

A Survey: Swarm Based Routing Algorithm toward Improved Quality of Service in MANET

Sumit Kumar¹, Dr. Madan Lal Saini², Dr. Sandeep Kumar³

¹Research Scholar Jagannath University, Jaipur, Rajasthan, India

²Poornima University, Jaipur, Rajasthan, India

³Amity University, Jaipur, Rajasthan, India

Abstract

Ad Hoc Network or MANET is defined as a network that has many free nodes mostly composed of mobile devices or its particle. It is the network that is continuously moving or we can say it is a mobile network. Topology in MANET is dynamically changed over time. It is a decentralized and self-organized communication system. Due to Dynamic topology used in MANET traditional routing algorithms are not effective and it is challenging to manage routing. In order to developing highly efficient routing algorithm which can produce low packet delay, High transmission rate, minimum Jitter, better QOS for MANET is very difficult. Now a days algorithms based on Swarm Intelligence are producing good result for routing in MANET using optimization.

In this paper we tried to review literature related to techniques which gives good performance in routing, delay, jitter, QOS systematically in MANET, also shown better Quality of Services using Swarm Intelligence in MANET. The main objective to perform this survey is just to have deep knowledge about techniques available for routing in better way to produce good results in Network

Keywords:Swarm Intelligence, MANETs, Mobile Adhoc Networks, Routing.

Introduction

A MANET is a group of device like mobile nodes which are independent to each other and communicate with each other through wireless links. In MANET there is not a fix infrastructure due to dynamically changing topology and centralized control. As there is not a fix existing infrastructure for communication between mobile node so node can join and leave network at any time instance. At the same time instance any node can behave like a host or as a router which can direct packets from source node to destination node. All nodes available in MANET are capable to discover new path and maintain to propagate required packet to its destination.

1.1 Characteristics of MANET

Some important characteristics of MANETs are mentioned below:

- Dynamic topologies are used as the nodes move at an unknown speed freely in any directions.
- Routing is a multi-hop fashion process. Every node connected in particular network can act as a host or router, and by following an established route may deliver packets in path.
- Bandwidth is one of the major constraints of MANET due to the wireless nature of the

communication media. Because wireless media can be easily influenced by multipath interference, noise, fading and also have limited availability of spectrum.

- The operations in MANET are mostly power-restricted due to battery life.
- Because of decentralization, a MANET is robust and has limited physical security.

MANETs are vulnerable to multiple types of attacks.

- Scalability is also a main limitation of MANET due to their resource poorness nature.

Ad hoc network can be deployed in places with no fixed infrastructure. Wireless mobile ad hoc networks are best suited for conference meetings, lecturer, crowd control, search and rescue, disaster recovery, on-the-fly conferencing applications, networking intelligent devices and automated battlefields.

A typical MANET made by portable devices illustrated below:

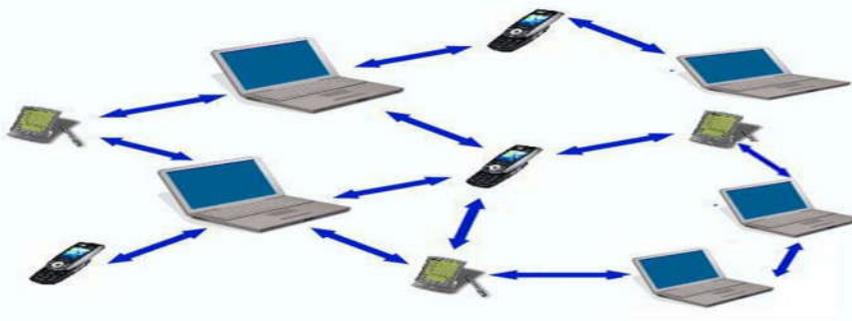


Figure 1.1: Representation of Mobile Ad-hoc Network

1.2 Challenges in MANET

The following are the Challenges looked in MANETs:

1. **Dynamic topology:** The topology of MANETs is dynamic, due to which the trust relationship among hubs might be aggravated. Additionally if a few hubs are identified as traded off, trust might be exasperates.
2. **Overhead in Routing:** As the hubs regularly changes their area with in network, So in this manner at times some stale courses are produced in the directing table which causes superfluous steering overhead.
3. **Packet misfortunes:** Ad hoc remote systems encounters a much higher packet misfortune because of components, for example, visit way breaks because of versatility of hubs and expanded impacts because of the nearness of shrouded terminals and so on
4. **Frequent course changes:** The system topology is exceedingly unique due to the development of hubs, consequently visit way softens happens up on-going session. This circumstance regularly prompts visit course changes.
5. **Hidden terminal issue:** The shrouded terminal issue alludes to the collision of bundles at an accepting hub because of the synchronous transmission of those hubs that are not inside the immediate transmission scope of the sender, yet are inside the transmission scope of the collector.

6. **Security dangers:** The remote versatile specially appointed nature of MANETs brings new security difficulties to the system outline.
7. **Quality of Service (QoS):** Providing distinctive QoS levels in a constantly changing situation will be a test. Because of innate stochastic component of correspondences quality in MANET, it winds up hard to offer settled certifications on the administrations offered to a gadget.
8. **Limited data transmission:** When contrasted with infrastructured systems wireless link proceed with have essentially bring down limit. Also, the acknowledged throughput of remote correspondence in the wake of representing the impact of clamor, impedance conditions, different access and blurring and so forth. Is regularly substantially less as contrasted and radio's most extreme transmission rate.
9. **Limited power supply:** Power supply of hubs is confined in MANETs because of which a few issues are caused. At the point when a hub finds that it has just constrained power supply then it might carry on in a narrow minded way.

2.1 QOS in MANET

As the quantity of Internet clients keeps on developing, arrange execution prerequisites must build ideal alongside them. Furthermore, a large number of the most recent online administrations require high measures of data transfer capacity and system execution. System execution is a component of concern both for the client and the specialist co-op. Web access suppliers need to apply strategies and advancements to give the most ideal administration before their rivals beat them to it. So we make utilization of QoS.

Nature of administration (QoS) alludes to a system's capacity to accomplish greatest data transfer capacity and manage other system execution components like dormancy, mistake rate and uptime. Nature of administration likewise includes controlling and overseeing system assets by setting needs for particular kinds of information (video, sound, documents) on the system. QoS is solely connected to arrange activity created for video on request, IPTV, VoIP, gushing media, videoconferencing and internet gaming.

There are three major parts for essential QoS execution:

1. Identification and stamping methods for organizing QoS from end to end between arrange components.
2. QoS inside a solitary system component.
3. QoS arrangement, administration, and bookkeeping capacities to control and direct end-to-end activity over a system.

2.2 QOS parameters

Distinctive applications have diverse prerequisites with respect to the treatment of their activity in the system. Applications produce activity at different rates and for the most part require that the system have the capacity to convey movement at the rate at which they create it. Likewise,

applications are pretty much tolerant of movement delays in the system and of variety in rush hour gridlock delay. Certain applications can endure some level of movement misfortune while others can't. These necessities are communicated utilizing the accompanying QOS-related parameters:

- Bandwidth - the rate at which an application's activity must be conveyed by the system
 - Latency - the defer that an application can endure in conveying a bundle of information.
 - Jitter - the variety in dormancy
- Loss - the level of lost information

In the event that unending system assets were accessible, at that point all application activity could be conveyed at the required data transmission, with zero inertness, zero jitter and zero misfortune. Be that as it may, organize assets are not vast. Subsequently, there are parts of the system in which assets can't take care of demand. QOS systems work by controlling the allotment of system assets to application activity in a way that meets the application's administration prerequisites.

3.1 Traditional Routing Algorithms in MANET

The term steering is essential for a system. Steering is a procedure of finding a capable, trustworthy and secure way from a source hub to a goal hub by means of transitional hubs in a given system. Steering in MANET is a testing work because of dynamic topology in arrange as portable hubs can move toward any path in the MANET. Versatile impromptu systems are anything but difficult to convey and arrange which makes its prominence in correlation the wired systems. Quick system setup is the fundamental component of MANET. MANET is helpful in places without any interchanges framework or when that foundation is antagonistically harmed. A little system can be setup by portable hubs (PC, PDA, Smart Devices) for sharing assets. Directing calculations in MANET ought to give following essential desires:

- Stable circle free availability
- Secure steering
- Reduced control overhead
- Have versatility and dispersed steering
- Support QoS movement prioritization
- Respond to changes in hub versatility.

The steering conventions can be basically sorted as: level directing, progressive directing and area mindful steering on organize structure. In level based directing, all hubs assume a similar part. In progressive – based directing, be that as it may, hubs will assume an alternate part in the system. In area mindful based directing, hub positions are misused to course information in the system.

There are three directing calculations in MANET, in particular, table-driven (or proactive) steering conventions, on-request (or responsive) steering conventions, and half and half steering conventions. One thing is general for both convention classes is that each hub taking an interest in steering assumes an equivalent part.

1. Reactive Routing Protocol (On-Demand): It doesn't periodically up date the directing table.eg. Specially appointed on request separate Vector Routing (AODV), Dynamic Source Routing (DSR), and Temporally Ordered Routing Algorithm (TORA), and so on.
2. Proactive Routing Protocol (Table Driven): It intermittently refreshes the routing table. e.g. Upgraded Link State Routing (OLSR), Cluster-based Gateway switch Routing (CGSR), and so on.
3. Hybrid Routing Protocol (Reactive/Proactive): It is a blend of both Proactive and Reactive Protocols. e.g. Zone Routing Protocol (ZRP) and so on.

Swarm Intelligence Models in MANET

This area quickly assessed the Swarm Intelligence Models in MANET.

Swarm Intelligence (SI) is a branch of EC wherein the flow of gathering is in charge of its survival. In SI, a gathering of people or particles participate with each other to discover ideal answer for the issue close by. To date, a few swarm knowledge models in view of various normal swarm frameworks have been proposed in the writing, and effectively connected in some genuine applications.

Cases of swarm knowledge models are:

- Ant Colony Optimization
- Particle Swarm Optimization
- Artificial Bee Colony
- Bacterial Foraging
- Artificial Immune System

Swarm knowledge is characterized as the community oriented execution of unconsolidated and auto sorted out get together. These comprise of basic delegates collaborating with the circumstance and among them. The delegates cooperate and erratically, without keeping up any principles. Comprehensively the states of mind of these modest agents end up being "canny". Sustenance and nectar searching techniques of ants and honey bees separately are cases of such conduct. The practices of swarms are like portable specially appointed systems (MANETs).

A swarm is a substantial number of alike, basic operators connecting locally among themselves, and their condition, with no fundamental control to enable a worldwide fascinating conduct to rise. Swarm-based calculations have as of late come up as a group of nature-roused, populace based calculations that are equipped for delivering minimal effort, quick, and vigorous answers for a few complex issues. Swarm Intelligence (SI) is a branch of Artificial Intelligence that is utilized to show the corporative conduct of social swarms in nature, for example, subterranean insect settlements, bumble bees, and feathered creature runs. Despite the fact that these operators (swarm people or creepy crawlies) are generally unsophisticated with constrained abilities all alone, they are teaming up with certain behavioural examples to helpfully accomplish assignments important for their survival.

4.1 Artificial Bee Colony

The ABC calculation is made out of three honey bees: utilized honey bee, spectator honey bee

and scout. Half of state comprises of utilized honey bees, and the other half comprises of passerby honey bees. Utilized honey bees misuse the nectar sources investigated previously and give data to the passerby honey bees holding up in hive about nature of nourishment source. Scouts either arbitrarily looks through nature to locate another sustenance source in view of an inward inspiration or on conceivable outside signs. One of the utilized honey bees is chosen and regarded as the scout honey bee. The choice is controlled by a control parameter called "restrict". On the off chance that an answer speaking to a sustenance source isn't enhanced by a foreordained number of trials, at that point that nourishment source is deserted by its utilized honey bee and the utilized honey bee is changed over to a scout. The quantity of trials for discharging a nourishment source is equivalent to the estimation of "restrain" which is a critical control parameter of ABC.

This emanant clever conduct in scrounging honey bees can be outlined as:-

1. At the underlying period of the searching procedure, the honey bees begin to investigate nature haphazardly so as to discover a sustenance source.
2. After finding a sustenance source, the honey bee turns into an utilized forager and begins to abuse the found source. The utilized honey bee comes back to the hive with the nectar and empties the nectar. In the wake of emptying the nectar, she can backpedal to her found source site straightforwardly or she can share data about her source site by playing out a move on the move zone. In the event that her source is depleted, she turns into a scout and begins to haphazardly look for another source.
3. Onlooker honey bees holding up in the hive watch the moves publicizing the productive sources and pick a source site contingent upon the recurrence of a move relative to the nature of the source.

Periods of ABC

ABC contains four primary stages:

1. Initialization Phase
2. Employed Bee Phase
3. Selection Phase of Onlooker Bees
4. Scout Bee Phase

4.2 Ant Colony Optimization (ACO)

Insect Colony Optimization (ACO) is a meta-heuristic approach for taking care of enhancement issues. (2)ACO calculations have been utilized to take care of various issues in specially appointed systems. Subterranean insect calculations were first proposed by Dorigo and partners as a multi-specialist way to deal with troublesome combinatorial enhancements issues , for example, the voyaging salesperson issue, chart shading, quadratic task issue and steering in correspondence systems etcetera. The motivating wellspring of ACO is the searching conduct of genuine ants that agrees to discover most brief ways between nourishment sources and the home. Truth be told, while strolling from nourishment sources to the home and the other way around, ants discharge a concoction substance (the pheromone) on the ground, and the heading picked by the accompanying ants is the way set apart by a more grounded pheromone focus.

Figures 2.1 (an) and (b) outline how, after some time, the ants on the shorter way achieve the

nourishment source sooner as contrast with ants on the long way. Ants on achieving the goal; begin another course in reverse towards the source settle by following a similar way and predispositions the way by saving more pheromone on the most limited way. As time advances, the pheromone on non-ideal ways dissipate while the pheromone on close ideal ways is strengthened. The essential standards driving this framework can be connected to numerous combinatorial enhancement issues like steering in

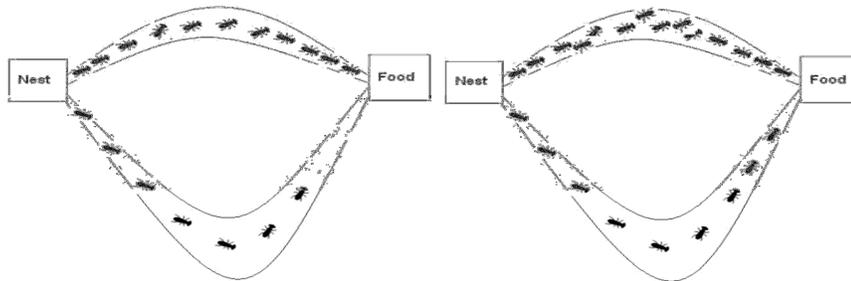


Figure 4.2 Double Bridge Experiment (a) Ants on the shorter path reach to food source earlier.

(b) Ants on the shorter path return to nest before the ants on longer path

4.3 Particle Swarm Optimization (PSO)

PSO is a populace based stochastic enhancement method and was proposed by Kennedy and Eberhart in 1995. This calculation depends on certain social practices saw in herds of feathered creatures, schools of fish, and so on., from which certain parts of insight rise. In PSO, every part is spoken to by molecule having speed and position of every one of them. The molecule's best position is assessed by the most elevated wellness esteem.

Different advances associated with PSO calculation are as:

- Initialize the molecule in a given hunt space.
- Evaluate the execution of every molecule.
- Compare the molecule's wellness esteem with best. On the off chance that the estimation of molecule is superior to anything best at that point set this incentive, best case scenario
- Update the position and speed of particles.

4.4 Bacterial Foraging Optimization Algorithm (BFOA)

This calculation is worldwide streamlining calculation roused by rummaging conduct of microorganisms named air conditioning *Escherichia Coli*. BFOA is enlivened by chemotaxis behavior of microscopic organisms. These microscopic organisms get the bearing to sustenance in view of slopes of chemicals the data preparing methodology is accomplished through arrangement of procedures.

- Chemotaxis pivot: Cells move along the surface each one in turn.
- Reproduction: Best arrangement of microbes of is chosen, with the goal that it contributes to the people to come.
- Elimination and Dispersal: Cells are disposed of and new examples are inserted.

□□Literature Review

Keeping in mind the end goal to get to all significant data numerous sources have been explored. The target of conveying writing audit was to increase further comprehension of various systems that exists in writing and to discover hole in the examination.

Add up to 27 applicable papers were chosen for survey. These papers were distributed in standard in diaries and meetings.

In the year 2010, SwapnaPriyaJaladi proposed another QoS enhancing calculation for portable specially appointed system. This calculation consolidates the thought process of Ant Colony Optimization (ACO) with Optimized Link State Routing (OLSR) convention to distinguish various stable ways between source hub and goal hub to enhance the QoS [17]. DebajitSensarma and KoushikMajumder, in 2011 outlined another proficient and vitality mindful multipath steering calculation in view of ACO system, motivated by the practices of natural ants, which bolsters constant and mixed media applications.[18]. With title "Applying QoS in MANET utilizing Stigmergy of Ants", in year 2011, Sanjeev Kumar and et.al displayed a swarm keen framework proposition for keeping up nature of administration parameter for correspondence in MANET, which was strong and produces satisfactory control overhead while giving numerous achievable courses for mixed media traffic.

In 2012, Radwa Attia1, et.al gave presents two steering calculations in MANETs propelled by the insect settlement streamlining (ACO) directing calculations. By recreation work creator demonstrates that these calculation beat the regular AODV, AntNet, and AntHocNet regarding end-to-end delay, bundle conveyance proportion while accomplish satisfactory overhead. R.T.Thivya Lakshmi, et.al, in the year 2012, proposed Ant Colony Optimization and Particle swarm streamlining Techniques to guarantee the Quality of Service parameters and furthermore to improve the MANET security. "Audit on Intelligent Routing In MANET" distributed different methods to accomplish astute steering in a MANET utilizing Ant Colony Optimization, Bee Colony Optimization, and Termite Hill Building strategy in 2012 by HimadriNathSaha, et.al. In the year 2013, MehtabAlam, AsifHameed Khan, IhtiramRaza Khan, examined the appropriateness of Swarm Intelligence (SI) in MANETs.

AnujK.Gupta, Anil K. Verma, and Harsh Sadawarti, distributed nitty gritty examination of various Ant based calculations was introduced. What's more, reason that the ACO calculations show highlights which are profoundly attractive in a specially appointed steering convention in the year 2013. To augments the lifetime of system and gives a viable multi-way information transmission in effective way in MANET," RichaKalucha, Deepak Goyal", in the 2013, ponder diverse swarm calculations and recommend that ABC is best. In "Insect Colony based Routing for Mobile Ad-Hoc Networks towards Improved Quality of Services" another QoS calculation for portable specially appointed system has been proposed. which joins the possibility of Ant Colony Optimization (ACO) with Optimized Link State Routing (OLSR) convention to distinguish numerous steady ways amongst source and goal nodes.

In the year 2013, Sumit Kumar, Rama Chaudhary, Nitin proposed two new calculations MODANT and FITANT to discover ideal and solid way to rout. Creator proposed ABIRP calculation to enhances the Energy effectiveness, strength and dependability while directing inside MANET, in "Insect based Intelligent Routing Protocol for MANET". AshuTyagi, PankajSharma in 2013, proposed another QoS calculation for portable impromptu system. The

proposed calculation consolidates the possibility of Ant Colony Optimization (ACO) with Optimized Link State Routing (OLSR) convention to distinguish stable ways in the middle of source and goal hubs.

Mrs. D. AhimugaSivasakthi, To upgraded Ant Routing (OAR) for enhancing QoS had been proposed. It is profoundly versatile and accomplishes higher data transfer capacity, shorter deferral, and most brief ideal course regarding bounce tally and pheromone. In the year 2014, A Routing technique was proposed to help sight and sound interchanges in portable specially appointed systems in light of Ant Colony structure by thinking about QoS. This proposition depends on subterranean insect like versatile operators to build up various stable ways amongst source and goal hubs by Dr.Gireeshkumar Dixit, Mr.P.Vishvapathi, Ms.K.Priyadarshini in "Steering for Portable Ad-Hoc Networks towards Enhanced Value of Services". BeeIP another steering convention roused by bumble bees was exhibited in 2014. BeeIP was quantitatively contrasted with best in class directing methodologies. Greatest quality of this calculation was normal end-to-end defer and bundle conveyance proportion.

In the year 2015, various ACO propelled specially appointed steering conventions were considered and incomplete correlation made by Anuj K. Gupta, Harsh Sadawarti, and Anil K. Verma. A review of the current ACO based steering conventions was given here. Different ACO based calculations contrasted and unique ones and better outcomes acquired as far as end to end postpone and directing overhead etc[29]. "A Review on Ant Based Routing Protocols for Manet" was given by AmandeepKaur, Aashdeep Singh in 2015, where different insect state steering calculations with their particular favorable circumstances and impediments have been contemplated. Utilizations of subterranean insect state calculations to take care of the steering issue in MANET have been tended to. A capable versatile multipath QoS-mindful steering convention in light of ACO (QoRA) proposed for MANETs in 2015 by Aymen Al-Ani and Jochen Seitz. They give correlation of QoRA AODV in view of QoSmetrics data transfer capacity, postponement, and parcel misfortune proportion supports the higher ability of QoRA to give QoS prerequisites to sight and sound applications over AODV.

DharmendraSutariya, ParizaKamboj played out "A Survey Of Ant Colony Based Routing Algorithms For Manet" in 2015, and audit different insect based directing calculations and analyzed them regarding convention properties, execution grids and system parameters, in view of this it is inferred that Ant based calculation gives best QoS results to MANET. To fulfill vitality and postpone imperatives of QoS, in year 2015, Mustafa Hamid Hassan proposed another vitality and deferral mindful steering convention that consolidates cell automata (CA) with the crossover hereditary calculation (GA) and African Buffalo Optimization (ABO) to enhance the way determination in the impromptu on-request remove vector (AODV) directing convention. In the year 2015, Sameer Abdulateef Hussein and DahlilaPutriDahnil, proposed A QoS steering calculation relevant in MANET, which fulfill the vitality limitations that enhance the system lifetime .

A way choice based PSO safe steering way to deal with exchange information from blockage free and assault safe way recorded in "Fluffy Swarm Intelligence Approach to Improve QoS (Quality of Service) in MANET" in year 2015 [34]. An enhanced procedure was proposed in the year 2016 by HarkiratKaur, Shivani Sharma, to deal with the issue of hubs amid bundle transmission. MerinAchankunju, R. Pushpalakshmi, A.Vincent Antony Kumar proposed A molecule swarm advancement calculation in light of secure QoS grouping in versatile impromptu systems (MANETs) in 2016.

Tuned Cuckoo Search Algorithm (TCSA) proposed and recreations are completed in 2017 by

Maguteeswaran, S. Rajalakshmi, utilizing PSO to fulfill QoS required in versatile impromptu system. In this three most fundamental execution measurements, to be specific, bundle conveyance proportion, way achievement proportion, and normal end-to-end defer are estimated with the end goal of correlation with different strategies [37.]B. Jayalalitha, Dr. P. Chenna Reddy, outlined Anthocnet steering convention in 2017, for specially appointed system to decrease the overhead in anthocnet.

Conclusion

In a request to discover procedures that were proposed by specialists for utilizing swarm knowledge in MANETs, A precise writing survey has been completed. There are different strategies that exists in writing however has restrictions and requirements. In this manner, Intensive research and study was done in the field to examine and get top to bottom information about the subject.

We found that because of accessibility of constrained assets, planning a proficient steering methodology for MANET is exceptionally testing. Because of this analysts are pulled in for studying attributes of MANET, for example, security and unwavering quality, Quality of Service (QoS), between systems administration, control utilization and multicasting for their examination.

Swarm insight procedures, for example, Ant Colony Optimization, Particle Swarm Optimization, Bird-flight algorithm, Artificial Bee Colony, are preferable approach over the customary directing methods utilized before.

Our goal is to plan and create productive and solid new or variation of existing Swarm based steering calculations for MANETs to enhance Quality of Service.

References

- [1] Kaur, Amandeep, and Aashdeep Singh. "A Review on Ant Based Routing Protocols for Manet." International Journal 5.3 (2015).
- [2] Singh, Gurpreet. Design And Development Of Aco Routing Protocol For Manets. 2014
- [3] Anchugam, C. V., and K. Thangadurai. "Link quality based Ant based Routing Algorithm (LARA) in MANETs." International Journal 4.1 (2017): 52-60.
- [4] R.T.Thivya Lakshmi, R.Srinivasan, G.S.Raj. "An Efficient Algorithm for Improving Qos in MANETs".International Journal of Scientific and Research Publications.Volume 4.Issue 2. February 2014.ISSN 2250-3153
- [5] Luo, Heng. A Best Effort QoS Support Routing in Mobile ad hoc Networks. 2011.
- [6] Alam, Mehtab, AsifHameed Khan, and IhtiramRaza Khan. "Swarm Intelligence in MANETs: A Survey." (2016).
- [7]Siwach, Vikas, Dr Yudhvir Singh, and DheerDhwaj Barak Seema."An Approach to Optimize QOS Routing Protocol Using Genetic Algorithm in MANET." International Conference on Emerging engineering Trends and Management. 2012.
- [8] Persis, D. Jinil, and T. Paul Robert. "Ant based multi-objective routing optimization in mobile ad-hoc network." Indian Journal of Science and Technology 8.9 (2015): 875-888.

- [9] Rajan, C., et al. "Investigation on novel based naturally-inspired swarm intelligence algorithms for optimization problems in mobile ad hoc networks." World Academy of Science, Engineering and Technology International Journal of Mathematical, Computational, Natural and Physical Engineering 9.3 (2015).
- [10] Saha, HimadriNath, AparajitaChattopadhyay, and DebabrataSarkar. "Review on intelligent routing in MANET." Computing and Communication (IEMCON), 2015 International Conference and Workshop on.IEEE, 2015.
- [11] Bee Optimization To Enhance Quality Of Services In Manet.
- [12] Kalucha, Richa, and Deepak Goyal. "A Review on Artificial Bee Colony in MANET." (2014).
- [13] Gupta, Anuj K., Anil K. Verma, and Harsh Sadawarti. "Analysis of various Swarm-based & Ant-based Algorithms."Proceedings of the International Conference on Advances in Computing and Artificial Intelligence.ACM, 2011.
- [14] KamaldeepKaur, LokeshPawa. Review of Various Optimization techniques in MANET Routing Protocols. IJSETR. Volume 4. Issue 8.2015
- [15] ER. Jatinjain, ER. Jujhar Singh. Implementation of an Improved Path Selection Algorithm Using Particle Swarm Optimization Technique.International Journal of Engineering Trends and Technology. Volume 24.2015.
- [16] DweepnaGarg, ParthGohil. Ant Colony Optimized Routing For Mobile AdhocNetworks . International Journal of Smart Sensors and Ad Hoc Networks (IJSSAN) .2012
- [17] Jaladi, SwapnaPriya. "Ant Colony Optimization Based Routing to Improve QoS in MANETs."
- [18] Sensarma, Debajit, and KoushikMajumder. "An efficient ant based qos aware intelligent temporally ordered routing algorithm for manets." arXiv preprint arXiv:1308.2762 (2013).
- [19] Kumar, Sanjeev, Santosh Kr Paul, and Shyam Singh Rajput. "Applying QoS in MANET using Stigmergy of Ants."International Journal of Computer Applications 85.8 (2014).
- [20] Attia, Radwa, RawyaRizk, and Mahmoud Mariee. "An Ant Inspired QoS Routing Algorithm for MANETs." Ad Hoc & Sensor Wireless Networks 10.2-3 (2010): 111-134.
- [21] Saha, HimadriNath, AparajitaChattopadhyay, and DebabrataSarkar. "Review on intelligent routing in MANET." Computing and Communication (IEMCON), 2015 International Conference and Workshop on.IEEE, 2015.
- [22] Roy, Bibhash, et al. "Ant colony based routing for mobile ad-hoc networks towards improved quality of services." Journal of Emerging Trends in Computing and Information Sciences 3.1 (2012): 10-14.
- [23] Kumar, Sumit, and Rama Chaudhary. "Optimization of routing algorithms in ad-hoc networks using swarm intelligence." Information and Communication Technologies (WICT), 2011 World Congress on.IEEE, 2011.
- [24] Karthikeyan, D., and M. Dharmalingam. "Ant based intelligent routing protocol for MANET." Pattern Recognition, Informatics and Mobile Engineering (PRIME), 2013 International Conference on.IEEE, 2013.
- [25] Tyagi, Ashu, and Pankaj Sharma. "Implementation of Ant Colony Optimization with OLSR in Mobile Ad hoc Network." IJCSIT) International Journal of Computer Science and Information Technologies 4.6 (2013): 927-930.
- [26] Sivasakthi, D. Adhimuga. "Optimized Ant Routing For Improving Qos In MANETs." International Journal Of Engineering And Science 3.9 (2013): 33-36.
- [27] Dr.Gireeshkumar Dixit, Mr.P.Vishvapathi, Ms.K.Priyadarshini. "Routing for Portable Ad-Hoc Networks towards Enhanced Value of Services".International Journal of Engineering Inventions. Volume 2,Issue 12.2013.
- [28] Giagkos, Alexandros, and Myra S. Wilson. "BeeIP–A Swarm Intelligence based routing for wireless ad hoc networks." Information Sciences 265 (2014): 23-35.

- [29] Gupta, Anuj K., Harsh Sadawarti, and Anil K. Verma. "MANET Routing Protocols Based on Ant Colony Optimization." *International Journal of Modeling and Optimization* 2.1 (2012): 42.
- [30] Al-Ani, Aymen, and Jochen Seitz. "QoS-aware routing for video streaming in multi-rate Ad hoc Networks." *Wireless and Mobile Networking Conference (WMNC), 2016 9th IFIP.IEEE, 2016*.
- [31] Sutariya, Dharmendra, and ParizaKamboj. "A survey of ant colony based routing algorithms for manet." *European Scientific Journal* (2013).
- [32] Hassan, Mustafa Hamid, and Ravie ChandrenMuniyandi. "An Improved Hybrid Technique for Energy and Delay Routing in Mobile Ad-Hoc Networks." *International Journal of Applied Engineering Research* 12.1 (2017): 134-139.
- [33] Hussein, Sameer Abdulateef, and DahlilaPutriDahnil. "A New Hybrid Technique to Improve the Path Selection in Reducing Energy Consumption in Mobile AD-HOC Networks." *International Journal of Applied Engineering Research* 12.3 (2017): 277-282.
- [34] SonalKhurana, GarimaChaudhary. "Fuzzy Swarm Intelligence Approach to Improve QOS (Quality of Service) in MANET".*International Journal of Advanced Research in Computer Science & Technology (IJARCST 2015)*. Vol. 3.Issue 2.2015
- [35] Kaur, Harkirat, and Shivani Sharma. "Performance Evaluation of Re-Routing based Hybrid ACO-PSO based Routing Algorithm for MANETS." *International Journal of Computer Applications* 142.13 (2016).
- [36] Achankunju, Merin, R. Pushpalakshmi, and A. Vincent Antony Kumar. "Particle swarm optimization based secure QoS clustering for mobile ad hoc network." *Communications and Signal Processing (ICCSP), 2013 International Conference on.IEEE, 2013*.
- [37] Rajalakshmi, S., and R. Maguteeswaran. "Quality of Service Routing in Manet Using a Hybrid Intelligent Algorithm Inspired by Cuckoo Search." *The Scientific World Journal* 2015 (2015).
- [38] Jayalalitha, B., and P. Chenna Reddy. "Design of an ANT based routing algorithm for mobile ad-hoc networks." *Communication and Electronics Systems (ICCES), International Conference on.IEEE, 2016*.