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ADAPTIVE QUALITY OF SERVICE BASED ROUTING AND QUEUE MANAGEMENT FOR MOBILE AD HOC NETWORKS USING HYBRID ACO AND GA

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ABSTRACT. Designing a highly efficient routing for the decentralized mobile networks is a challenging job. In a way to satisfy the multiple needs of routing strategies such as lower delay, high packet delivery ratio, high network throughput, minimum energy consumption, etc., the proper routing without link breakage, queue scheduling and congestion control are the important things to be concentrated. Many Swarm Intelligence (SI) inspired algorithms like ACO (Ant Colony Optimization) and Genetic Algorithm (GA) offers optimal routing solutions for the networks without any central control (or) administration. In this paper we propose a novel hybrid protocol (HACOGA) by combining ACO and GA. The work of this protocol is bisected into two phases. In phase I the ACO algorithm is used to find the possible path sets from the source to destination by considering two QoS parameters such as delay and mobility rate. After completing fifty iteration the phase I hands over the job to phase II where the work of GA starts, in exploring the efficient path by finding the fitness of the path by considering the bandwidth, residual energy and buffer overflow as QoS parameters. The proposed hybrid algorithm works effectively in finding the optimal path by utilizing the combined benefits of both algorithms and its performance is tested under simulation study.

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1. Introduction

Many real world complex problems can be solved using the some of the efficient ways from nature. In such a way ACO, [18] and GA, [13, 14], are bio inspired algorithms which plays a major role in solving and and optimizing the complex problems in the mobile adhoc networks. Due to the nodes are mobile in nature the topology is not a stable one. The unstable toplogy in the networks leads to a poor quality of service in the network. To attain the required QoS in the network three things to be majorly concentrated such as routing scheduling and congestion deduction.

Several swarm intelligence inspired algorithms are discussed in the literature for efficient and optimal routing problems, [12]. In those optimization technique ACO, GA, PSO (Particle swarm optimization), artificial bee colony optimization are some of the methods used for routing process in the networks. Many hybrid algorithms [16, 17, 19–21] are also designed by many authors to satisfy the special needs of the network especialy energy, routing, bandwidth utilization etc. ACO is one of the best optimization algorithm in which the foraging behaviour of the real ants depicts the structure of mobile adhoc networks where nodes search for their neighbour nodes to find the shortest path from the source to destination. GA is another important optimization algorithm used for problems which are discrete in nature. GA works in the basis of natural selection it means that in nature the good genes are selected and the bad ones are rejected. In genetic algorithm operation a possible solution sets are maintained (string) called chromosome. GA works in three steps first is the fitness evaluation function the second one is selection of parents and the next is reproduction. The chromosomes are the initial population for GA process which are selected at random. The fitness of each individual (path) is calculated and the good fitness paths are retained and the remaining are discarded. In the selection process the parents are selected for reproduction and reproduction is done by crossover or mutation. In this paper an efficient hybrid algorithm is developed to meet the best QoS requirements in the network such as less delay, increased throughput, less energy [15] consumption, less control overhead and high packet delivery ratio by varying the speed of the nodes and constant bit rate.

The rest of the paper designed as follows: In section 2 literature reviews are discussed. In section 3 the QoS parameters considered in this work is explained one by one. In section 4 the proposed HACOGA system is presented. In section 5 the results of the proposed method is discussed. Finally the conclusion of the paper is presented in section 6.

2. Preliminaries

In Manets the QoS is an important thing to be viewed seriously. While considering the QoS parameters we have to concentrate three important factors such as proper routing, load balancing that is proper scheduling queue for the data packets and congestion control. Many authors have discussed the above mentioned aspects in different ideas and techniques. Some of the research works developed by many researchers are discussed below.

The authors in [1] have considered a disaster area and framed a new idea to transform information from source to destination. In this work more weightage is given for the metric packet delivery ratio because in disaster management segment transferring of data is the main objective. They have used the satellite links to transmit the data packets by designing a headquarters of the network. The authors have compared their proposed system with the normal routing protocols like AODV (Adhoc on demand vector) and MOMDV and exposed that there is an increase in packet delivery rate and the network throughput. They also have shown that delay has been reduced and the traffic loads are balanced in the proposed model by using the satellite links.

In the paper [2], the authors have introduced a new hybrid algorithm by combining ACO with FDR particle swarm optimization. In this works the lifetime of the node and the energy consumption of the nodes in the network are considered. The ACO algorithm is utilized for finding the optimal path by considering the residual energy of the node and the algorithm FDRPSO is used to minimize the energy consumption in the network. While finding the optimal path a duty cycle algorithm is incorporated with ACO where the duty cycle algorithm is used to swap the nodes among active and sleep state to avoid nodes to be active all time though it is not in the communication range.

In the paper [3], the authors proposed a PSR (proactive source routing) protocol which is called as the lightweight proactive protocol. The PSR protocol works good by attaining good overhead and this protocol maintains up-to-date information about the network topology when compared to the baseline protocols like DSDV, OSLR and DSR.

In the article [4], the authors have reviewed the basic ACO algorithm and hop count minimization for WSN and proposed a new hybrid algorithm named ACOHCM routing technique. The main objective of the paper is maximizing the network lifetime. This hybrid algorithm depends on the hop count classification of network which works under planar network topology. It clearly maintains the information about the current location of the node. In the path selection process the pheromone update is done by probabilistic node state transition formula. The authors state that this protocol works efficiently in reducing energy consumption, load balancing, reliable routing and with a high speed of convergence.

The authors in [5] have discussed ant colony optimization and particle swarm optimization for mobile adhoc networks. They proposed a new hybrid technique by combining ACO with PSO and they have used the tree based clustering method. The cluster head in the network is formed by considering the residual energy of the nodes and in the clusters data aggregation is done by hybrid ACOPSO. The authors conclude that this hybrid method works efficiently for finding the shortest path and increases the network lifetime. In the research paper [6], the authors have considered a dual channel transmission mode. One layer is used as a control layer and another one is the data link layer. Using the control layer the control packets are transmitted and using the data link layer the data packets are transmitted. By using the dual channel method the message clashes are eliminated and it reduces the delay in the channel. If there is a congestion in the control layer and in-case there are resources available in the data layer to transmit packets then the data packets can be transferred from the control layer to data layer which jointly completes packet scheduling and reduces delay and congestion. In the article [7] the authors have proposed a hybrid algorithm by combining GA with ACO. The authors have used the opposite advantages of both algorithm. GA converges rapidly and also GA is helpless in feedback information in which ACO is good. Hence in this hybrid algorithm the results of GA is used to reset the new pheromone value and then using this new pheromone value ACO do a parallel work by updating pheromone and finds an optimal path.

In the research paper [8] the authors have combined GA and ACO and developed a cloud based database route scheduling algorithm. In this process the results of GA is used to initialize the pheromone values of ACO algorithm. The fusion of the two algorithms is done by a control function in the GA process. In the paper [10], the authors have concentrated on the overall network lifetime. They have considered the bottle neck area near the sink node. They proposed a new method by combining duty cycle method network coding method in the bottle neck area for forwarding the data packets to the sink node. In the bottle neck area the sensor nodes are divided into two sets namely simple relay nodes and network code sensor nodes. The work of relay node is it simply forward data what it receives but the network coder sensors nodes use the algorithm based on the network coder. By implementing this method small number of transmissions is required to transmit a large volume of data from the bottle neck area to the sink node which helps in improving the network lifetime.

In the paper [11], the authors have developed a new energy aware routing protocol named EAPR (Efficient Power Aware Routing) which hugely increases the network lifetime. In this algorithm for data transferring process the residual energy of the node is considered. Additionally the expected energy spent on the particular link in the data forwarding process is also considered. The authors have used a min max formula and the path is selected by considering nodes with high packet capacity and with less residual data transmission capacity. The authors have compared their work with protocols like MTPR and DSR and the authors have concluded that EAPR works better in a heavy load network and yields a good packet delivery ratio.

3. QoS Parameters

Depending on the QoS constraints the optimum path in the network should be chosen. There are many metrics to be considered for the required QoS such as bandwidth, delay, packet loss, energy consumed, throughput and overhead etc. In our proposed work we have considered delay, available bandwidth, mobility rate, buffer overflow, node residual energy for the routing process and these metrics are explained below one by one in the following sections.

3.1. **Delay.** In the packet transmission process from source to destination the packets are forwarded from one node to another node and by the way it forms a path in the network. During this process the delay should be reduced for obtaining the required QoS. In the packet transmission process the total delay is calculated by considering three types of delay namely transmission delay, queuing delay and processing delay which is given in equation (3.1). The transmission delay is the time taken to transmit packets from one node to another node. Queuing delay is the time taken for the packets to wait in the queues to get sequenced. Once the packets are sequenced in a particular order the packets wait for a correct channel to transfer the data packet and this delay is called the contention delay which also avoids data collision in the network.

$$Delay = TD + QD + PD\,. \tag{3.1}$$

3.2. **Bandwidth reservation.** In the data transferring process bandwidth is a very important aspect to be considered. The available and the consumed bandwidth of the sender node and the receiver nodes should be updated in each and every single hop transmission to avoid the loss of data packets. Since the nodes in the network works in a shared medium and due to its dynamic topology there will be congestion and buffer overflow in the network if there is no proper information about the available and the consumed bandwidth. To find the available bandwidth and consumed bandwidth we use the formulas given by equations (3.2) and (3.3) which is illustrated in [9].

$$B_{self}(I) = \sum_{k} B_I(k) \tag{3.2}$$

where $B_{self}(I)$ is the total amount of bandwidth needed by the node I to receive data packets from its $'k'$ neighbours.

$$B_{available}(I) = B - \sum_{J \in N(I)} B_{self}(J), \tag{3.3}$$

where B is the raw data rate of a node I.

The bandwidth reserved for any flow j to the node I is given in [1] by the equation (3.4):

$$B_{reserved}(j) = \begin{cases} B_{min} \\ 2B_{min} \end{cases} \tag{3.4}$$

As given in [9] the consumed bandwidth for the j^{th} flow to be received by node I and to forward j^{th} flow is given by the equation (3.5):

$$B_{consumed}(I,j) = B_{uplink}(I,j) + B_{downlink}(I,j), \tag{3.5}$$

where $B_{uplink}(I,j)$ is the bandwidth reserved for the flow j on the upstream neighbour of node I and $B_{downlink}(I,j)$ is the bandwidth reserved for the flow j on the downstream of node I. $B_{uplink}(I,j)$ and $B_{downlink}(I,j)$ will take the value B_{min} or $2B_{minas}$ given in equation (3.3) for unicast flows. Each node may have more than one downstream node as forwarding nodes hence in [1], they define a new formula for finding the $B_{downlink}(I,j)$. There are two types of downlink nodes one is receiver downlink node and the another one is forwarding downlink node. The bandwidth consumed for a downlink node is given as follows

$$B_{downlink}(I,j) = \begin{cases} (1 + D_f) * Br_{f_{min}} \\ (\frac{D_r}{D_{r+1}}) * Br_{f_{min}} \end{cases},$$

where D_r is the number of receiver downlink node and D_f is the number of forwarding downlink nodes. By comparing the values of $B_{available}(I)$ and $B_{consumed}(I,j)$ as given in [1], each node will be able to find whether to accept or neglect the flow from the neighbour node.

3.3. **Residual Energy.** The amount of energy used by a node after transmitting or receiving data packets is the residual energy. In the path selection procedure residual energy is considered in order to avoid the unnecessary energy consumption. In the network if a forwarding node wants to send a data packet to its neighbour node first it should be verified that the receiver node has the minimum energy to receive the data packets and it chooses the node to transmit data by giving priority for the node which uses the less energy to transmit the data to the next node. It can be verified by the following formula given in equation

$$E_p^{res}(t) = E_p^{res}(t-1) - [E_p^{Tr^*} k(t-1,t)] - [E_p^{Rc^*} k(t-1,t)],$$

where is the amount of energy remaining at the node p at time t. Initially when time $t = 0$ there will be full energy. If there is some transmission is done the energy level will reduce. E_p^{Tr} and E_p^{Rc} are the amount of energy consumed for transmitting and receiving data packets by the node p respectively and k is the number of bytes transmitted form time $t-1$ to t. Once the residual energy of the neighbour nodes are found the forwarding node will be selected by giving priority to the node which has consumed minimum energy to transmit data to its neighbour nodes by using the formula $E_{select} = \min[E^{res}_{pi}(t), E^{res}_{qj}(t)$. By using this equation the best minimum energy consumed by a node is selected to transmit data to the neighbour nodes.

3.4. **Buffer Overflow.** If any node receives data packets more than its available capacity then there will be a buffer overflow. To overcome this buffer overflow there should be a proper queue management. If B is a receiver node and q_j be the length of the queue of j^{th} sample at the present time and Q be the total number of queue length samples collected over a period of time then the average queue traffic load at the node B is given as follows

$$L_T(B) = \frac{\sum_{j=1}^{n} q_j}{Q}.$$

And the traffic load intensity function at node B is given by

$$L_{TI}(B) = \frac{(L_T(B))}{q_m ax},$$

where $q_m ax$ is the maximum queue length of the interface queue of the node B at the MAC layer. Then the packet forwarding success probability with respect to possible queue overflow (PQ) at the node B can be modelled using the formula given by

$$PQ = 1 - L_{TI}(B)\,.$$

3.5. **Mobility rate changes.** Node mobility is an important aspect to be monitored in the packet forwarding process. By computing the neighbourhood link change rate, the node mobility in its neighbourhood can be determined. This mobility rate change rate is used to analyse the find the possible causes for packet loss. The rate of link change at any node f is given by the following equation:

$$\delta_f = \lambda_f + \mu_f,$$

where δ_f is the new link arrival rate and μ_f is the new link breakage rate. As the results based on [17], the maximum link arrival rate is equal to the breakage rate and the maximum link change rate is given by the following equation:

$$\delta f fmax fmax_{fmax}.$$

hence the link change rate is

$$\delta_f = \frac{\lambda_f + \mu_f}{2\sigma_f}, \tag{3.6}$$

where $\sigma_f = \dfrac{\rho}{\pi r^2}$ represents the average density of the nodes in the network as given in [17] and ρ is the average number of nodes in the transmission range. Hence by using the above formula the probability of packet forwarding with respect to the link change rate is given by

$$P_{f_{ij}} = 1 - \delta_f.$$

From equation (3.6) it is clear that if the value of δ_f is high that is nodes are more dynamic then the probability of successful packet forwarding will be low. And also equation (3.6) is helpful for the forwarding nodes to decide to which neighbour node the data can be forwarded.

4. Proposed System Model

In this paper we propose a new novel hybrid algorithm by combining the two bio inspired meta-heuristic approaches, namely ACO and GA. When there is a need of routing in network to forward data packets from source to destination we have to consider the QoS metrics such as delay, bandwidth, buffer overflow, energy and mobility rate changes. In our work we have considered the above mentioned important QoS metrics in the routing problem. The proposed system works in two phases. In phase-I the ACO algorithm is used to find the possible optimal paths. This algorithm is basically used for optimizing problems. It works by studying the amount of a chemical substance called pheromone which is produced by the ants in the path it traverses. By using this pheromone value the remaining ants follow the path from source to destination. If many ants use the same path then the pheromone value in that path will be high. Lower the value of pheromone the use of that particular path will be less because the pheromone value evaporates when the path is not used by the ants and its value reinforces when the path is used by many ants. This process is repeated up to fifty iterations by considering two metrics such as delay and mobility rate. Through this ACO process all the possible and optimal paths from source and destination are found. Now the phase-II work starts that is the genetic algorithm starts to work. The optimal paths selected by the ACO process are encoded in the GA process and fitness and the population size of each path is calculated. The paths with highest pheromone value are retained and the remaining paths are neglected. These chosen paths will forms the initial population for GA process for crossover and mutation. After crossover and mutation operation new offspring of the population are produced. The GA operation terminates when there is no new offspring is produced in a three consecutive iterations. Hence the optimal path is obtained by combining ACO and GA.

4.1. **Phase I : Route exploration by ACO.** Ant colony optimization is a metaheuristic approach which is useful for finding the optimal path in the networks and it is suitable to find the optimal path in the manets. The real ants wander from place to place in search of food whereas in manet the nodes(ants) search for their neighbour nodes in its transmission range to send the data packet from source to destination. In the path construction process the ants lays a chemical substance called pheromone which is key factor for the following ants to identify the path from source from destination. The ant chooses its neighbour that having high pheromone value because the amount of the pheromone Δ_ω deposited in the path decides the quality of the path. If the pheromone value in a link is high the probability of choosing that path by the ant sis also high whereas the pheromone value in the unused is less since it will evaporate.

ACO algorithm is an iteration process and in each iteration $'M'$ number of artificial ants are created. Depending upon the size of the network the value of $'M'$ can be chosen. Each link e_{ij} there is a pheromone value ω_{ij} which is associated with a solution component c_{ij} . The set of all possible solution components $c_{ij}^{'s}$ are denoted by $'C'$. In the ACO process delay and mobility rate are the metrics considered for path construction. The maximum value of iteration I_{max} is 50.

Initially when the iteration starts the path set $P^S = \phi$. By continuing the iteration many possible paths from source to destination are added to the path set P^S by adding a feasible solution component from $n(P^S) \subseteq C$. When an ant is present in node $'i'$ then the following node $'j'$ is selected stochastically from the nodes which are not already visited. The unvisited paths are selected precisely with a probability which is proportional to the pheromone value that associated with the link e_{ij} using th following formula:

$$Path_{ij}^{k} = \begin{cases} \frac{[\omega^{ij}]^{\alpha} * [P_{f_{ij}}]^{\beta} * [Delay^{ij}]^{\gamma}}{\sum [\omega^{ij}]^{\alpha} * [P_{f_{ij}}]^{\beta} * [Delay^{ij}]^{\gamma}} & if c_{il} \in n(P^{S}) \\ otherwise \end{cases},$$

where $Path_{ij}^{k}$ is probability of an ant $'k'$ selects the link e_{ij} and $n(P^S)$ is the set of feasible components, $P_{f_{ij}}$ and $Delay^{ij}$ are the relative metrics for mobility rate changes and delay which is given in equations (3.6) and (3.1) respectively. α, β and γ are the control parameters with relative importance of pheromone.

4.2. **Local Update.** In a single iteration there is a possibility of several ants producing the same solution. In order to avoid the identical solution by many ants the pheromone value is updated and the pheromone value will decrease in the unused path and the ants are encouraged to choose the remaining unvisited edges to create new different solutions. Hence a local updation of pheromone is done by the following formula

$$\omega_{ij} = (1 - \eta)\omega_{ij} + \sum_{k=1}^{m} \Delta\omega_{ij}^{K}, 0 < \eta < 1,$$

where η is the residual pheromone coefficient, $(1 - \eta)$ is the pheromone evaporation rate and $\Delta\omega_{ij}^{K}$ is the pheromone deposited by K^{th} ant while traversing the link e_{ij} and its value is calculated by considering the metrics delay and mobility rate.

$$\Delta\omega = \begin{cases} \frac{R}{Delay_{ij} * P_{f_{ij}}} & \text{when any ant passes through the edge } e_{ij} \\ 0 & \text{otherwise}, \end{cases}$$

where $Delay_{ij}$ and $P_{f_{ij}}$ are the relative metrics of delay and mobility rate, and R is a constant.

4.3. **Global Update.** The update of the pheromone value is done at the end of the path construction process. It is updated using the following formula:

$$\omega_{ij} = (1 - \eta)\omega_{ij} + \eta\Delta\omega .$$

At the completion of the global update, the set of possible paths from source to destination satisfying the QoS requirements are identified. After completing 50 iterations the process of ACO gets over and GA starts to work.

4.4. **Phase II - Route Exploration by GA.** In the ACO phase the set of all possible paths from source to destination that satisfying the QoS parameters such as delay and mobility rate are obtained. From all the possible paths, the path sets with a high value of pheromone are considered as the initial population for GA phase. From all the obtained possible paths the weaker paths are eliminated and path with good fitness value are retained based on the fitness function by applying genetic operations. In the GA process three QoS parameters such as bandwidth, residual time and buffer flow are considered. As a final point the optimal path sets are obtained satisfying required QoS in the network.

4.5. **Fitness Evaluation.** The fitness of all the obtained path is evaluated by designing an objective function and a penalty function. The objective function influences the cost of each individual node in the path which is given by the following formula

$$Z(f) = \frac{1}{C(p)} \,,$$

where $C(p)$ considers the QoS parameters such as minimum bandwidth, buffer overflow and the node energy for any data traffic. The penalty function is defined for the metrics by considering the set of constraints Ω. The penalty function for the bandwidth is defined as

$$B_w(f) = \Omega_b\{B - B_{consumed}(I)\}, B > B_{consumed}(I) \,,$$

where B is the raw data rate of any node and $B_{down}(p)$ is the bandwidth required for a downlink node and

$$\Omega_b^z = \begin{cases} 1 & if z \leq 0 \\ D_b & if z > 0 (0 < D_b < 1) \end{cases}$$

where D_b is the constant value that indicates the penalty degree of bandwidth. The penalty function for the residual node energy is defined as follows:

$$RSE(f) = \Omega_{rsy}\{R_i - E_{pij}^{res}\}$$

and

$$\Omega_{rsy} = \begin{cases} 1 & z \leq 0 \\ R_{rsy} & z > 0 (0 < R_{rsy} < 2) \end{cases}$$

represents the degree for the residual energy, R_i is the residual energy of any node i and E_{pij}^{res} is the energy lifetime of the link between the nodes i and j. The threshold value of residual energy is set as $2J$. the penalty function takes the value If a node's residual energy is less than its threshold energy then that node is not applicable to send data packets but it can receive data packets. Based on this the fitness function for all the paths is defined as

$$Fit(P) = O(f)[.u..B_w(f) + \in ..RSE(f) + vPQ(f)]$$

where u, $\in$, v are the positive real values used as the normalising coefficients for bandwidth, residual energy and buffer overflow. The Fit(P) takes the value 1 if satisfies the QoS constraints or else it assigns a real value between 0 and 1.

4.6. **Selection of Initial Population.** The initial population for the GA operation is attained by encoding the multiple paths found stochastically using the ACO process with good pheromone value. The population size of each path is calculated to avoid the path satisfying the same fitness criteria. Finally the path for GA operation is selected based on the fitness value. The path with highest fitness value is retained for the initial population of GA. The size of each path is calculated using the formula given in the following equation

$$Path_{size} = Numberofnodes - 15\,.$$

4.7. **Selection Operation.** In general the selection operators are stochastic. Probabilistically selecting a good one and removing the bad ones based on the evaluation of the objective function defined. Here we applied a Roulette wheel procedure where each path is assigned a probability value p_i and the cumulative probability value C_i is calculated for each path. A path is selected if the value of C_i is greater than a random number r which is selected already. $'r'$ takes the value between 0 and 1.

$$C_i = \sum_{j=1} p_j\,.$$

4.8. **Crossover Operation.** Crossover operation is a recombination of genes in the selected nodes. It is used to find a new best path from the selected path by a genetic recombination method. In this method any two paths P_i and P_j are selected randomly and in those paths common nodes are identified. From the common node a gene or a pattern of gene is selected for crossover and then exchanged between nodes. A single point crossover is applied if there is a single common node and from that particular node a different path is followed to the destination. A two point crossover is applied if more than one node is in the selected paths and after the crossover operation a different subset of path will be followed. The length of the path that is the chromosome length decides the crossover pattern in the nodes. If there are no common nodes available between any two randomly selected paths then some other paths are selected at random for crossover operation.

4.9. **Mutation operation.** Mutation is simply changing one or more parts of the chromosome. From a randomly selected path a randomly selected node x is simply changed by some other node y. The random node y is selected from an adjacent node set which contains nodes which are adjacent to the random node x. This operation can be omitted if there is no proper node is present in the adjacent node set.

4.10. **End conditions.** The genetic algorithm operation is done for each population to generate a new individual path and find its fitness. The process is repeated until a specific number of iterations are reached. GA process is stopped when the best value of fitness is no longer found from one generation to the next and if there is no unique offspring is included in the population after three successive iterations.

5. Results and Discussion

5.1. **Simulation Setup.** The proposed hybrid algorithm is tested using the simulation tool NS-2 using the programme language C++ and the tool command language with a Linux platform. The following table gives a brief explanation about the simulation setup.

PARAMETER	VALUE
Simulator	NS-2.34
Topology	Random
Number of nodes	50
Bandwidth	2.4Ghz
Propagation Model	Two Ray Ground
Physical Model	Wirelessphy
Antenna model	OmniAntenna
Queue Size	50
Traffic type	CBR,UDP
Mobility Model	Random Way Point
Routing Algorithm	HACOGA
Packet size	512
Mac protocol	802.11 standard
Simulation Time	200Sec
Initial energy	100j
bandwidth	2Mbps

6. Simulation Results

The hybrid ACO and GA protocol has been established in this paper. The efficiency of the work is tested under simulation study to satisfy the required QoS metrics. Comparisons are made in the graphs for simple ACO and GA with the proposed NHACOGA. In this work the delay, bandwidth, buffer overflow, residual energy, and mobility rate changes are the parameters considered. The performance metrics such as overhead, delay throughput, packet delivery ratio and energy are analysed by varying the number source and destination pairs and also the same metrics are analysed by varying the speed of the nodes.

Figure.1 and figure.2 show the less control overhead by varying the number of CBR and the speed. And the graphs implies that in the proposed method there is a less overhead when compared with the simple ACO and simple GA.

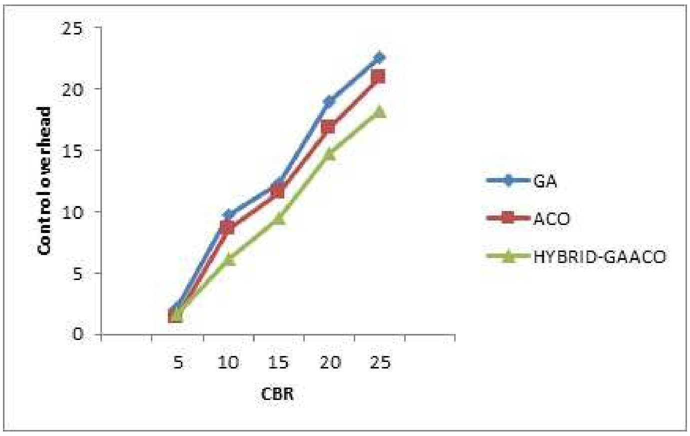

Fig.1 CBR verses Control overhead

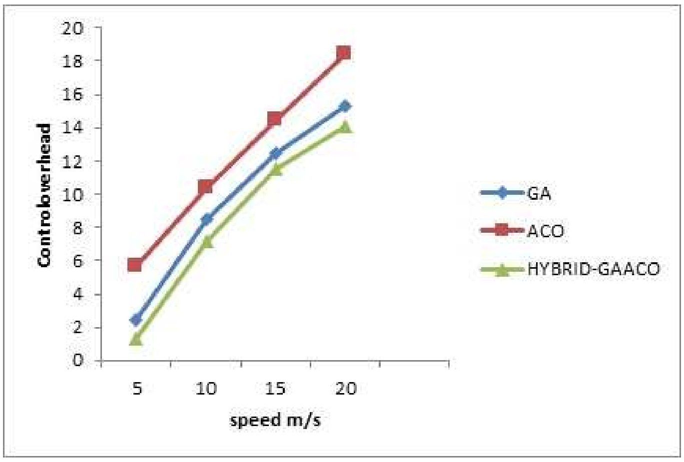

Fig.2 Speed verses Control overhead

The average end to end delay is time utilized by the data packets to be transferred from the source to destination. Figure.3 and figure.4 depict that in the proposed system the end to end delay is less when compared with the ACO and GA.

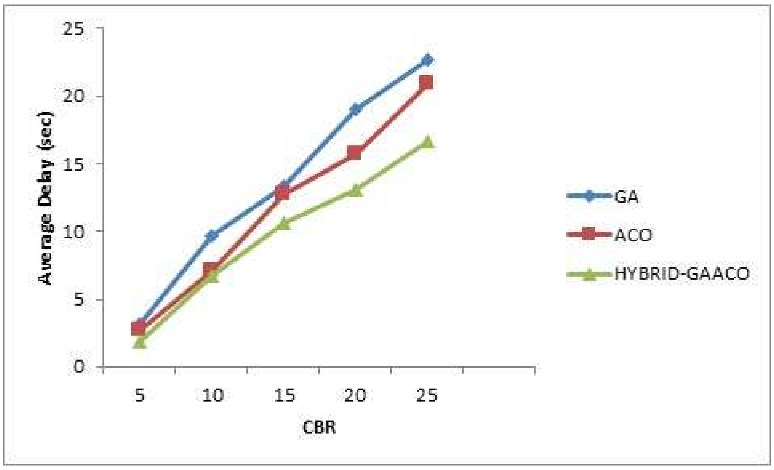

Fig.3 CBR verses Average delay

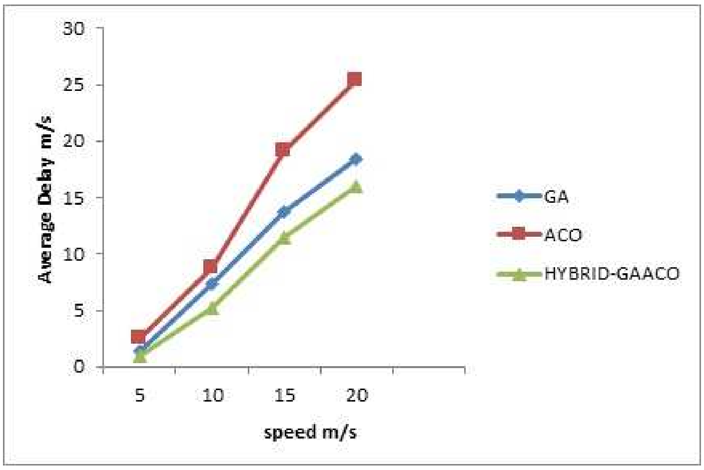

Fig.4 speed verses Average delay

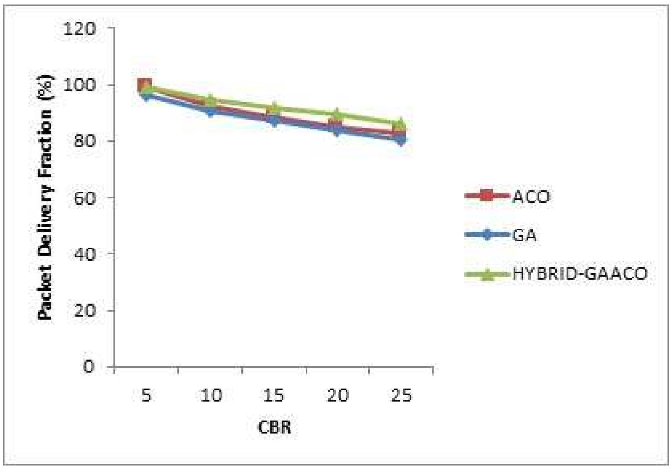

Fig.5 CBR verses Packet delivery ratio

Figure.3 shows that there is a slight improvement in the packet delivery ratio for the proposed hybrid technique than the traditional ACO and GA and there is less packet loss rate in the proposed system by varying the speed which is shown in figure.6

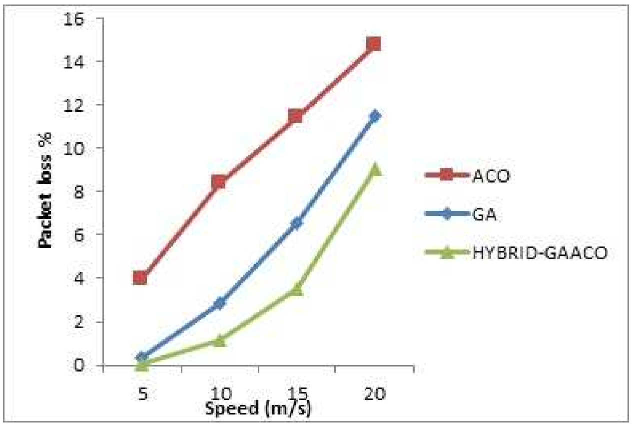

Fig.6 speed verses Packet Loss

The throughput of the network is given by the total amount of data transmitted divided by the time taken to transmit the data packets. The proposed system shows a better throughput on comparison over CBR and speed which is given in figure.7 and figure .8.

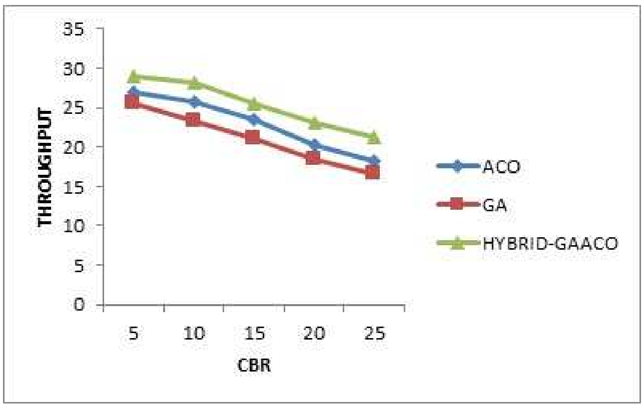

Fig.7 CBR verses Throughput

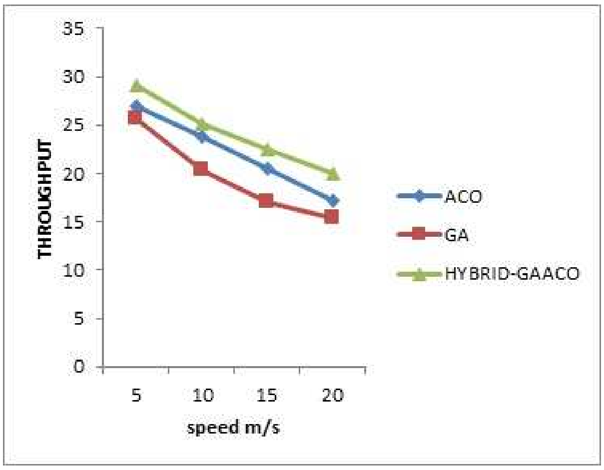

Fig.8 CBR verses Throughput

Energy consumption in the network is an very important aspect to be considered. In the proposed method by using the hybrid protocol the energy consumtion in the network low in both the cases by varying the CBR value and the sped which is shown in figure.9 and figure.10.

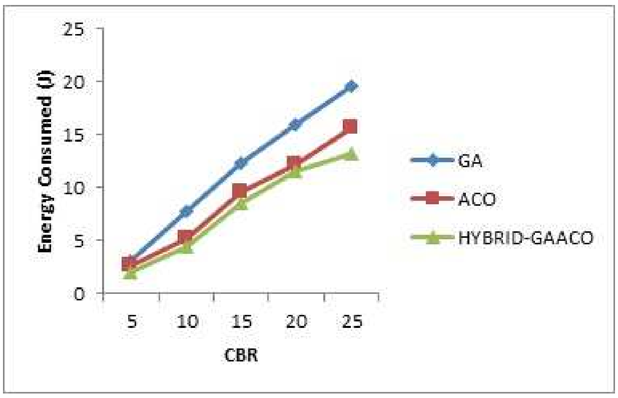

Fig.9 CBR verses Energy consumed

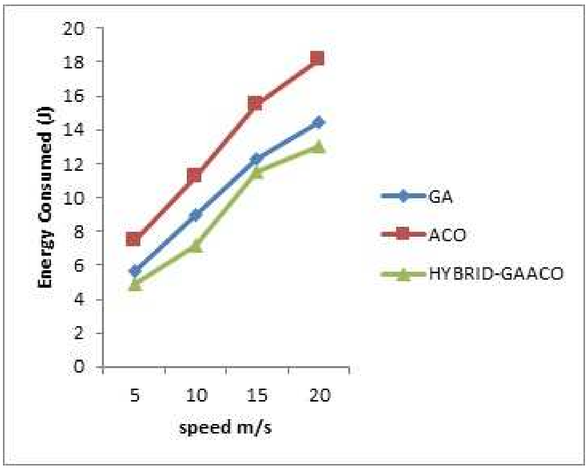

Fig.10 Speed verses Energy consumedt

7. Conclusion

Due to the characteristics of Mobile adhoc network the routing and queue management in it is a mystifying task. In this paper we propose a new hybrid algorithm by combining the traditional ACO and GA. This proposed method works in two phases whereas in the first phase the possible paths from the source to destination is found by calculating the pheromone values using ACO technique by considering to parameters namely delay and mobility rate changes. The process is repeated until 50 iterations. The paths found using ACO process is formed as the initial population for GA process by calculating the fitness value of each individual path in which QoS parameters such as bandwidth, residual energy and buffer overflow are considered. Finally the optimal path from the source to destination is found by applying the genetic operations such as crossover and mutation. The proposed method is tested under simulation study and found that the proposed hybrid method works effectively in satisfying the QoS parameters.

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