European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 7, Issue 11, 2020

Optimal Path Selection for Autonomous Robot Navigation Using Hybrid PSO-GA Routing Protocol

Uppalapati. Srilakshmi[*1], Maridu. Bhargavi[#2], Bavidisetty. Mounika[#3], Nannapaneni. Uttej Kumar[#4]

[#1,2,4]*Department of CSE,* [#1,2,4]*VFSTR Deemed to be University Vadlamudi, Guntur, A.P, India.*

[#3]Department of CSE, [#3]Stanley College of Engineering and Technology for Women, Hyderabad.

[1]srilu.uppalapati@gmail.com
[2]mb_cse@vignan.ac.in
[3]*bmounika@stanley.edu.in*
[4]uttejkumar171f18@vignan.ac.in

Abstract

A hybrid metaheuristic (genetic algorithm)-PSO algorithm have presented toward find an optimal path among a preliminary point along with the end point in a grid environment for autonomous robot navigation is presented. GA is combined with PSO to develop new solutions through the use of particle-built solutions by crossover and mutation operators. The use of cubic B-spline techniques to create nearly optimal collision free continuous path Simulation of conventional GA and PSO algorithms prevents premature convergence and time complexity. This hybrid algorithm avoids The initial feasible path generate from GA-PSO hybrid planner results be taken with purpose to demonstrate the value of the proposed GA-PSO hybrid road planner and to plan the autonomous robotic path more smoothly.

Keywords: *genetic algorithm, global path planning, autonomous robot, navigation, particle swarm optimization.*

1. INTRODUCTION

Global path planning was a major challenge in several corrections, also have the design of large-scale VLSI circuits, GPS applications and autonomous robotic navigation. Many methods, like cell decomposition [1-2], skeleton as well as potential field[3], have addressed the problem of global path planning. Furthermore, the issue of global path management has been frequently addressed through soft computing techniques like fluttered logo, neural networks, along with evolutionary algorithms. Jung et al.[4] have introduced a neural network approach for mobile robots. In [5] a smooth logic approach was proposed to address the problem of path planning. To address optimizing problems, Hocaoglu et al.[6] used an evolutionary algorithm. GA and PSO were considered to be effective metaheuristic algorithms to find optimal solutions to complex combination problems. Among those approaches. GA was developed by Holland[7] on the basis of evolutionary principles and was proven strong when it exploited its strong optimization capability[7-8] to locate best resolution. Kennedy and Eberhart's PSO algorithm[9] provides a probabilistic approach to the solution of optimum issues. Another powerful way of solving optimization problems was considered to be PSO algorithm[9-10]. This paradigm for calculations and modelling is directly related to the organization and performance of birds and insect swarms in groups. The optimization of particle swarm was an efficient and robust approach which is utilized in a variety of applications for global optimization problems (11-12). Although all Intelligent optimization algorithms are commonly used, GA and PSO have their own advantages and disadvantages[13-14]. GA carries out chromosomal recombination and mutation operations. The search capacity is high globally, however, it is slow to converge, as no memory mechanism applies. When the population changes, the search experience is discarded. Because of good data the resolutions were kept through particles, also the PSO has a far more powerful intelligent background. There is productive collaboration among particles, known as sharing of their search experiences with the particles in the swarm[13-14]. This article presents a hybrid GA-PSO metaheuristic approach to avoid the problems with the global route planning of traditional GAs and PSOs. Even from proposed hybrid GA-PSO algorithm the collision-loose course can be received, the ensuing course includes a series of line segments. Unfortunately, one of these discontinuous route is not ideal for self sufficient robotic navigation from the manage angle, as it's miles vital to forestall robots at every nook. Such segments should be deformed or uniformly balanced. B-splines are powerful also widely used curvature interpolations in several disciplines [15-17]. This interpolation system is without a doubt beneficial for self sustaining cell robots to smooth pathways. This paper aims to expand a hybrid GA-PSO algorithm for solving the global path trouble of self reliant robot navigation path making plans.

Remainder of this paper was structured accordingly. Section II proposes to solve global path planning problem utilizing a hybrid, metaheuristic GA-PSO algorithm. Section III explains how the GA-PSO hybrid algorithm and B-spline technique can be applied towards discover regional, almost optimum continuous route for autonomous robot navigation. Section IV performs a number of simulations to reveal presentation with merit of methods proposed. This paper was concluded in Section V.

2. LITERATURE SURVEY

In this Author[18], a fractional PI D-controller was intended for a USV autopilot with flexible shape characteristics, strong robustness and powerful anti-disturbance competencies. At the same time, genetic algorithm (GA) was mixed by a Particle Swarm Optimization Algorithm (PSO) with a purpose to solve the multi-parameter and complicated structure of the PID Controller in fractional classes and to increase the global optimizing and converging accuracy of PSO, increasing the speed of the algorithm. In contrast to the fractional-order PI D control, the system simulates and discusses the complex efficiency and robustness of the two control methods on the basis of the GA-PSO algorithm and the PID controller based on the PSO algorithm.

In [19], the author looked at the Functional Link Neural Network model (FLANN) with different learning algorithms, such as the Least Mean Square (LMS) and the Bio-based Algorithms, the Standard Biogenetic Algorithms (SGA) and PSO, the Standard genetic Algorithms (SGA) and Particle Swarm Optimization (PSO).

This author[20] develops a system of financial income assessment indicators, financial sustainability, fiscal average growth rate, tax average growth rate and financial expenditure of these indicators as a key part of this paper risks GA-PSO mixed planning algorithm with a powerful impact on credit risk assessment.

The Author[21] utilizes a combination of the genetic (GA) and PSO algorithms to find a better solution by using a thread parallel to resolve the execution speed.

3. PROPOSED WORK

The proposed GA-PSO hybrid algorithm has a standard GA-hybrid PSO, which can cover and creates novel population. PSO and GA cooperatively research into the solution space in projected GA-PSO hybrid algorithm. These two global path planning algorithms are described below in a short way and the GA-PSO hybrid approach to address the optimal problem is presented.

3.1 GA for global path planning

Genetic algorithms are efficient and heuristic process of scanning. This principal thought be to build fitness on the way to assess each chromosome in a population according to its objective function. A chromosome that is in good condition was preferred based on resolution to given issue after a number of iterations. The first element of this algorithm is a series of randomly chosen chromosomes and two genetic operators. The selection operator is used for the generation with generation. The better fitness values of the chromosomes in the next generation are more likely to be selected. A chromosome provides a collection of grid points for global path planning in GA computing, including a starting point and end point. The genetic operators, including the range, crossover and mutation, determine the optimal collision-free path. Next step was introduction of GA genetic operations.

3.2 Reproduction (Selection)

The main aim of reproduction is to duplicate good and bad solutions for a population while maintaining a constant size of population. This process is used to move these individuals to intersection and mutation modules for new descendents for identified individuals from the population. Ultimately, the selection policy ensures the survival of the best-suited people.

3.3 Crossover

Crossover has been used in the selection of GA and is the fundamental method for genetic rearrangement. The location of the crossover is randomly identified and other sections of the strings for new solutions are exchanged.

3.4 Mutation

The mutation be a procedure that requires the introduction of some kind of spontaneous alteration to the bits of the chromosomes. This operator is required to preserve certain population diversity.

3.5 Fitness function

The global road design problem was analyzed to exploit a workable crash-free way for a mobile robot to move from start to target in an organized obstacle environment. Proposed GA-PSO algorithm can be apply towards calculation of a collision-free route in view of an environmental context, initial and final positions. There are a variety of grid points (genes of a chromosome) in the chollid-free path including a starting point and ending point. A chromosome had a variable length of two to maximum length of M. The fitness function represented by an assessment may be either viable(collision-free) or unfeasible.

$$F = \sum^{Mmax,i=0} D_i + \alpha_i T$$

Where M max represents the number of the segments of the line, di is the distance from the two track nodes along the path, T is constant, αi is 0 while αi is viable = N when the track segment crosses the obstacles.

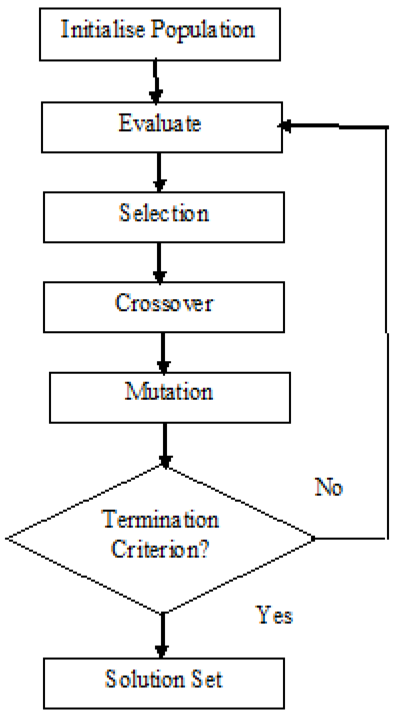

Figure1: **Flowchart of Genetic algorithm**

3.6 Particle Swarm Optimization

The optimization of the particulate swarm is a stochastic optimisation technique for the population developed in 1995 based on the social behavior of bird flocking and fish education.

The device is initialized by a random solution generation and by updating generations it searches for optimum solutions. PSO has many parallels, such as a genetic algorithm (GA), with the developmental computer technology. Nevertheless, PSO has no evolutionary regulators, such as crossover and mutation, in comparison to GA. Potential solutions known as particulate matter fly in the sense of PSO to detect the ideal particles. Specific information is given in the following sections.

Compared with GA, PSO have advantages from the easy implementation of PSO and few parameters. In many areas, PSO has been effective: task optimization, neural network training, flight control of machines, and other fields where GA is applied. PSO was used extensively.

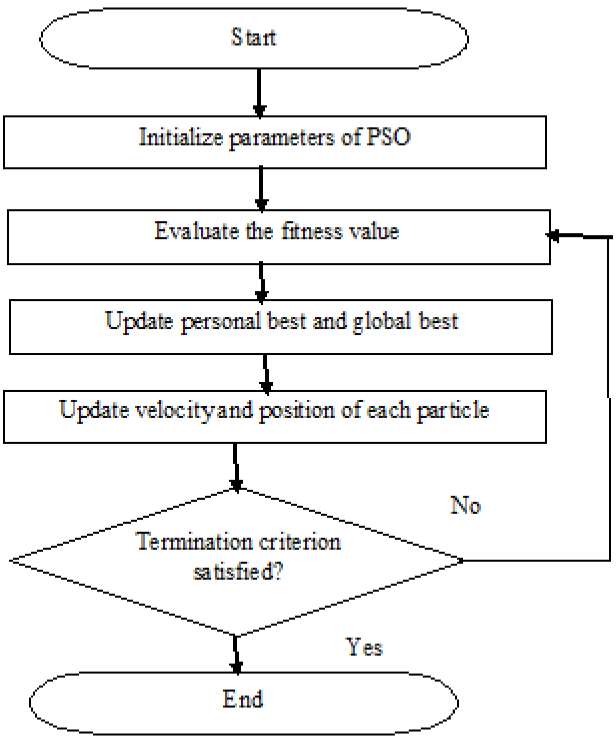

Figure2: Flowchart of PSO

The pseudo code of the procedure is as follows

for every particle

Set the particle in motion

End

Do

for every particle

Fitness value estimation

If you have the best exercise value in history (pBest).

Set the new pBest current value

End.

Choose the particle with the best fitness value for the gBest

for every particle

Equation (a) Calculates particle velocity

Equation (b) change the particle location

End.

4. RESULT AND DISCUSSIONS

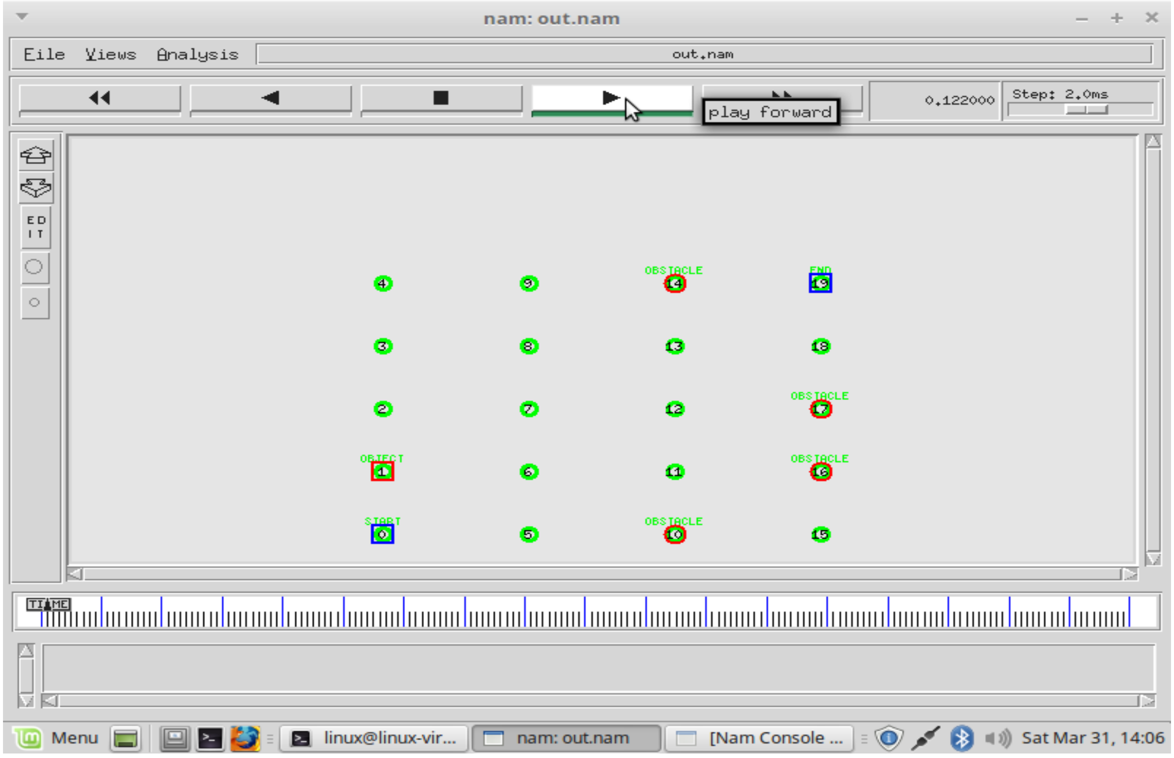

Figure3: Nodes in Grid System

- The grid system is composed of 20 nodes and defined as a matrix. The nodes start with 0-19 and are shown by circles.
- The Source and destination nodes represented by Blue Squares are 0 and 19 in this Grid system.
- The Obstacles identified by the Red Circles are 10, 14, 16, 17.

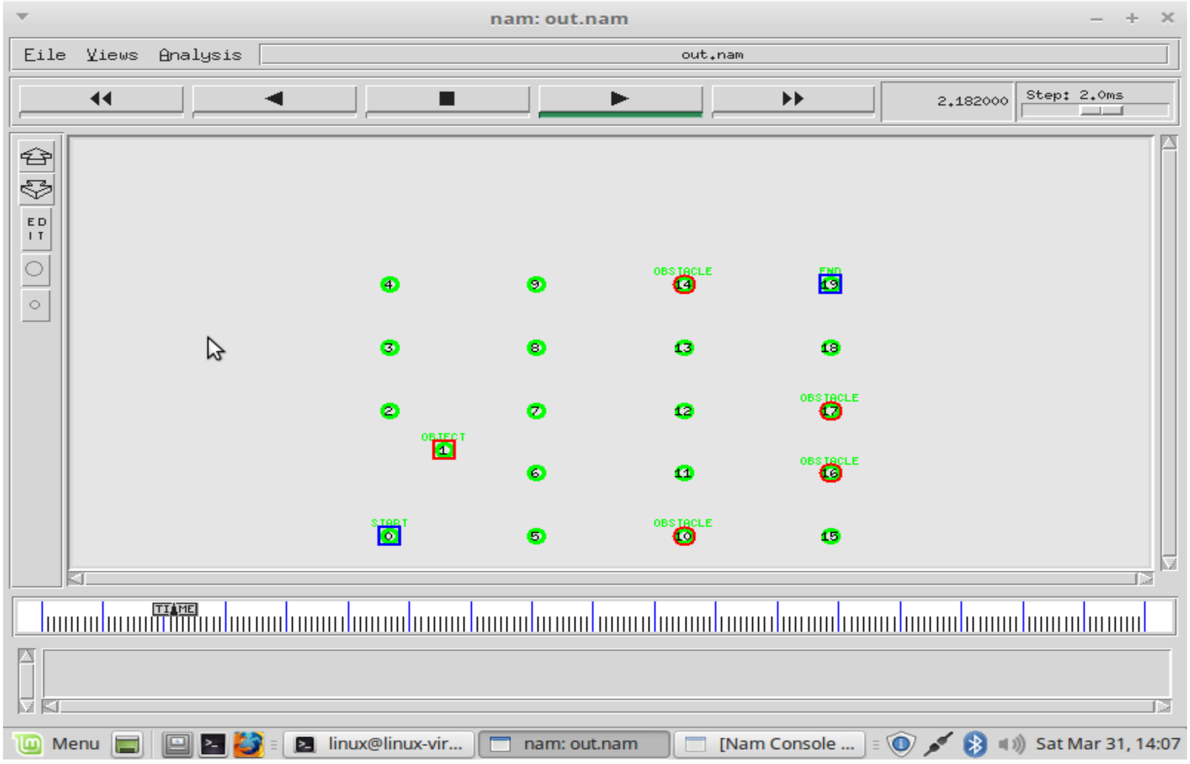

Figure4: Object Movement

➢ Here, an object is selected and running between several points after a command is executed. During execution, this object avoids obstacles.

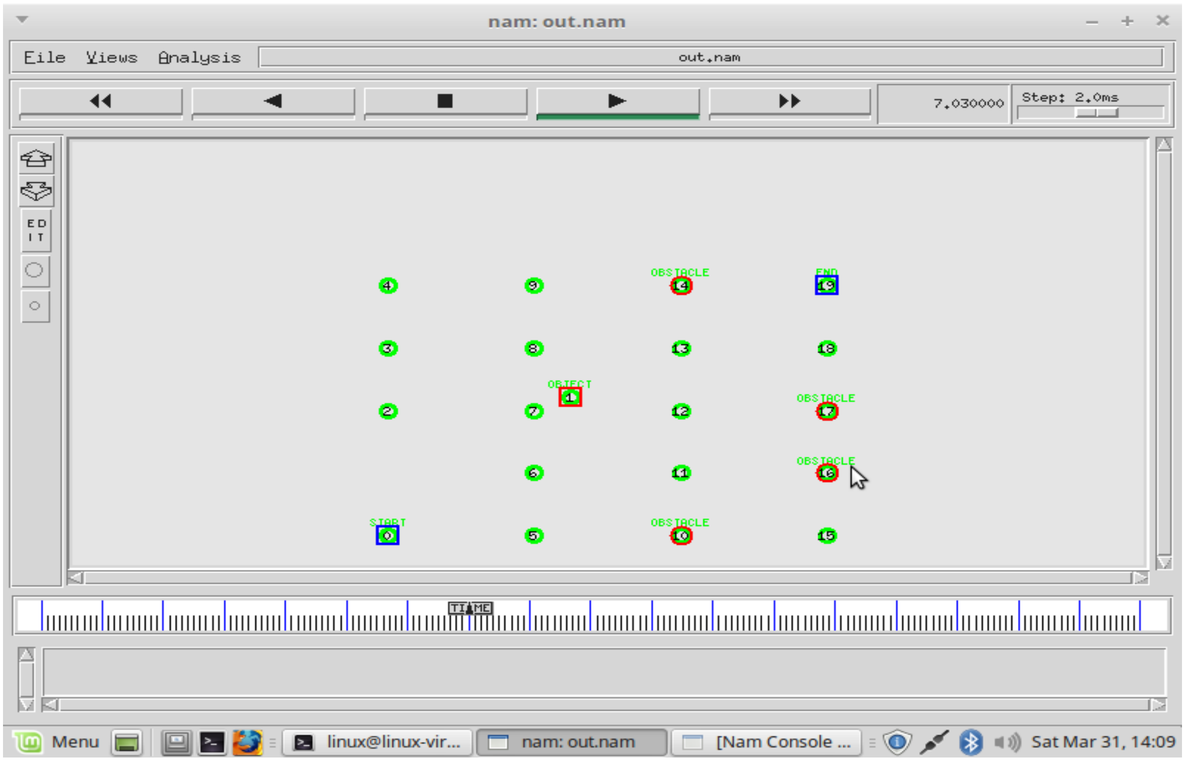

Figure5: Moving of an Object between Nodes

➢ This is object selected (i.e) 1 moving object to destination.

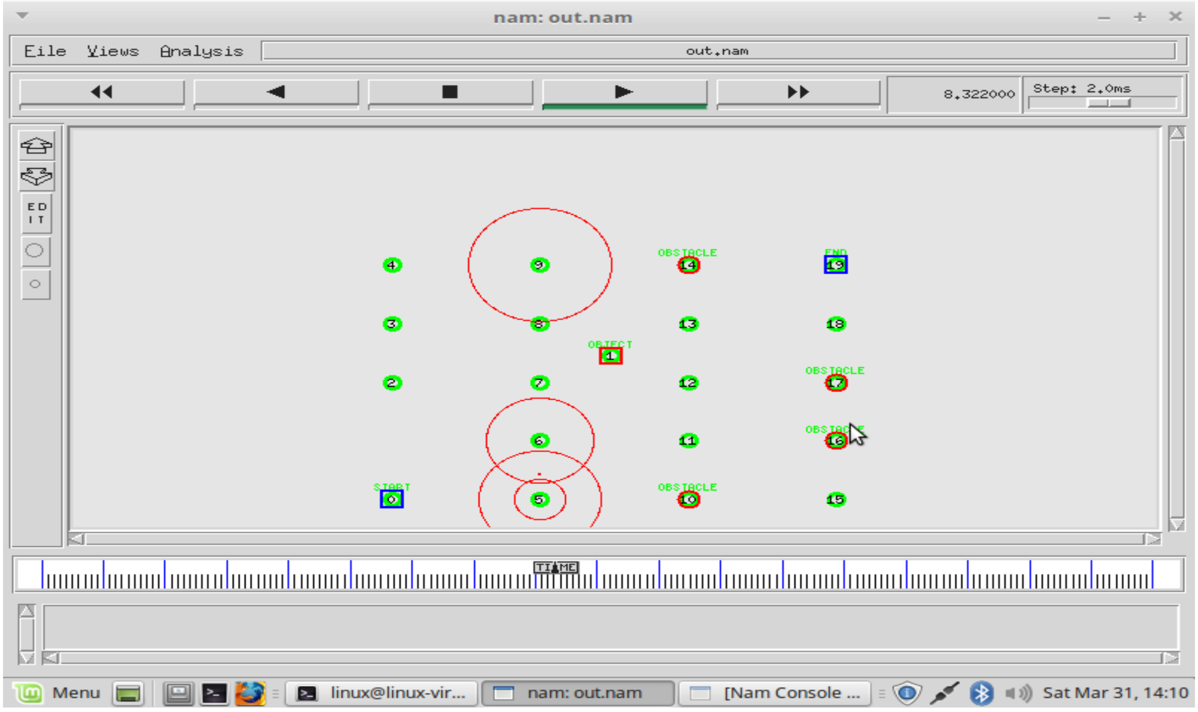

Figure6: Looking for Neighborhood Nodes

➢ The object moves between the nodes and obstacles in the system. But that removes the node of obstruction.

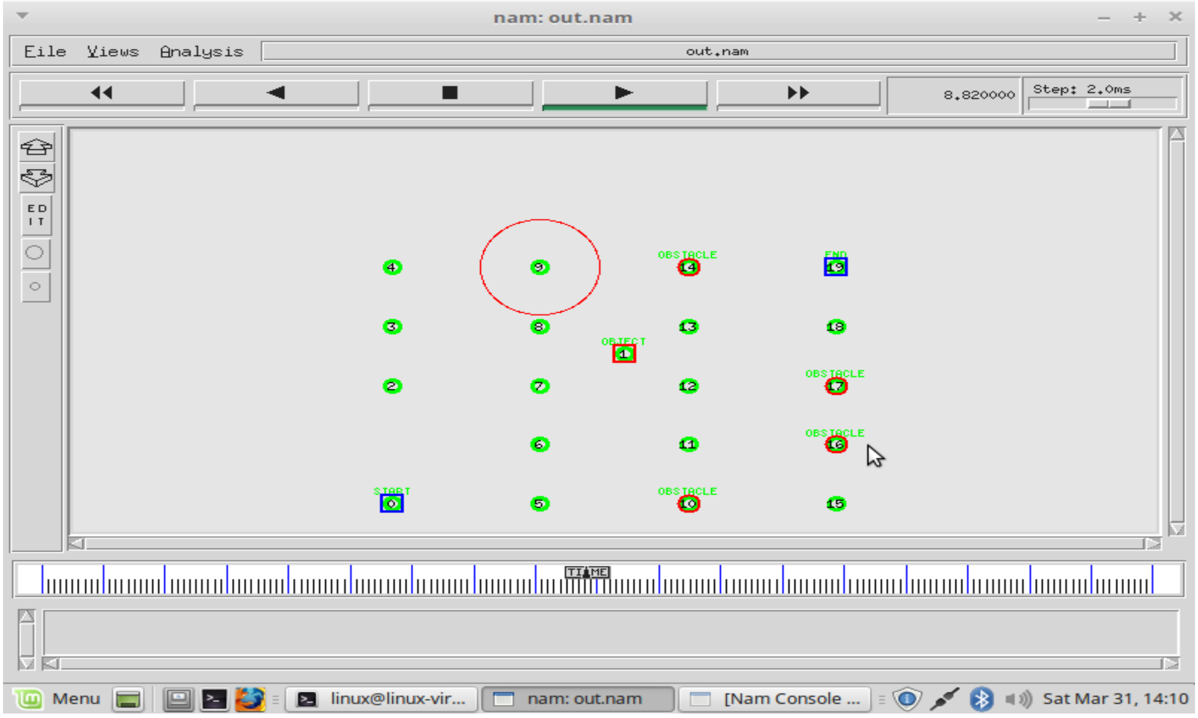

Figure7: Reaching Near Object

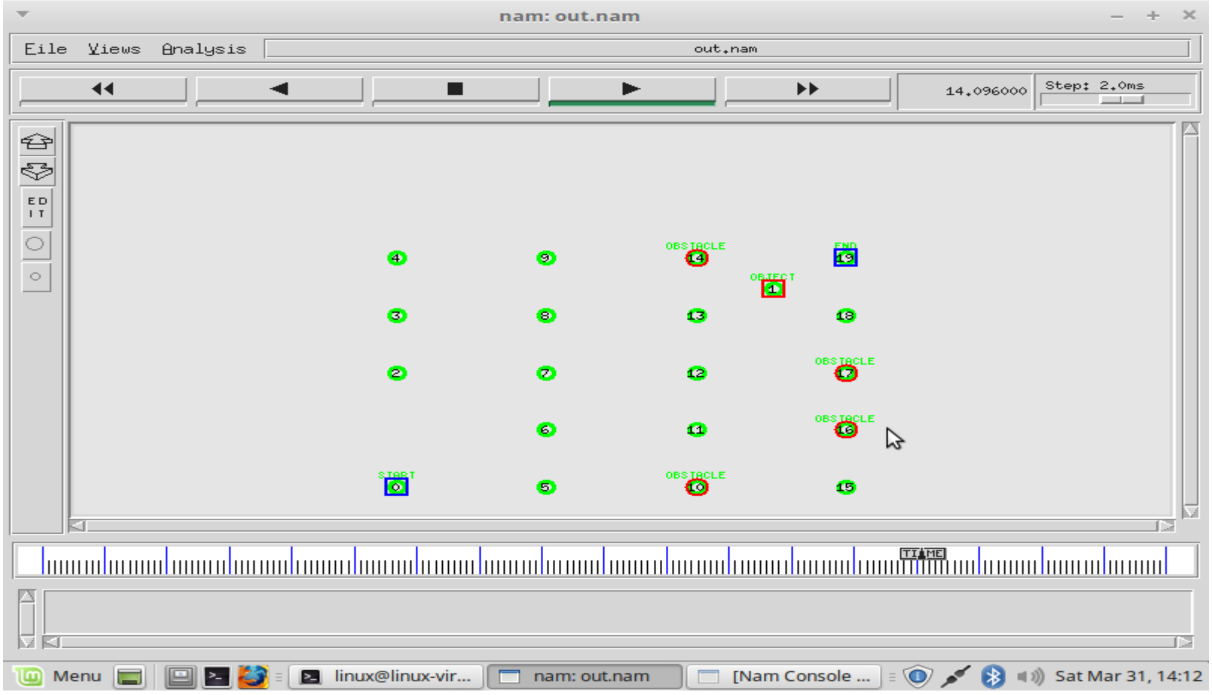

Figure8: Path generated by avoiding the obstacles

- The object you have selected collects all data close to the object's neighbor. And it continually moves to the grid system destination.
- Here is another object selected moving by avoiding obstacles from source to destination.

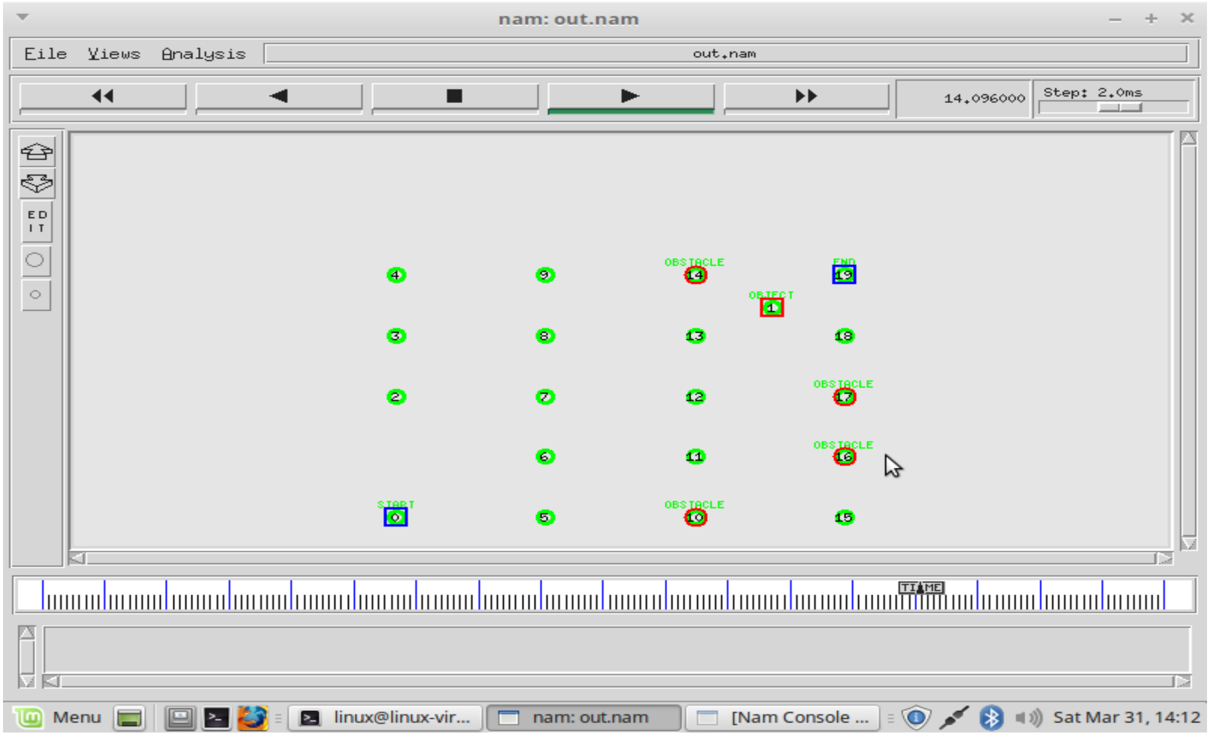

Figure9: Object towards destination

- Here the object moves to the destination selected. It will reach the destination after the object is accomplished.

➢ The object selected is reached by avoiding the obstacles in the grid system. The path is the shortest and reaches the goal in the shortest possible time.

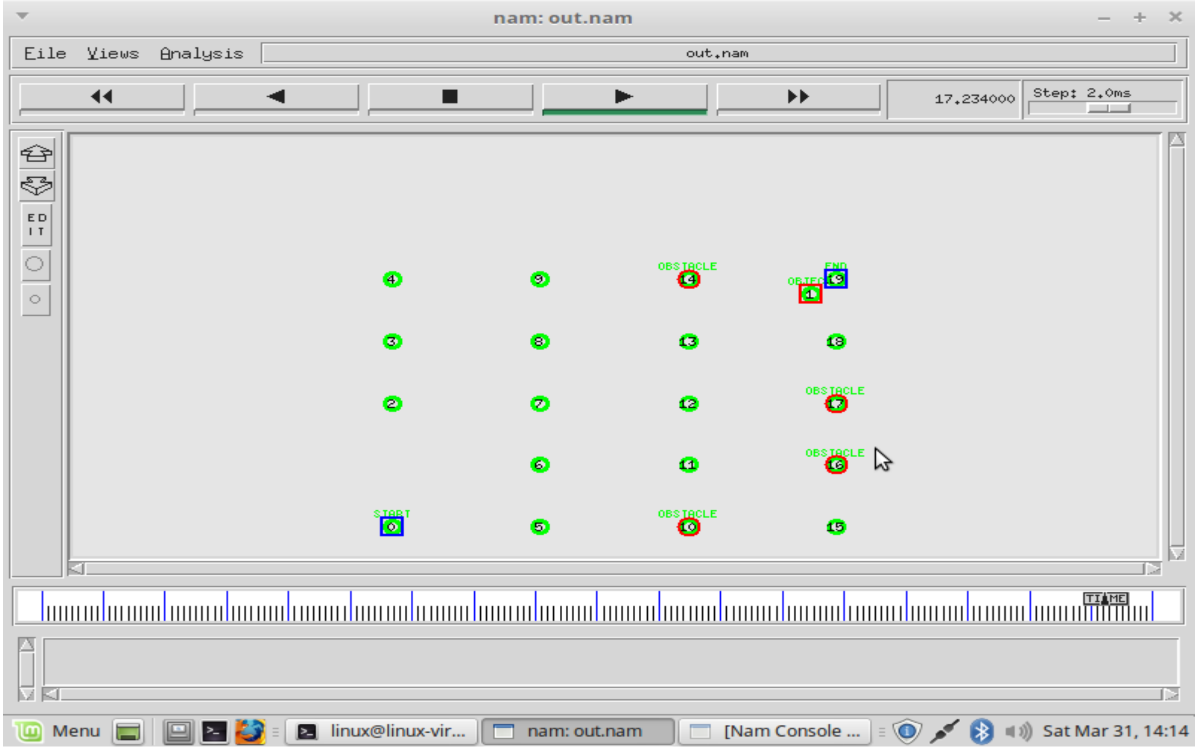

Figure10: Object reaches the destination node

➢ By eliminating any obstacles, the object selected is reached in the grid system. The path is the shortest and meets the goal in a specified amount of time.

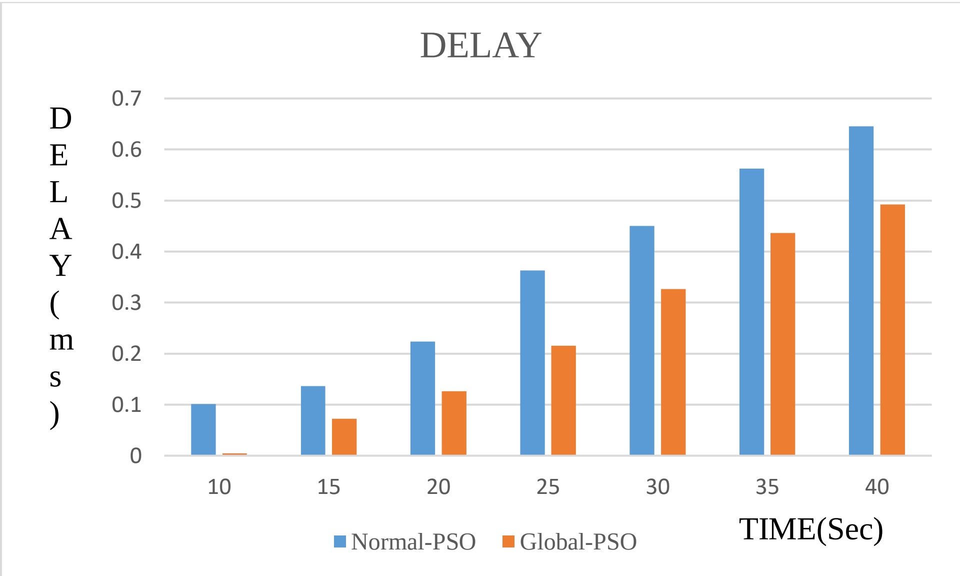

Figure11: Delay

The end-to - end delay of a network is shown in Figure 11. This demonstrated that our Global-PSO method proposed was successful when compared to existing works such as Normal-PSO by reducing network delaying.

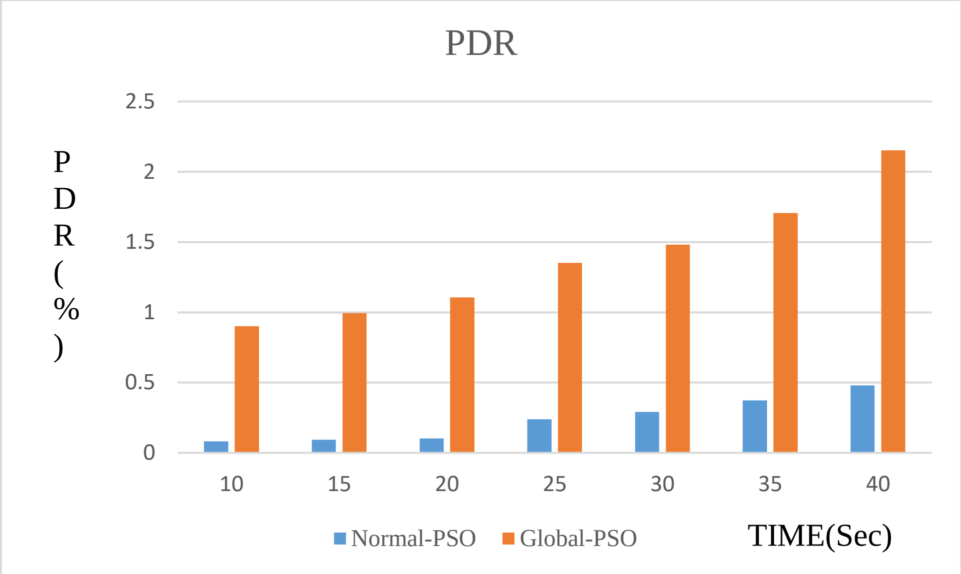

Figure12: Packet Delivery Ratio

The PDR (Packet Delivery Ratio) on network is shown in Figure 12. This shows that our proposed Global-PSO method has performed well when it compared the existing works such as Normal-PSO, increasing delivery packets on the network.

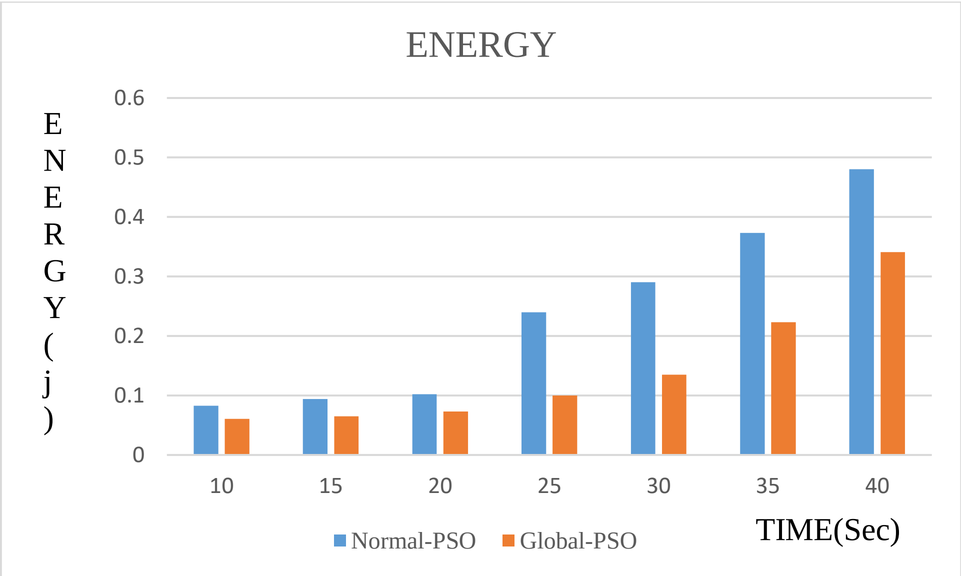

Figure13: Energy

The energy in the network is shown in figure 13. This demonstrates that our proposed Global-PSO method works well when comparing energy efficiency in the network to existing operations such as Normal-PSO.

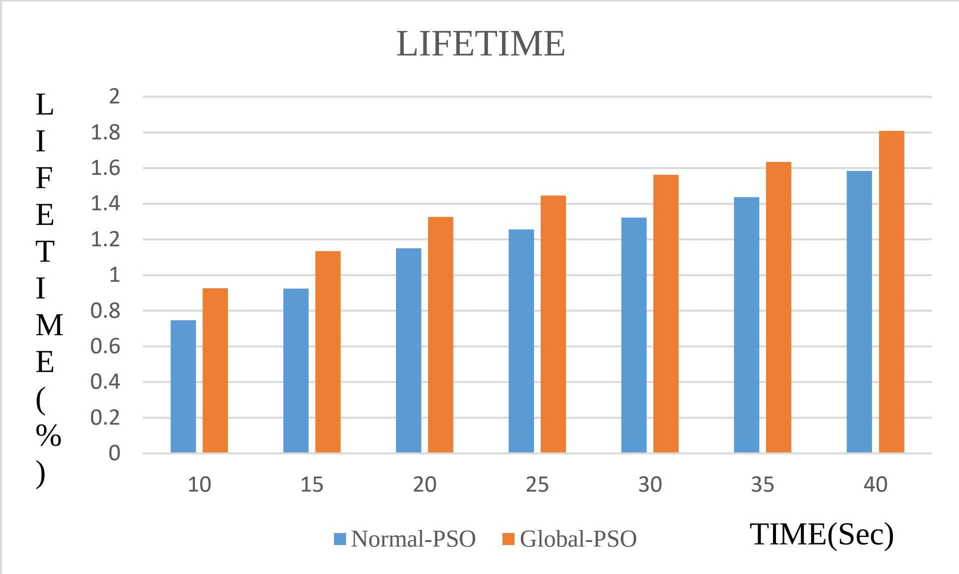

Figure14: Lifetime

The lifetime of the network is shown in Figure 14. This shows that our proposed Global-PSO method has been successful when compared with current works such as Normal-PSO through increased service life in our network.

5. CONCLUSION

We used an efficient PSO (particle swarm optimization) PSO (genetic algorithms) mechanism in our project to find optimum network router selection. Our mechanism helps to choose the way between the sender and the receiver. The proposed system optimizes the path between user communications and resolves the obstacles. The proposed GA-PSO has demonstrated the sustainable paths in various environments through simulation results. We used the NS-2 tool in our project to find the best routing route to optimize the results. It will help to break the networks and solve each network 's problem.

REFERENCES

[1] A. Hourtash and M. Tarokh, “Manipulator path planning by decomposition: algorithm and analysis,” *IEEE Transactions on Robotics and Automation*, vol. 17, no. 6, pp. 842-856, 2001.

[2] C. Cai and S. Ferrari, “Information-driven sensor path planning by approximate cell decomposition,” *IEEE Transactions on System, Man, and Cybernetics-Part B: Cybernetics*, vol. 39, no. 3, pp. 672-689, June 2009.

[3] E. Rimon and D. Koditschek, “Exact robot navigation using artificial potential functions,” *IEEE Transactions on Robotics and Automation*, vol. 8, no. 5, pp. 501-518, October 1992.

[4] I. K. Jung, K. B. Hong, S. K. Hong and S. C. Hong, “Path planning of mobile robot using neural network,” *Proceedings of the IEEE International Symposium on Industrial Electronics*, vol. 3, pp. 979-983, Slovenia 1999.

[5] H. Surmann, J. Huser and J. Wehking, “Path planning for fuzzy controlled autonomous mobile robot,” *5th International Conference on Fuzzy Systems,* vol. 3, pp. 1660-1665, New Orleans, September 1996.

[6] C. Hocaoglu, and A. C. Sanderson, “Planning multiple paths with evolutionary speciation,” *IEEE Transactions on Evolutionary Computation,* vol. 5, no. 3, pp. 169-191, 2001.

[7] J. H. Holland, “Adaptation in natural and artificial systems,” *University of Michigan Press,* Ann Arbor, 1975.

[8] J. C. Gallagher, S. Vigraham and G, Kramer, “A family of compact genetic algorithms for intrinsic evolvable hardware,” *IEEE Transactions on Evolutionary Computation,* vol. 8, no. 2, pp. 111-126, 2004.

[9] J. Kennedy and R. C. Eberhart, “Particle swarm optimization,” *Proceedings of IEEE International Conference on Neural Networks,* pp. 1942-1948, November 1995.

[10] M. I. Solihin, W. Kamal and A. Legowo, “Optimal PID controller tuning of automatic gantry crane using PSO algorithm,” *Proceeding of the 5th International Symposium on Mechatronics and its Applications (ISMA08),* Amman, Jordan, May 27-29, 2008.

[11] L. Messerschmidt and A. P, Engelbrecht, “Learning to play games using a PSO-based competitive learning approach,” *IEEE Transactions on Evolutionary Computation,* vol. 8, no. 3, pp. 280-288, 2004.

[12] A. Giaquinto and G, Fornarelli, “PSO-based cloning template design for CNN associative memories,” *IEEE Transactions on Neural Networks,* vol. 20, no. 11, pp. 1837-1841, 2009.

[13] R. Nie and J. Yue, “A GA and particle swarm optimization based hybrid algorithm,” *IEEE Congress on Evolutionary Computation,* pp. 1047-1050, 2008.

[14] S. W. Chen, J. S. Chiou, Y. C. Hu, K. Y. Wang and M. Y. Shieh, “Application of the GA-PSO with the fuzzy controller to the robot soccer,” *Proceedings of SICE Annual Conference,* pp. 2083-2087, 2010.

[15] C. G. Johnson and D. Marsh, “Modelling robot manipulators with multivariate B-splines,” *Robotica,* vol. 17, no. 3, pp. 239-247, May 1999.

[16] Q. Huang, S. Hu. and R. Matin, “Fast degree elevation and knot insertion for B spline curve,” *Computer Aided Geometric Design,* vol. 22, no. 2, pp. 183-197, 2005.

[17] Z. Wu, H. S. Seah and M. Zhou, “Skeleton based parametric solid models: ball b-spline surfaces,” *IEEE International Conference on Computer-Aided Design and Computer Graphics,* pp. 47-52, October 2007.

[18] G. Li, C. Guo, Y. Li and W. Deng, "Fractional-Order PID Controller of USV Course-Keeping Using Hybrid GA-PSO Algorithm," 2015 8th International Symposium on Computational Intelligence and Design (ISCID), Hangzhou, 2015, pp. 506-509.

[19] A. Utkarsh, A. S. Kantha, J. Praveen and J. R. Kumar, "Hybrid GA-PSO trained functional link artificial neural network based channel equalizer," 2015 2nd International Conference on Signal Processing and Integrated Networks (SPIN), Noida, 2015, pp. 285-290.
[20] K. Li, W. Cao and X. Hu, "Analysis on risk status of local government financing platform based on GA-PSO mixed planning algorithm," 2011 IEEE 18th International Conference on Industrial Engineering and Engineering Management, Changchun, 2011, pp. 47-51.
[21] P. Mudjihartono, R. Jiamthapthaksin and T. Tanprasert, "Parallelized GA-PSO algorithm for solving Job Shop Scheduling Problem," 2016 2nd International Conference on Science in Information Technology (ICSITech), Balikpapan, 2016, pp. 103-108.
[22] U. Sri Lakshmi, B. Srinivas Rao, “Secure Performance of intrusion detection system for manets using new digital signature” in IJIET, 7(1), on Jan 2016.

[23] U. Sri Lakshmi, B. Srivas Rao, “Proficient Interference Exposure Expedients to Secure MANET from Occurrences” in IJAT, 8(4), on Oct 2017.

[24] U. Sri Lakshmi, B. Srinivas Rao, “Mitigate the Routing overhead in WSN using new random walk detectors based approach” in Journal of Advanced Research Dynamic Control System International journal), issue 4, volume 10, on Oct 2018.

[25] U. Sri Lakshmi, B. Srinivas Rao, “A Cross Layer Protocol to Improve Energy Efficiency and QoS in MANET” in Journal of Mechanics Continua and Mathematical Sciences, (ESCI Indexed journal, Web of Science), issue 1, volume 14, on Feb 2019.

[26] U. Sri Lakshmi, B. Srinivas Rao, “An Overhead Aware Multipath Routing Protocol for Improving Relay Node Selection in MANET” in IJRTE (International journal), issue 1, volume 8, on May 2019.

[27] U. Srilakshmi, D. Yakobu, G. Jose Moses, P. Anusha, Dr. E. Laxmi Lydia, “Energy Efficient with load balancing Bee Ad-Hoc Routing Protocol for Manet” in Test Engineering & Management (International journal), volume 82, on Jan 2020.

[28] Uttej Kumar Nannapanenia, Dr. U. Srilakshmia, Alaparthi Sravyaa, Kavuru Tejaswia, “Cluster-Based Collection point Energy Efficient Routing Protocol for the Mobile Sink in Wireless Sensor Network” in International Journal of Future Generation Communication and Networking, Vol. 13, No. 2, 2020 pp.787-796.

[29] U. Srilakshmi, “Energy-Efficient Heterogeneous Optimization Routing Protocol for Wireless Sensor Network”, in INSTRUMENTATION MESURE MÉTROLOGIE!, Vol. 19, No. 5, October, 2020, pp. 391-397.

Author Profiles:

Uppalapati Srilakshmi, Asst.Prof, Department of CSE, VFSTR Deemed to be University, Vadlamudi Guntur Dist., A.P., India. She has done her Ph.D at Acharya Nagarjuna University in the year of 2019, her M.Tech at JNTU Hyderabad in the year of 2012 and B.Tech at JNTU Hyderabad in the year of 2006. Her research interests are Computer Networks, Network Security, Software Engineering and Machine Learning.

Maridu Bhargavi, Asst.Prof, Department of CSE, VFSTR Deemed to be University, Vadlamudi, Guntur Dist., A.P., India. She is doing PH.D in VFSTR Deemed to be University, her M.Tech at VFSTR Deemed to be University in the year of 2015, her B.Tech at Bapatla Women's Engineering College in the year of 2013. Her research interests are Data Mining, Computer Networks, and Cloud Computing.

Bavidisetty Mounika, Asst.Prof, Department of CSE, Stanley College of engg & Technology for Women, Hyderabad. She has done her M.Tech at Annamacharya Institute of Technology & Science, Rajampet, in the year of 2015, her B.Tech at MKITW, Rajampet, in the year of 2012. Her research interests are Computer Networks, Network Security and Machine Learning.

Nannapaneni Uttej Kumar, Asst.Prof, Department of CSE, VFSTR Deemed to be University, Vadlamudi, Guntur Dist., A.P., India. He has done her M.Tech at VFSTR Deemed to be University in the year of 2019 and B.Tech at Chirala Engineering College in the year of 2016. His research interests are Computer Networks, Network Security, Data Mining and Machine Learning.