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Exploration of Swarm Optimization and Its Impact in QoS under Wireless Mobile Communication

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Abstract- A Mobile ad hoc network (MANET) is a collection of wireless mobile nodes which dynamically join the network and cooperate with each other for multi-hop communication in absence of infrastructure or centralized administration. Due to dynamic behavior multi constraint QoS routing is the problems of ad hoc network. One of the popular studies for routing in the network in recent year is the swarm intelligence which imitates the collective behavior of biological species to solve routing problem in the network. Swarm Intelligence (SI) based techniques such as Ant Colony Optimization (ACO) algorithms have shown to be a good technique for developing routing algorithms for ad hoc networks. Ant based routing algorithms are based on the foraging behavior of ants. In this paper we proposed a new SI based multipath Routing. The multipath AOMDV is able to provide multiple bath but if the QoS improvement is possible in AOMDV through SI techniques. The route selection is done on the basis of pheromones values and due to that the possibilities of paths are also enhanced. The fitness function is used to local route repair. The main good feature of proposed routing is to also consider the PDR values on the established paths by that the link reliability is also enhanced. The performance of AOMDV and AOMDV with SI is evaluated on the basis of performance metrics and SI based AOMDV routing is showing the better performance in network.

Keyword: MANET, Swarm Intelligence, ACO, Routing, AOMDV

I. INTRODUCTION

A Mobile ad hoc network (MANET) is a class of wireless network where mobile nodes communicate with each other without any pre-existing infrastructure network and centralized control. In MANET, communications between neighboring nodes are done directly while the remote nodes are based on multi-hop wireless links. Mobile nodes in the network not only acts as hosts but also acts as source of data, destination for data and a forwarder of the data. Besides that they also functions as network router that discover and maintain routes to other nodes in the network. With the use of routing protocol, nodes are capable of communicating with other nodes in the dynamic environment of MANET. Routing in MANET is challenging in the absence of central coordinator as compared to other wireless networks where base station or fixed routers manage routing decisions.[1] Designing of routing protocol in ad hoc network depends on various factors like mobility, bandwidth, resource constraints, communication environment etc. Types of MANET applications and inherent characteristic make data routing quite challenging and general purpose ad hoc network routing protocols cannot work efficiently with it. For effective routing, MANET protocol should provide low control overhead, effective adaption to topological changes, low packet delays, high throughput and optimized battery power utilization. The balance of all these conflicting objectives is very hard. For the optimization of the stated objectives, Swarm intelligent based meta-heuristics approach ACO is more promising than other algorithms in MANETs. Swarm intelligence based algorithm Ant colony optimization (ACO) is considers the ability of simple ants to solve complex problems by cooperation.[2] The interesting point is that the ants do not need any direct communication for the solution process, instead they communicate by stigmergy .The notion of stigmergy means the indirect communication of individuals through modifying their environment. Several algorithms which are based on ant colony problems were introduced in recent years to solve different problems, e.g. optimization problems, including MANET. The paper is organized as follows. describes basic principles of ant colony optimization, describes survey of ant colony based algorithms.

II .SWARM INTELLIGENCE

Swarm intelligence is a relatively new approach to problem solving that takes inspiration from the social behaviors of insects and of other animals and In the other term SI is subfield of Computational Intelligence which provides solution for complex optimization problems which are not easily tackled by other approaches. Swarm Intelligence mainly consists on Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) and Honeybees paradigms. Swarm Intelligence based approaches are nature and bio inspired [8]. A swarm is defined as a set of (mobile) agents that collectively solve problems. Swarm Intelligence is the property of a system whereby the collective behaviors of unsophisticated agents cause sophisticated global patterns to emerge. Swarms are abundantly found in nature. In the nature animals form into swarms to search food, build nests, to hunt and avoid being hunted etc. Each individual of the swarm has simple rule of action and access to a limited amount of information via its immediate neighbours or local environment. However, despite of limited information and simple actions of members, the swarm, as a whole, is capable to accomplish very hard problems of the computation and optimization. Theses paradigms mimic the behavior of real insects for food searching, organized living and defensive styles for computational problems. The application of the SI paradigms is mostly dependent on the nature of the

computational problems. Mostly real hard problems can be simulated by exploitation of SI based algorithmic approaches. The SI based approaches are more promising from other conventional techniques for optimization problems[1]. Due to the nature, architecture, topology and functionality of ad hoc and wireless networks, Swarm Intelligence approaches are most suitable for the routing and energy resources optimization related issues in MANET. so that Bio inspired, Swarm Intelligence approaches are more promising for ad hoc. The swarm intelligence based paradigms are shown in "Figure 1"

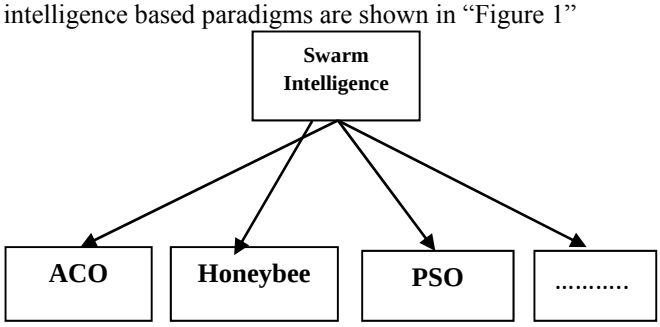

Fig. 1 Sub Domain of Swarm Intelligence

A. Ant Colony Optimization

Ant Colony Optimization is paradigm of Swarm Intelligence that is inspired by the collective behavior of ants[1]. The Ant Colony Optimization algorithmic approach models the concept of food foraging, net building, and division of lab our, cooperative support, self assembly and cemetery organization of real ants for the meta-heuristic approaches, for the optimization problems. ACO meta-heuristic computational approach was proposed by Marco Dario in 1996. The basic principle of ACO is simulation of ability of ants to find the shortest path between their nest and a food source. Ants are capable to find the shortest path between their nest and food source, without any visible, central and active coordination mechanism. The real ants drop a pheromone, chemical from their bodies naturally, on the path which leads them for the various decisions. The path optimization between nest and food is achieved by ant colonies by exploiting the pheromone quantity dropped by the ants. The path selection of the ants is done on the bases of the pheromone concentration deposited on the set of paths[3]. With high concentration of pheromone value path's selection probability is greater than others. The indirect pheromone based communication is known as stigmergy. There is a natural evaporation of the pheromone, which favors the shorter path than the larger one. An artificial ant can be considered as a simple computational agent. In the implementation of artificial ant, probabilistically path selection mechanism is introduced. In basic ACO algorithm pheromone value update and pheromone value evaporation is done by using the mathematical formulae. Generally the pheromone evaporation rate is directly proportional to the length of path. The ACO based meta-heuristic approaches are very suitable for the problem scenarios where optimized multi-path section is desired. Here some important features of ad hoc networks which flavors the designing of swarm intelligence based protocols, particularly ACO inspired algorithm routing protocols. Some of them are given as following. Dynamic Topology: The dynamically change topology, causes bad performance of mostly routing algorithm in mobile multi-hop ad hoc networks. The working principle of ACO is based on agent systems and works individually and flavors high adaptation to the current topology of the network. Local Work: The ACO based algorithms are based only on local information, so it no needs the transmission of routing tables or other information to neighbor nodes in networks. Support for Multi-path: The selection decision is based on the pheromone value on the current node. It provides the multi-path selection choices. The representative application areas of Swarm Intelligence based meta-heuristic algorithmic approaches,[8] are stochastic optimization problems, NP-hard, industrial problems, dynamic optimization problems, telecommunication networks, multi-objective optimization and continuous optimization.

B. Honeybees

The bees algorithm is population based, bio inspired approach for optimization problems that mimics the food foraging behavior of swarms of honey bees. The bee's algorithmic approaches exploit the concept of honey bees for food searching, defense and locatable behavior of real honeybees[1]. The artificial bees mostly are divided into three groups namely as employed bees, onlooker bees and scout bees performing their corresponding duties. The literature survey shows that the Honey Bee Algorithm (HBA) was proposed by Craig A Tobey in 2004, Vertia Bee Algorithm (VBA) formulated by Xing-She Yang in 2005 and same time Artificial Bee Colony (ABC) by D Karabogo for numerical function optimization[6]. The working of the bee's algorithm starts with the placement of scout bees in the search space and fitness of the scout bees is evaluated. The bees having higher fitness then a threshold is chosen as selected bees and corresponding visited sites by then are selected for neighborhoods search. As SI based approaches are iterative and termination criteria are proposed for the termination of the algorithm. Like other SI approaches, Honeybee algorithms have vase domain of application, training neural networks, scheduling jobs, data clustering, tuning a fuzzy logic controller, computer vision and multi-objective optimization. The prominent application of Honeybees based algorithms are in the field of ad hoc and wireless sensor networks.

III. Related Work

Z .Ali and W. shahzad ,(2013) proposed "Analysis Of Routing Protocol in Ad HOC and Sensor Wireless Network Based on Swarm Intelligence"[1] which is bio inspired computational intelligence approaches , that are very effectively applied to NP-hard problems and results more promising. The similar multi-objective constraints based issues like mobility, path optimization, resource utilization and energy awareness, are effectively solved by exploiting SI based meta heuristics in MANETs and WSNs. In this work they concludes that ACO approaches are very promising for route optimization in MANETs while PSO is very effective for load balancing and energy

optimization in WSNs. The author concluded in the view of algorithmic approaches under observation that bio inspired, Swarm Intelligence based routing protocols are more promising for Ad hoc network.

Ahmed M. Abdel-Moniem , Marghny H. Mohamed , Abdel-Rahman Hedar (2010) an ad-hoc routing protocol that uses the ant colony optimization technique[2] and also to find multiple disjoint routes between a source node and a destination. We compared the performance of the proposed protocol with that of the AODV routing protocol in terms of end-to-end delay, Throughput, Network Load, sent routing traffic, received routing traffic, number of dropped data packets, and simulation duration for both cases when the nodes are stationary and when they are moving.

Se-Young Lee et al. (2005) proposed Ad hoc Network Multicasting with Ant System (ANMAS) which is based on ant colony optimization system.[3]The Algorithm particular utilizes the indirect communication method of the ants via "pheromone" to effectively obtain dynamic topology and to generate multicasting paths. It adopts the well-known CBT (Core Based Tree) into the ANMAS framework with proper modifications to make "tolerable" multicasting group in the MANET environment. The pheromone of each node contains its distance to the core and the measure of its "safety" of the path to the core. The newest pheromone information is used so that multicasting routes are adaptively constructed depending on dynamic topology changes. In this paper they shows the comparison between ANMAS and ODMRP (On demand Multicast Routing Protocol), They concluded ANMAS provides a good packet delivery ratio with a small increase in the number of control packets, which do not depend proportionally on the number of sources. ANMAS will be highly effective for the domains that need multiple-to multiple node multicasting.

P. Deepalakshmi et al. (2011) proposed an Ant based Multi objective on demand QoS Routing algorithm (AMQR) for MANET is highly adaptive, efficient, and scalable and reduces end-to-end delay in high mobility cases. [7]In this approach have phases of route exploration and route maintenance. Ant like packets is used to locally find new paths. Artificial pheromone is laid on communication links between adjacent nodes and route reply and data packets are inclined towards strong pheromone, where as next hop is chosen probabilistically. Each node running this algorithm contains three tables namely neighbour, path preference and routing. The neighbour node which has a higher path preference value will be copied to routing table for the related destination on desired. In this work researcher analyze the behavior of AMQR has been compared with AODV and ANTHOCNET in terms of delay, throughput, jitter with various flow counts, node mobility and various pause times. They provides good packet delivery ratio, reduces delay and jitter but with high routing overhead.

Leandro dos Santos Coelho and Piergiorgio Alotto in this paper [9] focuses on the Artificial Bee Colony (ABC) algorithm which is a new stochastic population-based meta-heuristic approach originally proposed by Karaboga [10, 11]. The method is inspired by the intelligent foraging behavior of honeybee swarms and due to its simplicity, robustness and ease of implementation is attracting increasing interest. This paper first presents the basic ABC algorithm and then proposes an improved version called Gaussian ABC (GABC) which shows a clear superiority in the solution of Loney's solenoid benchmark.

IV. DISCUSSION ABOUT EXISTING WORK

A) Using the Ad hoc On Demand Distance Vector Protocol and Ant Colony based optimization [4], modified routing protocol is highly adaptive , efficient and scalable .On this paper simulation result shows that the proposed protocol yields better performance than the conventional AODV protocol.

B) Using the ANMAS[3] will be highly effective for the domain that need multiple to multiple node multicasting.

C) Using the Ant based Multi objective QoS Routing Algorithm (AMQR) for MANET [7] is highly adaptive, efficient, scalable and reduce end to end delay in high mobility cases.

D)Using SI based routing algorithm,[1] Computational intelligence approach are more effectively applied on NP-hard problem and Multi objective constraints based like Mobility, resource Utilization and energy awareness are effectively solved by SI based meta heuristics in MANET.

V. PROPOSED WORK

Ad-hoc communication is dynamic nature because node dynamicity and each node as treats as router, that resolve the problem of static network communication, it easily deploy where no any static network communication exist, but ad-hoc network is very challenging where node movement is higher as well as denser network. So here proposed a new technique to resolve the problem of disconnection as well as path or channel usability, that technique name is swarm optimization base optimized path establishment for multi-flow ad-hoc communication. In that technique swarm put down pheromone on the earth in order to mark some favourable path that should be followed by other members of the dependency. Swarm base approach initially we identifies more route from initial to destination and marks all path is favourable path for all follower, but on the bases of path cost between source to destination. If we get four paths between them so calculate path cost of each available path and on the bases of cost we distribute the data transmission and send data from that all path, that mechanism balance the load of network and also minimize the congestion from the network.

In our approach we use ad-hoc on-demand multipath distance vector routing protocol and send data through more than one path, that provide separate path for data packet and acknowledgement packets and increases the reliable data delivery of the communication network.

1) Proposed work Step's

Step1: Deploy network scenario through NS-2

Step2: Apply MAC protocol as 802.11

Step3: Identifies all available path using Swarm method

Step4: Communication route establishment using AOMDV
Step5: identifies up and down path for communication.
Step6: generate trace file for analytical result finding
Step7: analyze Packet delivery ratio, throughput, routing overhead, end-to-end delay
Step8: find out outcome result.

2) Proposed Architecture:

In this section elaborate proposed architecture in split view name as traffic generation and transport layer phase, routing phase, swarm optimization phase and external module. Initial sender broadcast route request packet with the help of routing phase and in that phase we get multiple route and calculate packet delivery ratio and if that value less the eighty percentage than apply fitness function for local route repair mechanism, after that use swarm optimization phase here we assign pheromone to each node, if in range and participated in route, we also update pheromone value of node on the base of movement and data forward. Last module is external module that written in TCL language and connected with internal module using OTCL binding and simulation scenario crated by tool command language and generate test traffic (cbr/ftp) after that we get output result.

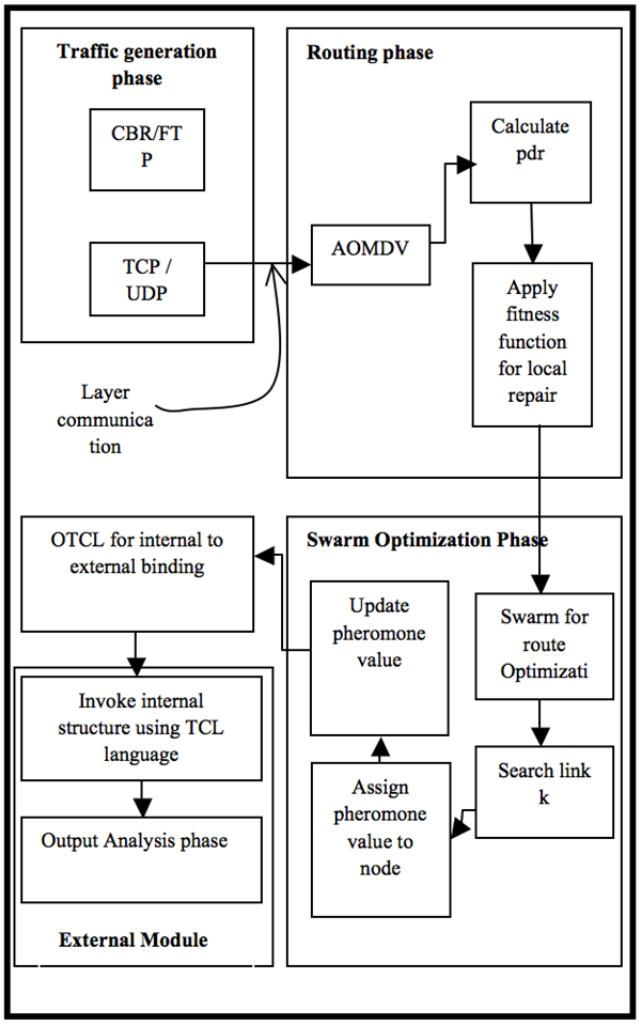

Fig. 1: Proposed AOMDV-Swarm Protocol

3) Proposed Algorithm

Initialize: Routing: AOMDV
Pdr = 0; packet delivery ratio
f_n = 0; fitness value
Recv = 0; no of received packets
Fwrd =0; no of forward packets
Delay = 0; initialize delay
Drop =0; initialize data drop
$\partial = \ell + 10$; ∂ steepness function and ℓ from 0 to 90
Procedure: AOMDV-link layer detection
If (node recv == true && forward ==true)
{
Calculate PDR = (recv/forward)*100;
}
If (PDR> 80% && ∂ ==10 to 100)
{
Route is true
}
Else {apply fitness F_n to repair local route;
$f_n = \frac{pdr}{n} - (route\ pkt + delay + drop)$
Local repair route (f_n);
}

Swarm module for multipath search optimization

Step 1: apply swarm in all node
Step 2: n: mobile node
Step 3: search path from S to R (S and R both ϵ n)
Step 4: S search link to (n-1) node
If (k = n-1) link found
Step 5: assign pheromone value to all link
Step 6: swarm table () // increase /vaporise pheromone value
Step 7: if (rt-find(dest))
{
Vector pheromone = second
}
While (Vector-pheromone =! end)
{
Old ph = new ph value;
If (neighbour == next)
{
New ph value = old ph + r *(1-old ph);
}
Else {new ph value = (1-r)*old ph ;}
r = incr/decr ; 0<r<1
}
Step 8: Send data on the bases of pheromone value
Step 9: Calculate PDR, routing load etc.

VI. Simulation Setup

The proposed swan with AOMDV model has considered an area of 800 m × 600 m with a set of nodes placed randomly. It simulated by using Network Simulator (NS-2.31) [12]. Here each node is initially placed at a random position within the defined area. As it progresses, the simulation time is 100 seconds and then randomly chooses new location. Each node maintains its behavior, alternately pausing and moving to a new location during the simulation time. The simulation parameters are shown in table I.

Table 1 Simulation Parameters

Number of nodes	20, 30, 40, 50
Dimension of simulated area	800×600
Radio Range (meters)	250
Routing Protocol	AOMDV
Simulation time (seconds)	100
Transport Layer	TCP ,UDP
Traffic type	FTP, CBR
Packet size (bytes)	1000
Number of traffic connections	10
Nodes Speed (m/s)	Random

1) Performance Metrics

The following performance metrics are considered for evaluation:

i. *Packet Delivery Fraction (PDF)*: The ratio of the data packets delivered to the destinations to those generated by the sources.

ii. *Normalized Routing Load (NRL)***:** The ratio of number control packets sent from the source to the number of data packets received at the destination.

iii. *Throughput (data/second):* Total number of delivered data packets divided by the total duration of simulation time. We analyze the throughput of the protocol in terms of number of data received per second in network.

iv. *Packet Loss Ratio:* A number of data packet dropped in network from total sending packets in network not routing protocol packets dropped.

VII. Results Discussion

In this section the simulated results are discussed in detail.

1) Data Sending Analysis in different Node Densities

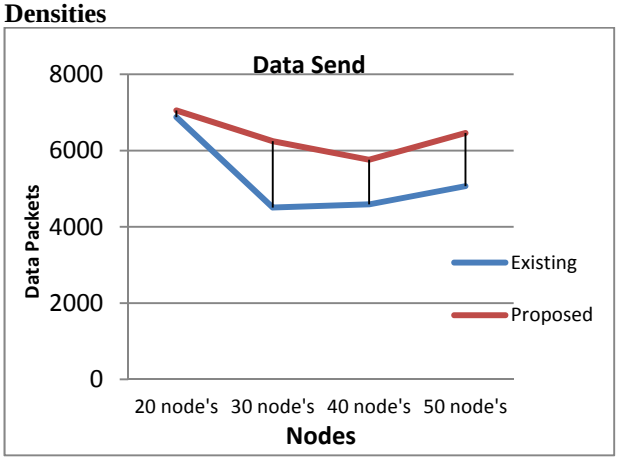

Fig. 2 Data Sending Analysis

The AOMDV protocol is reliable for data delivery and also the alternative paths are maintaining the connectivity in network. The Swarm Intelligence (SI) based AOMDV routing is the proposed work or proposed work in network. The data sending in analysis in case of AOMDV (existing) and SI with AOMDV (proposed) in shown in **figure2.** Here the data sending analysis is case of 20, 30, 40 and 50 node density and observe that the data sending in proposed routing is more due to establishment of numbers of pate selection through pheromones values. The nodes in network moves freely strong link connection is required for data sending that improves data sending in network.

2) Data Receiving Analysis in different Node Densities

The data receiving in network is improves the quality of network. If the sender is slow then the less number of packets are sending by them but if it received successfully then the network performance is healthier. The packets receiving analysis of AOMDV and SI with AOMDV is mentioned in figure 3. The different node density provides the better receiving in simulation time of 100 seconds. The Swarm Intelligence provides the better data receiving that improves the QoS of network. The number of path availability also provides the bandwidth for that data receiving improves.

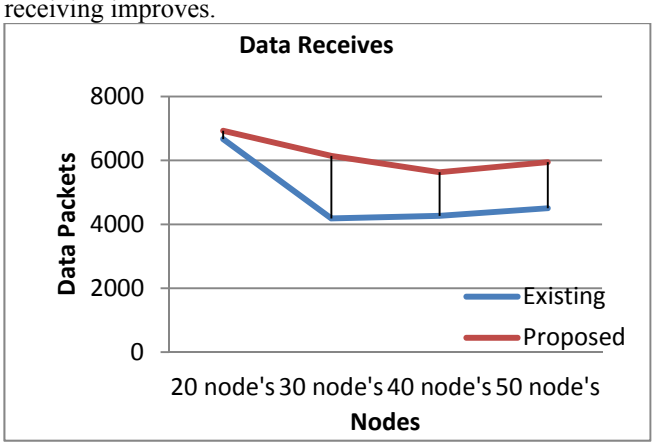

Fig. 3 Data Receiving Analysis

3) Control Packets Analysis in different Node Densities

The control packets flooding in network through sender is finding the destination after countable number of hop counts. The minimum hop count routes are selected that provides the better data delivery. The less control packets flooding provide the better performance. The control packets flooding in SI based AOMDV is less and the over head increases with increment on node density of nodes in network. The control overhead of AOMDV is very high and increment of node density the overhead enhanced swiftly. The overhead reduction provides the better routing in less flooding of packets.

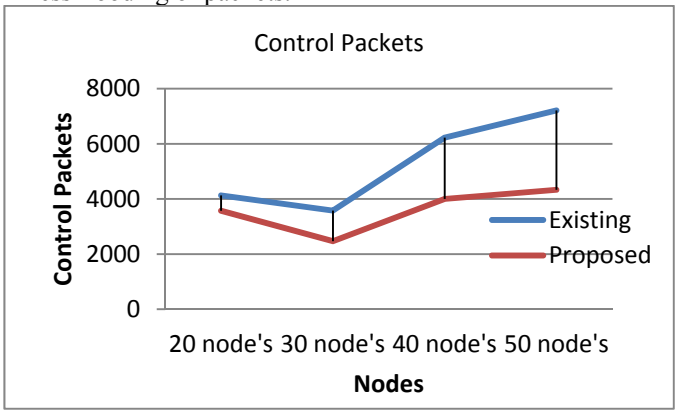

Fig. 3 Control Overhead Analysis

4) PDR Analysis in different Node Densities

The percentage of successful data receiving is evaluated from PDR. The figure 5 illustrated the t percentage of data analysis of AOMDV and SI with AOMDV. The PDR of AOMDV is degrades in network with respect to number of nodes in network increases. The degradation of PDR is only due to the unavailability of reliable link that successful delivery of data in network. However the PDR performance of SI with AOMDV is provides more than 98 % and in 50 nodes the performance is about 92 % i.e. too better than normal routing. The proposed routing approach improves the packets percentage metrics by improving the packet receiving to enhance QoS in network.

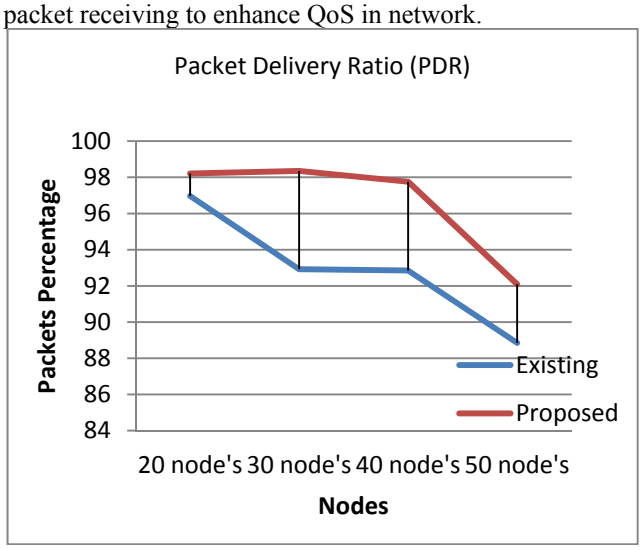

Fig. 5 PDR Analysis

5) NRL Analysis in different Node Densities

The Normal Routing Load (NRL) in measured in network w.r.t the data packets receiving in network. The routing load value is measured in AOMDV Protocol is 1.6 that means for 1 packet receiving 1.6 routing packets received in network. The performance of SI with AOMDV is better and provides <1 routing load in network. The performance of proposed routing technique is reduces the flooding in network by that the bandwidth consumption is also utilized efficiently and the data dropping is reduced. The NRL is increases swiftly in AOMDV but in proposed the routing load is maintain.

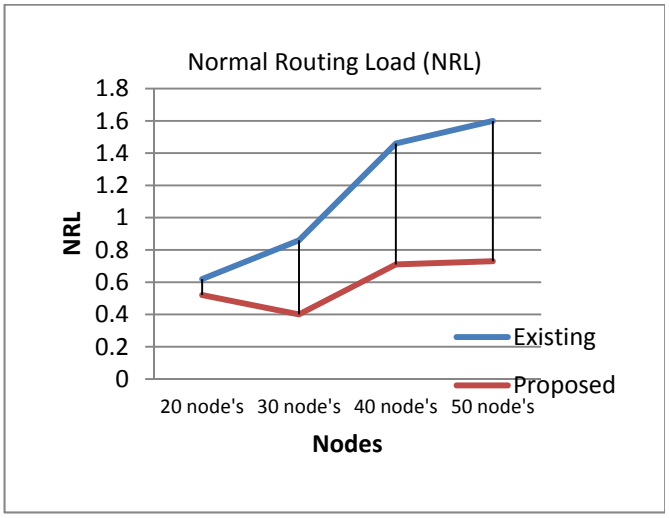

Fig. 6 NRL Analysis

6) Data Dropping Analysis in different Node Densities

The data drop in network is the major reason of performance degradation in network and the many data drop reasons like bandwidth consumption, route failure, improper routing and congestion etc. In AOMDV the packet dropping is more due to failure and availability of weighted path. The proposed SI based AOMDV routing is provides the multiple path on the basis of strong pheromones value and data is sending through this path but rest of the path is available for data sending in network that use is provides the less packet dropping.

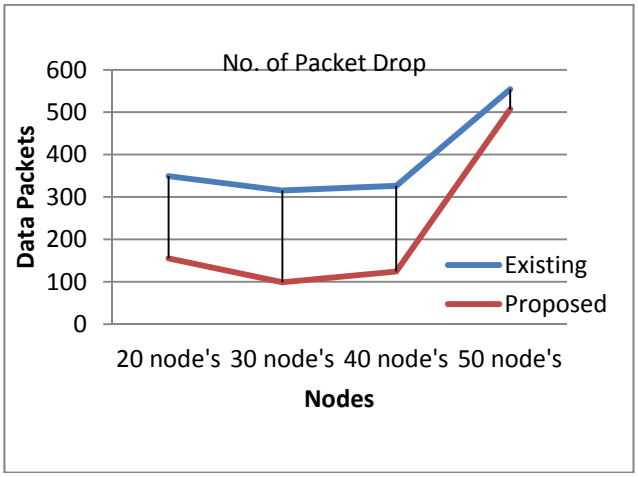

Fig. 7 Data Dropping Analysis

VIII. Conclusion

Routing refers to the discovery of a reliable-optimal path for data communication between the nodes in the network. With the advancement of the mobile ad-hoc network, many researches were proposed to increase the efficiency of network. The important factor affects the performance in MANET is discovering and maintaining path since the node's mobility causes topology change, which needs to be observed for effective communication. In this paper, we proposed an SI based AOMDV routing protocol to use the well-known ant colony optimization technique and also to find multiple disjoint routes between a source node and a destination. We compared the performance of the proposed protocol with that of the AOMDV routing protocol in terms of ,throughput , and network load, sent routing traffic, received routing traffic, number of dropped data packets, and simulation duration for both cases when the nodes are stationary and when they are moving. In the normal AOMDV a source node performs a route discovery procedure whenever an existing alternative routes is disconnected. In the proposed protocol, however, a source node can send data packets to its corresponding destination through maximum possible backup routes pre-established.

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