solution deviates. By exploiting the HEVC, the video which is required to be encoded is subjected as input to progressive scan imagery. In the HEVC design, there happen no coding features to aid the interlaced scanning that is exploited minimum generally for the distribution process and not exploited in displays. Nevertheless, metadata syntax permits the encoder to show that the interlace-scanned video is transmitted subsequent to the coding of all areas. The interlace-scanned video is transmitted, each video frame which consists of the even and odd-numbered lines as an individual image or it is transmitted subsequent to the coding the complete interlaced frame as an HEVC coded image. The bitstreams are produced by the compressed video which is subjected as input to the routing procedure to attain optimal path in order to transfer the video. In the VANET, by exploiting the shortest path algorithm, the utmost probable number of paths is attained.

## 4.2 K-path Discovery

For the k-path determination, Dijkstra's shortest path method is exploited from the sender to each and every vehicle available in VANET. Let, $k$ as the utmost probable paths presented in network.

## 4.3 Exploiting Adaptive Geographic Perception for $m$ Factor Selection

In the urban areas, for the establishment of video transmission, the adaptive geographic routing model is exploited in the urban areas. By exploiting this idea, a huge number of paths can be attained among the destination vehicles and the source.

In this model, from $k$ number of probable paths $m$ number of paths is identified.

$$X = \mathop{Min}_{i=1}^{k}[M_i] \tag{1}$$

$$Y = \frac{M_i}{X}, \quad m > Y \tag{2}$$

whereas, $M_i$ indicates the utmost bits to be transmitted, $X$ indicates the minimum bit factor which states the minimum bit transferring capability of the produced k-paths, $m$ indicates a number of the needed multipath, as well as $Y$ denotes the least bits required to be available in chosen multipath.

## 4.4 Proposed model for Optimal Path Selection

Exploiting the proposed BO-PSO method, which is the combination of the BOA and the PSO [12] method optimal $m$ paths are chosen. The BOA technique is a new optimization model which is perfect to find the optimal solution. Similarly, the PSO has the capability to attain the optimal solutions in an effective way within a minimum time period. Thus, to attain the optimal solution in an improved way both the techniques are integrated to generate the developed BO-PSO model.

*i) Solution encoding*

By exploiting the developed optimization approach, the solution vector indicates the optimal solution is ascertained. Here, $k$ count of paths is identified as well as optimal $m$ - paths are chosen from $k$ -paths to attain effectual video transmission in VANET. The chosen $m$ paths should be lesser than identified $k$ paths. Every path denotes the intermediary nodes occupied in communication.

*ii) Fitness evaluation*

In optimal path estimation, the fitness factor evaluation is significant. The fitness metric is calculated as,

$$Fitness = \frac{1}{a \times c}\sum_{r=1}\sum_{s=1}\left(P_{r,s} + Q_{r,s} + R_{r,s}\right) \tag{3}$$

whereas, $c$ states the count of nodes in the $r^{th}$ path, $a$ indicates the number of multipath, $P_{rs}$ is the delay in transmission, $R_{rs}$ indicates the Quality of service $Q_{rs}$ indicates the distance among the vehicles in VANET.

*a) Delay:* It indicates the delay related to the transmission of packets among the nodes in VANET.

*b) Distance:* The distance among the neighboring nodes of a path is called distance, it indicated as,

$$Dis\tan ce, Q_{r,s} = \frac{Q(D_{r,s}, D_{r,s+1})}{M} \tag{4}$$

whereas, $M$ indicates the normalization Factor.

*c) QoS:* It is derived on the basis of the QoS of packet transmission, sender, and receiver bytes.

$$Quality\,of\,Service, R_{r,s} = \frac{(A_{r,s} + S_{r,s})}{2} \tag{5}$$

whereas, $A_{r,s}$ indicates the QoS concerning packet transmission, $S_{r,s}$ indicates the QoS regarding the sender and receiver bytes. The QoS concerning packet transmission is computed on basis of packet received ratio at $s^{th}$ node of $r^{th}$ path to packet transmit $s^{th}$ node of $r^{th}$ path, it indicated as,

$$A_{rs} = \frac{1}{T}\sum_{q=1}^{T} B_{q,s} \tag{6}$$

whereas,

$$B_{q,s} = \frac{I_{r,s}}{J_{r,s}} \tag{7}$$

whereas, $J_{r,s}$ indicates the $s^{th}$ pack transmit at $r^{th}$ node, $I_{r,s}$ indicates $s^{th}$ pack received at $r^{th}$ node, as well as $T$ indicates a total number of transactions. At $r^{th}$ node packet transmit is indicated as,

$$J_{r,s} = \frac{1}{2}\left(\frac{G_{r,s}}{L} + \frac{H_{r,s}}{L}\right) \quad (8)$$

whereas, $H_{r,s}$ indicates a number of destination bytes, $G_{r,s}$ indicates a number of source bytes, as well as $L$ indicates transmission limit.

### 4.5 Hybrid BO and PSO Algorithm

PSO algorithm [14] is on the basis of the swarm of birds moving in order to search food in a multidimensional search space. The position and velocity are the significant characteristics of PSO that are exploited to find the optimal value. Each individual is named as a particle, and each particle is first initialized with random position and velocity within the search space.

BO algorithm is the nature-inspired meta-heuristic algorithm [10] that simulates the foraging and mating behavior of the butterfly. One of the most important characteristics of BO different from other meta-heuristics is that each butterfly has its own unique scent.

A new hybrid BO-PSO method is developed in this paper that is an integration of standard PSO [11] and BO algorithms [10] method. One of the important diverse among BOA and PSO is how novel individuals are produced. The disadvantage of the PSO method is a restriction to cover a minute space to solve the high-dimensional optimization issues. To integrate the benefits of the two methods, the functionality of both techniques and do not exploit both techniques one after another. Conversely, it is heterogeneous due to the technique included generating the ultimate outcomes of the two approaches. The hybrid is developed as below:

$$U_i^{t+1} = w \cdot U_i^t + C_1 \cdot r_1 \times \left(p_{best} - Y_i^t\right) + C_2 \cdot r_2 \times \left(p_{best} - Y_i^t\right) \quad (9)$$

whereas $C_1 = C_2 = 0.5$ , $w$ is computed by Eq. (10), $r_1$ and $r_2$ are an arbitrary number in (0, 1)

$$w(t) = w^{max} - \frac{\left(w^{max} - w^{min}\right) \cdot T_i}{T_{max}} \quad (10)$$

$$Y_i^{t+1} = Y_i^t + V^{t+1} \quad (11)$$

Additionally, the mathematical formulation of the local search phase as well as global search phase in fundamental BOA is computed. Nevertheless, the global search phase of hybrid a model can be devised as below:

$$Y_i^{t+1} = w. \cdot Y_i^t + \left(r^2 \times g_{best} - w \cdot Y_i^t\right) \times f_i \quad (12)$$

$$Y_i^{t+1} = w. \cdot Y_i^t + \left(r^2 \times Y_i^k - w \cdot Y_i^t\right) \times f_i \quad (13)$$

Whereas $Y_i^k$ and $Y_i^t$ are $j^{th}$ and $k^{th}$ butterflies selected arbitrarily from the solution space, correspondingly.

## 5. Result and Discussion

In this section, the proposed experimentation setup by exploiting the simulation tool and the analysis of the developed technique over the conventional methods was performed in order to exhibit the competence of the developed algorithm. The efficiency of the adopted routing protocol to achieve multipath routing in VANETs was analyzed via end-to-end delay, PDR, as well as throughput. Here, the proposed method is compared with the conventional models such as PSO, Artificial Bee Colony (ABC), Whale Optimization Algorithm (WOA), and Genetic Algorithm (GA).

***Table 1*** *Analysis of the proposed model with the conventional model regarding 50 users*

| Techniques | In the occurrence of 50 users | | |
|---|---|---|---|
| | End-to-end delay | Throughput | Packet Delivery ratio |
| PSO | 22.7208 | 82.8823 | 84.0544 |
| ABC | 20.3552 | 82.0827 | 84.7573 |
| WOA | 8.8738 | 82.8282 | 85.7877 |
| GA | 7.5802 | 83.3244 | 85.4024 |
| Proposed Algorithm | **7.8774** | **84.2877** | 87.5235 |

***Table 2*** *Analysis of the proposed model with the conventional model regarding 100 users*

| Techniques | In the occurrence of 100 users | | |
|---|---|---|---|
| | **End-to-end delay** | **Packet Delivery ratio** | **Throughput** |
| **PSO** | 8.8445 | 84.0558 | 84.5733 |
| **ABC** | 8.0758 | 84.3153 | 84.0143 |
| **WOA** | 5.4144 | 85.4855 | 84.803 |
| **GA** | 5.8544 | 85.5853 | 83.4881 |
| **Proposed Algorithm** | **4.4447** | **85.5085** | **84.4448** |

Table 1 summarizes the analysis of the techniques included in multipath routing in VANETs in the attendance of 50 vehicles. The end-to-end delay produced by the techniques in Table I exhibits that the adopted model yields minimum delay in transmission when compared with the conventional techniques. In Table 1, the proposed method is 12% better than the PSO, 15% better than the ABC, 17% better than the WOA, and 11% better than the GA for the throughput.

Table 2 summarizes the analysis of the techniques included in multipath routing in VANETs in attendance of 50 vehicles. The overall analysis exhibits that the developed model exhibits enhanced performance in video transmission in VANET.

In Table 2, the proposed method is 28% better than the PSO, 23% better than the ABC, 25% better than the WOA, and 26% better than the GA for the throughput.

## 6. Conclusion

In this work, the adopted BO-PSO method was presented for the video transmission from one vehicle to another to offer safe travel on road. Initially, the VANET was experimented with to calculate the number of routes needed for the video transmission by exploiting the adaptive geographic routing model. On the basis of the several metrics, the optimal paths are chosen were computed based upon the fitness measures. The developed model performance was calculated with the measures like a packet delivery ratio, delay, end-to-end as well as throughput. For a system to be efficient, the system should be able to process the least delay, and the adopted model presents the least end-to-end delay and finally, the adopted model presents the ability to transmit videos in an improved manner.

## Compliance with Ethical Standards

**Conflicts of interest:** Authors declared that they have no conflict of interest.

**Human participants:** The conducted research follows the ethical standards and the authors ensured that they have not conducted any studies with human participants or animals.

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