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Optimized AODV Routing Algorithm in MANET for Maximizing the Network Lifetime

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Abstract*: *In present scenario, Mobile Ad-hoc Networks (MANETs) is the emerging research topic in the applications like disaster situations (battle fields, earthquake, etc). The utility of MANET is increased by combining with the internet. The conventional techniques in MANET have a few issues like less infrastructure, standalone networks, and dynamic or complex topology. In order to address these issues, an efficient clustering and channeling algorithm (Hybrid K-means, Particle Swarm Optimization (PSO) based Ad-hoc On-demand Distance Vector (AODV) channeling algorithm) is developed for maximizing the network lifetime. The proposed algorithm finds the optimal cluster head selection for discovering the shortest path among the cluster heads. The Hybrid-K-means-PSO-AODV technique is applied to increase the Network Lifetime (NL), alive nodes, total packet send, throughput, and also to minimizes the dead nodes and energy consumption in a network. In the experimental phase, the proposed approach reduced the emery consumption up to 170 joules related to the existing approaches: PSO-PSO- MANETs and PSO-GSO- MANETs.

Keywords*: *Ad-hoc on-demand distance vector, k-means clustering, mobile ad-hoc networks, network lifetime, and particle swarm optimization..

I. INTRODUCTION

MANET is a developing research area in the field of wireless communication. Each node is a mobile node in the infrastructure less networks that depends on each mobile node features. In present decades, routing MANET is a challenging job, due to dynamic topology and dis-organized connectivity. In addition, a few major issues in MANET are error prone wireless channels, limited batter capacity in every mobile node, low capacity of wireless links etc [1].To address these issues, more number of methods are developed by the researchers. In MANETs, the routing protocols are classified into three dissimilar systems such as reactive, hybrid, and proactive, routing protocols [2]. A few routing protocols (AODV [3], and DSR [4]) utilizes hop count as route selection measure, which is not effective in the bottleneck and congestion networks that leads to low packet delivery ratio, longer delays and high overhead. So, load balancing is essential to avoid the traffic that helps to achieve better performance. Presently, several approaches are developed for balancing the load in routing. In Dynamic Load Aware Routing (DLAR) protocol, the route load is assumed as the route selection measure [5].

The load of a node is determined as the number of packets cushioned in the node queue and the load of a route is determined as the aggregate of the load of nodes in the route. The over-lapped and selected routes are utilized to update the load data that leads to congested bottle-necks. DLAR excludes the intermediate nodes to reply the route request messages. In MANETs, another effective protocol for data transmission is Load Aware Routing in Ad hoc (LARA) protocol [6]. In LARA routing protocol, the destination node chooses the route on the basis traffic cost and number of hops, during the route discovery mechanism. The traffic cost is determined as the sum of traffic queues. Mostly, the packet delay depends on the own interface queue and also the density of nodes. In contrast, Load Balancing Scheme (LBAR) collects more information to select the optimal route by means of minimal nodal activity [7]. In LBAR routing protocol, the route activity degree is identified by combining the node degree activity. In addition, Load Sensitive Routing (LSR) protocol is used in MANETs for minimizing the network complexity [8]. The LSR protocol depends on two factors (standard deviation and total path load). The source node in LSR protocol quickly attains the route information, and also responds quickly to calls for connections.

Correlated Load-Aware Routing (CLAR) protocol is an on-demand routing protocol [9]. In CLAR, traffic load is assumed as a primary route selection measure that mainly depends on the number of sharing nodes and traffic passing nodes. In addition, the Alternate Path Routing (APR) delivers effective load balancing by allocating the traffic among the set of diverse paths [10].One of the major issues in APR protocol is failure protection due to set of variation path [11]. The existing protocols are discussed only about traffic balancing, which does not concentrated on other energy problem. The existing routing protocols have several energy related problems. Hence, a successful system mainly depends on partitioning the network into clusters. In present decades, clustering is an effective approach that divides the network into groups [12]. In computer networks, clustering methods divides the network into dissimilar virtual groups on the basis of discriminated rules.

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The major goal of clustering is to attain high mobility and scalability in presence of large networks. Clustering based routing limits the amount of routing data that propagates in the network and also improves the route lifetime, and decrease the routing control overhead [13]. Though, the clustering methods solves many issues in MANET, still it is hard to select and implement the optimum cluster head in each and every cluster. There are various routing protocols and cluster based protocols are proposed for MANET and the well-known existing protocols are DSR, AODV [14]. In order to resolve the drawbacks of existing algorithms, an efficient channeling and grouping algorithm (hybrid AODV algorithm) is proposed in MANETs.

II. RELATED WORK

G. Singh, *et al*. [15] introduced Ant Colony Optimization based Routing Algorithm (ANTALG) for the random selection of transmitter (source) and receiver (destination) nodes to replace the agents among the nodes. The node trip time was recorded by creating the pheromone tables and data structures, while moving the ants (agents). The developed ANTLAG algorithm had the best pheromone value in the ants (agents), which was used as global updation for identifying an effective route. When the transmission time of HELLO packet was more, the network declares the transmission path as broken path.

S. Chettibi, and S. Chikhi,[16] developed a new routing protocol named as Dynamic Fuzzy Energy State based AODV (DFES-AODV). In each node, the forward probability of route request was decided by utilizingmamdani fuzzy logic system. The mobile nodes residual battery level and the energy drain rate were the inputs for fuzzy logic system. Also, an FSARSA-AODV algorithm was implemented with the fuzzy extension of the critic architecture for SARSA RL algorithm. The DFES-AODV was an energy efficient method and self-adaptive. In contrast, FSARSA-AODV need an empirical adjustment of numerous functional parameters.

W. Liu, and W. Kim, [17] presented a new routing (Stability Considered Density Adaptive Routing (SDR)) in MANET for creating a stable route and also to reduce the routing overhead. In SDR algorithm, various routing tactics were performed based on the density value that was termed as dense and sparse modes. While performing re-routing, overhead in the routing was minimized by assuming the stability value of every node. In the developed SDR algorithm, the residual energy of the node was not considered.

M.K. Rafsanjani, and H. Fatemidokht, [18] developed a new bio-nature inspired algorithm named as FBeeAdHoc in order to deliver secure routing among the MANET. The attacks from the malicious nodes were overcome by FbeeAdHoc secure routing protocol. Transmission efficiency of FbeeAdHoc was less compared to the BeeAdHoc algorithm.

W.A. Jabbar, *et al*. [19] developed a new routing algorithm called as Multipath Battery and Mobility Aware Routing Scheme (MBMA-OLSR) for improving the security in MANET. The developed routing algorithm used multi criteria node rank to increase the node speed and residual battery energy. The stability of the links were ranked for selecting the stable and efficient path for data transmission. In addition, the developed routing algorithm utilized energy and mobility aware multi-point relay selection process to set the node's willingness. The efficiency of energy was evaluated by transmitting more packets at low energy cost per packet. In the experimental study, the developed algorithm achieved the throughput only in the range of 14% compared to the existing routing algorithms, which need to be improved.

III. K-MEANS-PSO-AODV ALGORITHM

In MANET, the clustering algorithms deliver good network scalability and effectively utilize the resources of network. Mostly, the clustering algorithms are utilized in resource, location, and routing management for lessening computation overload, inadequate flooding RREQ packets, etc. In this research paper, optimized k-means clustering and PSO optimized AODV (Hybrid-K-means-PSO-AODV) channeling technique is used for improving the security in MANET. The hybrid k-means-PSO-AODV technique comprises of seven major steps, such as: 1) mobile node development, 2) clustering using PSO algorithm 3) Cluster Head (CH) selection based on node weight, 4) router estimation using AODV-PSO, 5) information received at CH, and 7) Successfully receiving the information. The flow diagram of Hybrid-K-means-PSO-AODV technique is shown in Fig. 1.

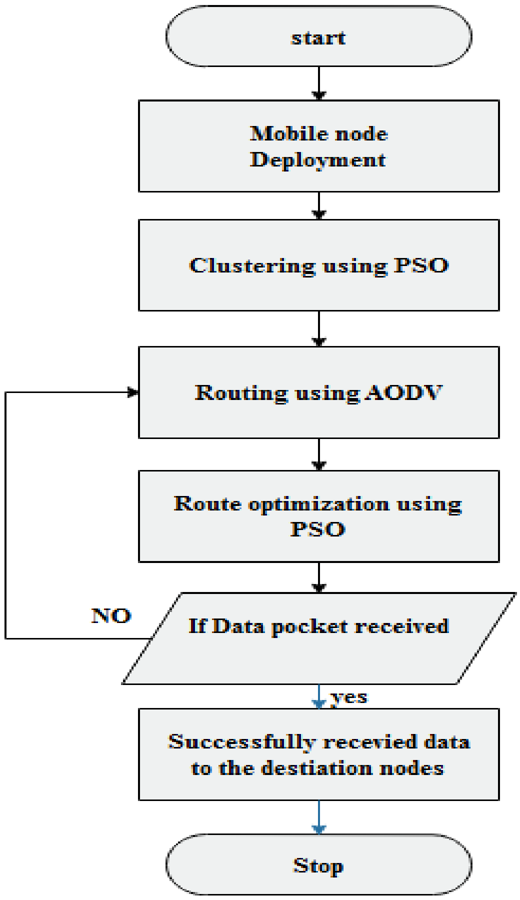


Fig. 1. Flow diagram of Hybrid-K-means-PSO-AODV

Clustering based on PSO with K-means algorithm:

Usually, PSO is an evolutionary computational approach, which is inspired from the social behavior of swarm rather than the advancement of nature as in the other evolutionary optimization approaches. Additionally, PSO is a sociologically inspired optimization approach, which works based on the sociological action related to bird flocking. Similar to other optimization approaches, PSO is also reset with a population of random solutions. Unlike other evolutionary approaches, each potential individual (solution) in PSO is related with a random velocity and position. In this research study, position of the particle is specified as $X_i = [X_{i1}, X_{i2}, \dots X_{id}]$ and the velocity of the particle is represented as $V_i = [V_{i1}, V_{i2}, \dots V_{id}]$ .In addition, every particle i has historically best position, which is denoted as $h_i = [h_{i1}, h_{i2}, \dots h_{id}]$. The best position of the particle is identified on the basis of position of neighborhood particles $n_i = [n_{i1}, n_{i2}, \dots n_{id}]$ .The vectors V_i and X_i are modified randomly and updated utilizing the equations (1) and (2) to find the new velocity and position of the particles i.

$$V_{id} = wV_{id} + B_1 r_{1d}(h_{id} - X_{id}) + B_2 r_{2d}(n_{id} - X_{id}) \quad (1)$$

$$X_{id} = X_{id} + V_{id} \quad (2)$$

Where, *w* is signified as inertia weight, which is used for regulating the exploitation features of the algorithm, Parameters B_1 and B_2 are denoted as acceleration co-efficient, and r_{1d} and r_{2d} are stated as two randomly generated values within the range of [0, 1] in the *d* dimensional space. The pseudo code of PSO algorithm is described below. The flow diagram of PSO is given in the Fig. 2.

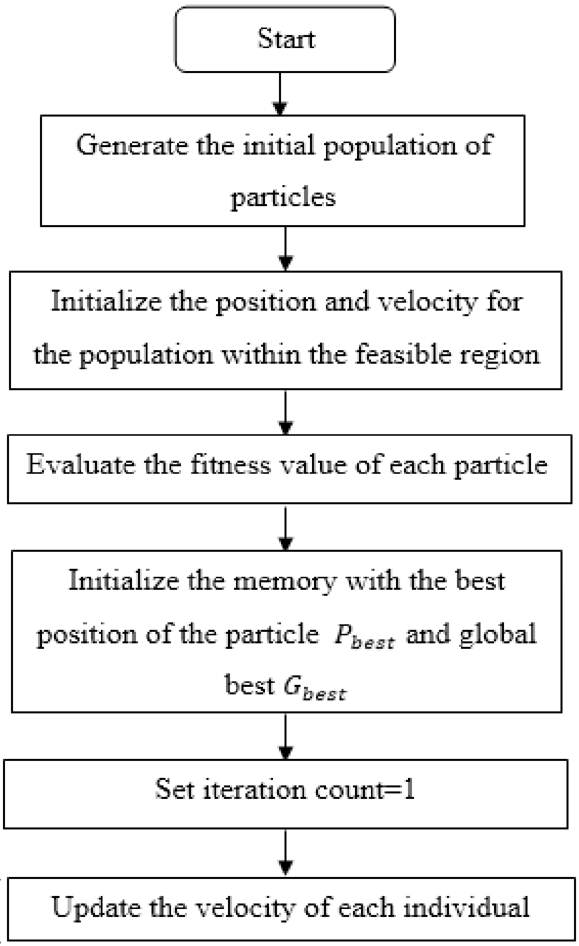


Fig. 2. Flow diagram of PSO optimization approach

Pseudo code of PSO algorithm:

For every particle i
For every dimension d
Initialize position X_i
    Initialize velocity V_i
  End For
End For
Iteration =1
Do
  For every particle i
    Evaluate fitness value
    If the fitness value is better than P_{best} in history
      Set the present fitness values as P_{best}
    End If
  End For
  Select the particle which have best fitness value G_{best}
  For every particle i
    For every dimension d
Evaluate velocity and position using the equations (15) and (16)

$$V_{id} = wV_{id} + B_1 r_{1d}(h_{id} - X_{id}) + B_2 r_{2d}(n_{id} - X_{id})$$

$$X_{id} = X_{id} + V_{id}$$

    End For
  End For

In this research, particles i are randomly deployed by using k-means clustering algorithm in order to find the active centroids in the clusters. The identified cluster centroids are optimized by utilizing PSO optimization approach. Respectively, the best particles i are selected by using PSO optimization approach, which are called as Cluster Head (CH). The CHs are determined by finding the distance between the optimized centroids with all neighborhood nodes. The G_{best} value is evaluated and the cluster is selected based on the minimum P_{best}. The following process is repeated for a few set of particles $20 \times Np$ from this P_{best} value is gathered. In addition, P_{best} value is attained from the position of the particle. This mechanism is repeated once again for updating the P_{best} value and position of the particles i. Here, the fitness function is the distance between the centroid groups and neighborhood particles, while the P_{best} value is minimum.

Clustering load balancing using PSO algorithm:

PSO enhances the grouping by solving the problem in communication networks for selecting shortest channelling process. PSO is an optimization technique, which simulates the flocking and movement of birds. The moving object can move through the free space and it can be attracted to the best positions.

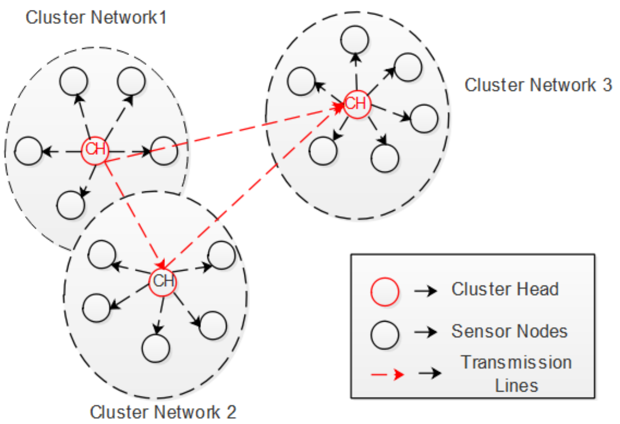


Fig. 3. Basic Grouping methods of SNs

Each bird is referred as a "particle", which fly with a certain velocity and move to find the global finest position. The grouping is done using PSO in MANET. Basic clustering methods of nodes are given in Fig. 3. Load balancing refers to reduced reply period, reduced throughput and routing overhead in the network. The grouping in nodes has been widely trailed by the investigation community for solving life-time, scalability and energy issues of sensor nodes.

In Fig. 3, the nodes are grouped to form different cluster networks. The CH is elected for each cluster networks based on the least possible value of degree. CH is used to assemble the data from their nearest nodes and move to the CH. During the steady-state phase, time slot will be schedule for group members for their communication

AODV channeling protocol

In MANET, the channeling protocols are planned by using mobile modes. In this research, AODV protocol is used for decreasing the control traffic and dissemination overhead. AODV is a reactive routing protocol, which delivers fast adaptation to low memory, dynamic link conditions, and network usage. In AODV protocol, identifying the fresh route is decided by route discovery function. Besides, route maintenance function is used to find the repair and breaks of an existing route. Usually, the reactive routing protocol does not have permanent route table. Related to other protocols, AODV quickly analysis the changes in network topology [20]. The information transfer of AODV channeling protocol is graphically given in the Fig. 4.

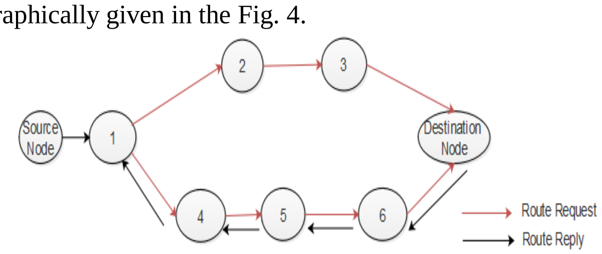


Fig. 4.AODVchannelling protocols-information transfer

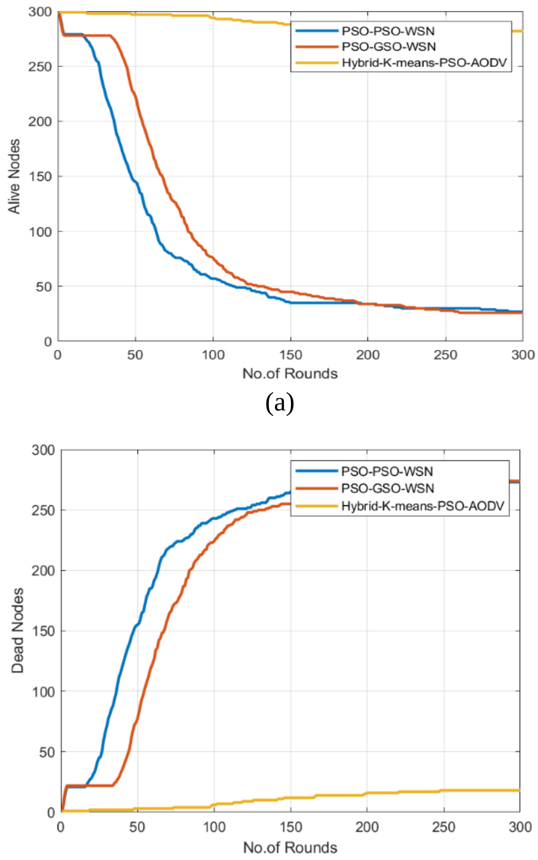
IV. RESULT AND DISCUSSION

To accomplish better performance of channeling and grouping in MANETs, Hybrid K-means-PSO-AODV technique was implemented in this research paper. Here, MATLAB (version 2017b) was used for experimental simulation with Intel ® core™ i3-7100U, 4GB RAM, 64 bit OS, and x-64 based processor. In this work, hybrid optimized k-means and optimized AODV are combined to attain best clustering and channeling in MANETS. Table 1 comprises of information about simulation parameters of Hybrid K-means-PSO-AODV approach.

Table 1. Simulation parameters of hybrid k-means-PSO-AODV approach.

Parameter	Value
Nodes	300
Topography Dimension	250*250 m
Topology	Random way-point
Distance	2.2678 (meters)
Energy Consumed	1.8020e+003 (joules)
Network Delay	596.9317ms
Elapsed time	0.000846 s

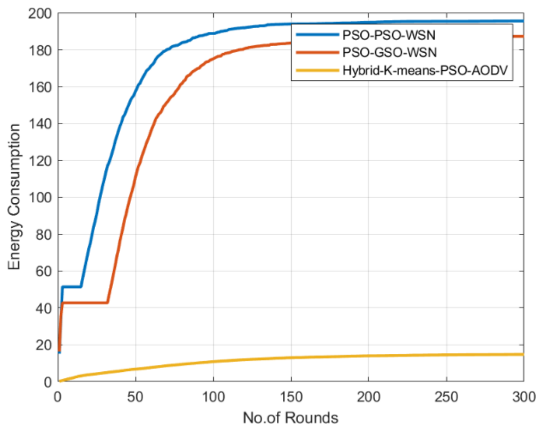
The hybrid k-means-PSO-AODV was experimented with 300 nodes to generate effective channeling and clustering process in MANETs. Assume that each sensor node has initial energy up to $1.8020e+003\ J$. Hybrid k-means-PSO-AODV algorithm is verified greatly and illustrates the experimental outcomes for both channeling and clustering. The communication area of the entire network is $250 \times 250 m^2$ and the position of the base station is $125,125 m^2$. For evaluating the performance of hybrid k-means-PSO-AODV method, the proposed method is compared with two existing methods i) PSO-PSO- MANETs, ii) PSO-GSO- MANETs. To execute the proposed method, the values of gamma, beta, step size, luciferin decay constant, luciferin enhancement constant and Del value are initially taken as per the table 2.



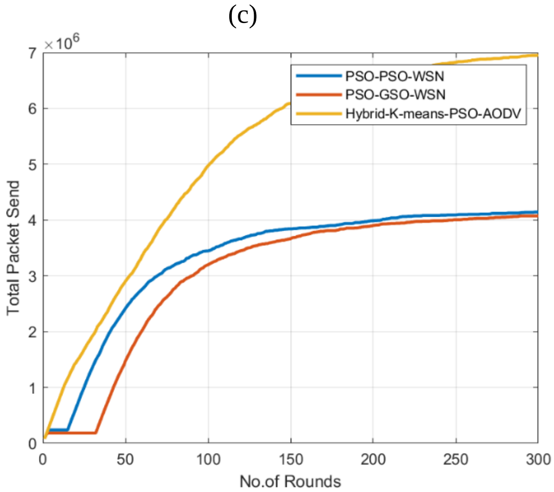
(b)

Fig. 5. (a) Alive nodes Vs No. of. Rounds, (b) Dead nodes Vs No. of. Rounds

Fig. 5. (a)-(e) represents the performance comparison of Hybrid K-means-PSO-AODV with two existing methodologies i) PSO-PSO- MANETs, ii) PSO-GSO-MANETs. Fig. 5 (a)represents that the alive nodes are greatly increased compared to two methodologies such as i) PSO-PSO- MANETs, ii) PSO-GSO- MANETs. NL and the amount of transmissions are increased by the maximization of alive nodes. Fig. 5 (b) shows the outcomes of dead nodes, compared to two methodologies such as i) PSO-PSO-MANETs, ii) PSO-GSO- MANETs, the dead nodes are highly decreased and it also increases the lifetime of the network. In order to avoid the dead nodes, the residual energy of each nodes are maintained at each iteration. It is carried out to eliminate the failure of nodes inside the transmission. In PSO-PSO-MANETs and PSO-GSO-MANETs methods, the nodes drain their energy after some transmissions, which causes more dead nodes.



(c)



(d)

Fig. 5. (c)Total packet sends Vs No. of. Rounds, (d)Energy consumption Vs No. of. Rounds

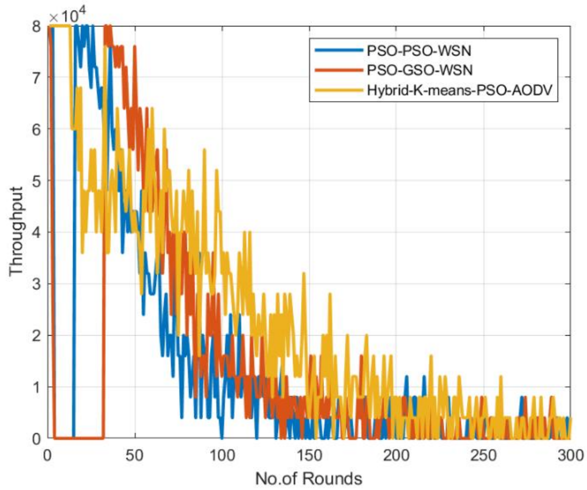


Fig. 5 (e). Throughput Vs No. of. Rounds.

Fig. 5 (c) displays the outcomes of the total packet send, compared to an existing method, the Hybrid K-means-PSO-AODV method transmits the high amount of information at the same time. The PSO-PSO-MANETs and PSO-GSO-MANETs algorithms have high end-to-end delay, so that the amount of transmission becomes small. Fig. 5 (d) displays the outcomes of the energy consumption, the Hybrid K-means-PSO-AODV showed good result related to the two existing methodologies; SO-PSO- MANETs and PSO-GSO-MANETs. By executing the channeling in every iteration, minimum utilization of energy is occurred that avoids the redundant transmissions. In order to achieve high load balancing amid existing algorithms, the proposed method uses high energy while transmitting the information. Figure (e) shows the result of throughput, the proposed method has more throughput value compared to existing methods. By improving the throughput, the communication rate of delivering the successful messages becomes more

Table 2.Comparison between PSO-PSO- MANETs and PSO-GSO- MANETs to the Hybrid K-means-PSO-AODV

Parameter	PSO-PSO-MANETs	PSO-GSO-MANETs	Hybrid K-means-PSO-AODV
Lifetime (Rounds)	150	220	250
Alive nodes	30	45	290
Dead nodes	275	260	10
Packet Send(Bits)	$3.9\ e^{6}$	$3.6\ e^{6}$	$6.1\ e^{6}$
Energy(J)	195	185	13

Table 2 represents the comparison of Hybrid K-means-PSO-AODV with two existing methods i) PSO-PSO- MANETs, ii) PSO-GSO-MANETs. The comparison is done by means of lifetime, dead nodes, packet Send (Bits),alive nodes and energy consumption (J).

Table 3. Comparison between three network scenarios

Parameter	MANETs #1(100)	MANETs #2(200)	MANETs #3(300)
Life Time (Rounds)	130	190	220
Alive Nodes	90	180	285
Dead Nodes	8	8	7
Packet Send(Bits)	5.8e6	6.4e6	6.9e6
Energy(J)	12.7	14.5	15

Table 3 shows the comparison between three network scenarios i) 100, ii) 200 and iii) 300. The comparison is done using following parameters lifetime, alive nodes, dead nodes, packet send (Bits) and energy consumption (J). The comparison is made in terms of amount of rounds Vs alive nodes, dead nodes, total packet sends, energy consumption and throughput. The alive nodes are increased and respectively dead nodes are decreased by increasing the amount of nodes at each level. Energy consumption of a network is decreased and also the NL is increased. The throughput of a system is maximized, when the amount of hops is decreased in each level.

V. CONCLUSION

In this paper, PSO with k-means and AODV with PSO is introduced that enhances the clustering and channeling performance of MANETs with limited movement after an initial random deployment. The algorithm has analyzed various particles sets to get best esteemed grouping with various glowworm sets for channeling the MANETs. The obtained results concluded that the Hybrid K-means-PSO-AODV method has achieved the best channeling and clustering of WSN related to the existing algorithms. The PSO-GSO-MANET method is used to increase the NL, alive nodes, and throughput performances. From the experimental study, the proposed method consumes less energy and the life time of the sensor nodes are effectively increased, compared to the existing methods.

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