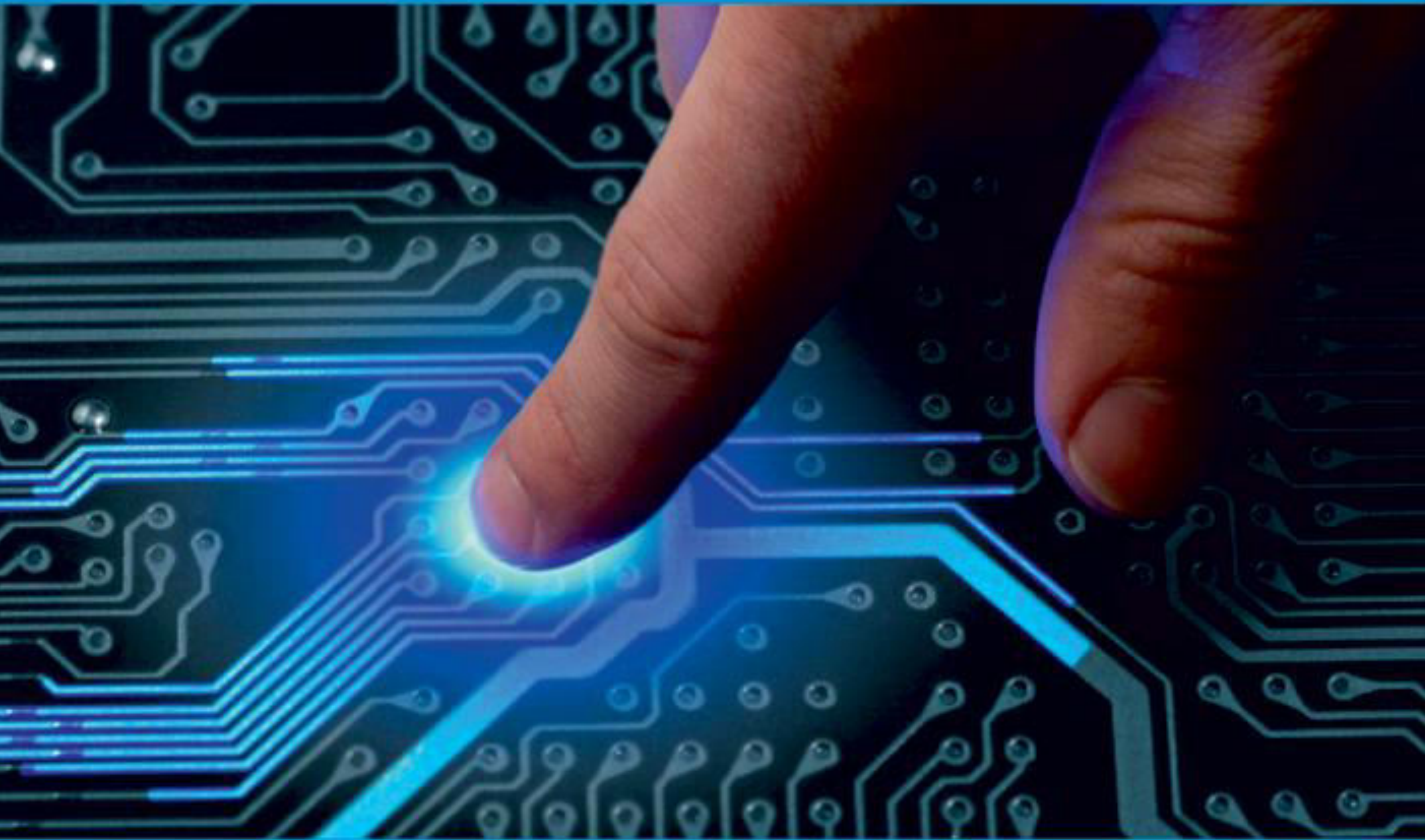
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 10, Issue 6, June 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.165

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.165 |

|| Volume 10, Issue 6, June 2022 ||

| DOI: 10.15680/IJIRCCE.2022.1006128 |

A Detailed Overview of Mobile Navigation Protocols

Shokendra Dev Verma [1], Kirti Bhatia[2], Shalini Bhadola[3], Rohini Sharma[4]

Student, Sat Kabir Institute of Technology and Management, Haryana, India[1]

Assistant Professor, Sat Kabir Institute of Technology and Management, Haryana, India[2]

Assistant Professor, Sat Kabir Institute of Technology and Management, Haryana, India[3]

Assistant Professor and corresponding Author, GPGCW, Rohtak, India[4]

ABSTRACT: The topic of robot localization is critical in the development of totally autonomous robots. It can be difficult for a robot to figure out what to do next if it doesn't know where it is. A robot's ability to localize itself is based on relative and absolute measurements that provide feedback on the robot's driving movements as well as the state of the environment around it. The robot must use this information to establish its location as precisely as feasible. The fact that there is ambiguity in both the robot's driving and sensing makes this difficult. The unclear data must be merged in the best possible way. In this paper we have studied and outlined different navigation approaches for mobile robots.

KEYWORDS: Mobile Robot Navigation, Optimization, Path Finding

I. INTRODUCTION

Mobile robots include humanoid robots, unmanned rovers, entertainment pets, drones, etc. Their capacity to shift autonomously, with enough intellect to respond and make decisions, sets them apart from other robots. They make decisions depending on the impressions they get from their surroundings. A source of input data, a way of decoding that data, and a mechanism of reacting to a dynamic environment by executing actions are all required for mobile robots (including its own movement). To sense and adapt to unknown surroundings, a complex cognition system is needed[1]. Fig 1 provides an outline of robot navigation.

II. RELATED WORK

There are now mobile robots that can jump, run, walk, and perform other actions similar to their biological counterparts. Legged robots,wheeled mobile robots,artificial intelligence, flying robots, robot vision, and other branches of robotics have emerged, involving several technological fields such as mechanical, telecommunications, and computer programming [2-5]. The realm of mobile robots, containing new trends, is covered in this article. Artificial intelligence, automated vehicles, network communiqué, pleasant robot-human interfaces, safe human–robot interaction, and concern regarding and observation are the driving forces behind these emerging trends.
There are 3 categories of mobile navigations: Global, local navigation, and personal. Global navigation is the capacity to describe the location of components in the atmosphere in relation to the reference axis and to move toward a predetermined goal. Local navigation is concerned with determining the environment's dynamic characteristics and establishing positional relationships among diverse objects. Personal navigation is the process of managing the many sectors of the environment in relation to one another while taking into account their relative positions. Fig 2 provides a classification of different navigation approaches.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.165 |
|| Volume 10, Issue 6, June 2022 ||
| DOI: 10.15680/IJIRCCE.2022.1006128 |

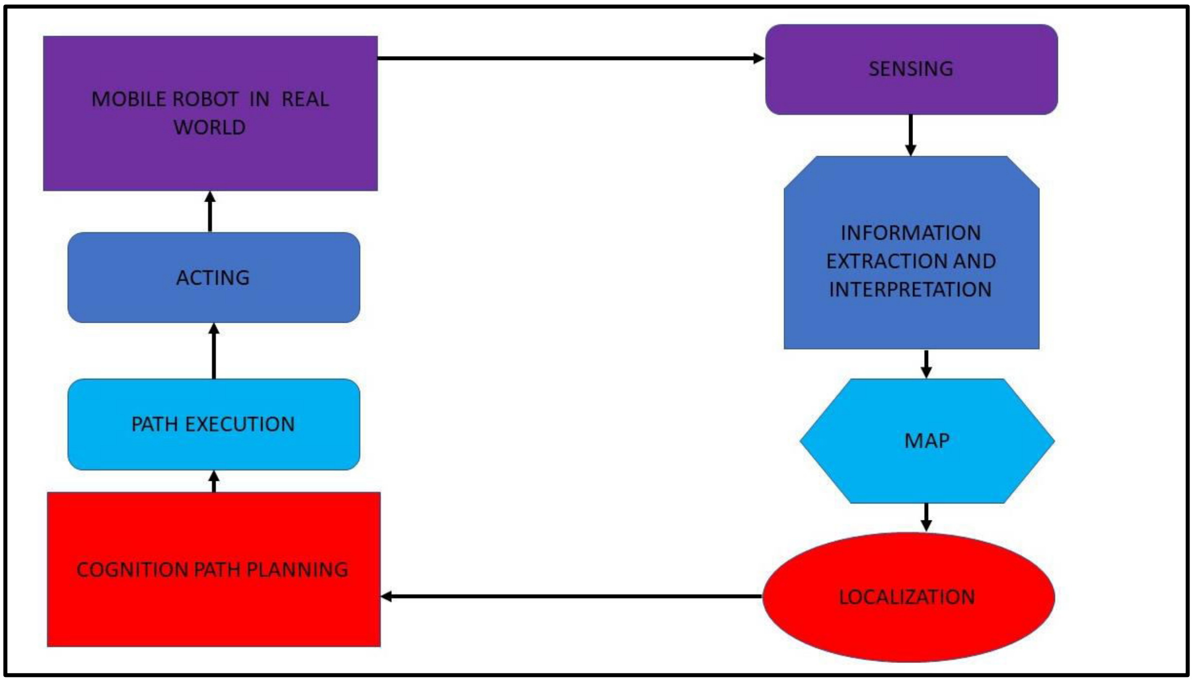


Fig 1: Robot Navigation Flow

TRADITIONAL APPROACHES

Because AI techniques had not yet been created, classical procedures were first less used for tackling robot navigational challenges. It has been noted that while employing conventional techniques to accomplish a process, either a result is produced or it is confirmed that no result exists. The fundamental disadvantage of this strategy is its large processing price and incapability to reply to environmental unpredictability; consequently, it is not recommended for real-time application.

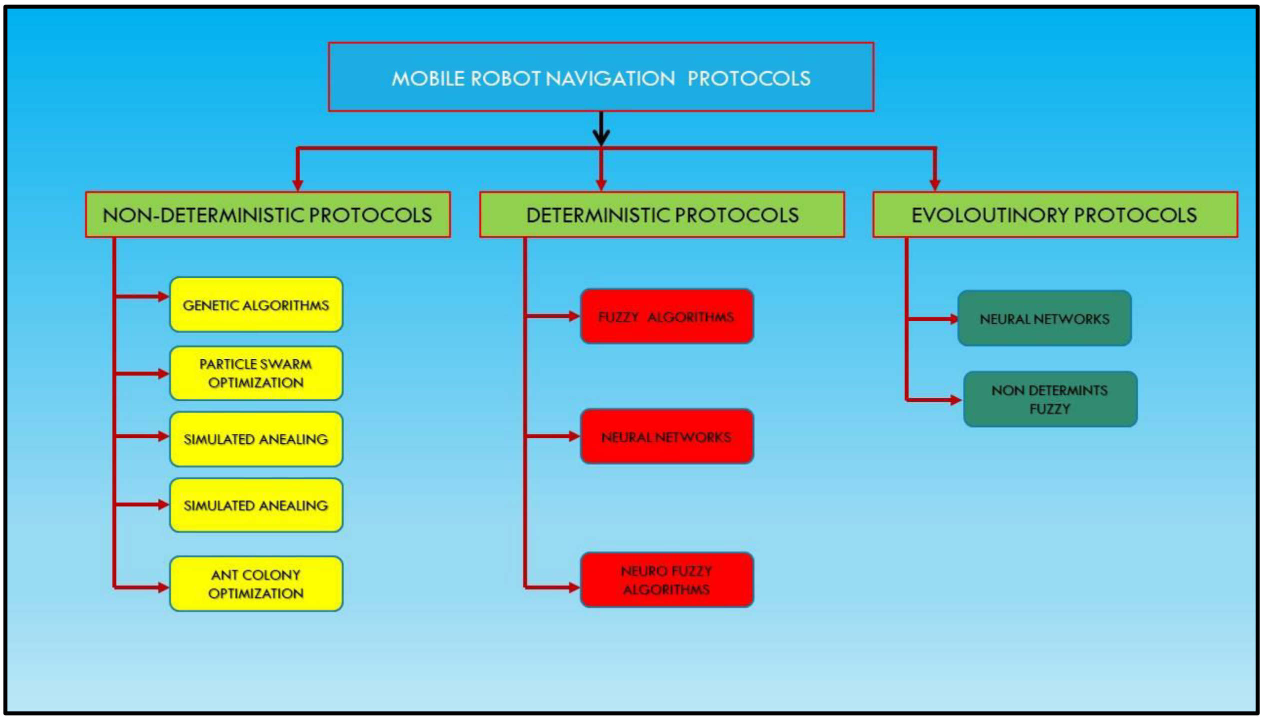


Fig 2: Classification of Robot Navigation Protoclos

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.165 |

|| Volume 10, Issue 6, June 2022 ||

| DOI: 10.15680/IJIRCCE.2022.1006128 |

CELL DECOMPOSITION (CD) APPROACHS

To achieve the purpose, this method splits the area into non-intersecting grids and employs link graphs to traverse from one cell to the next. To gain planning of path from the primary point to the goal location, pure cells (cells without impediments) are taken during traversing. Cells containing obstacles (corrupted cells) in the route are further separated into two new cells to produce a pure cell, which is then additional to the arrangement while finding the best route from the start to the finish. The start and finish cells in the CD method reflect the original and final positions, respectively. The mandatory route is shown by the series of pure cells that connects these sites [6], figure 3.Adaptive CD: It recognises the details contained in free space and follows the same principles as conventional cell decomposition in terms of avoiding free space. A quadtree-adaptive decomposition has been proposed by in [10]. When a grid cell is partly inhabited, it divides it into 4 equal subareas until it is empty.

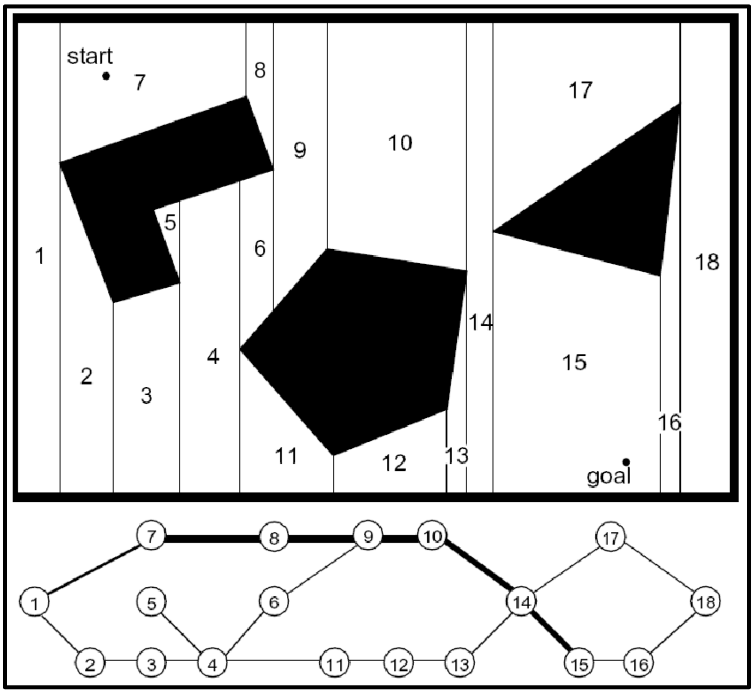


Fig 2: Cell Decomposition Approach

ROADMAP METHOD

It is a method of travelling from one location to another, with the link between the open spaces characterized by a collection of 1D curves [7]. When the roadmap is completed, it is used as a collection of similar paths through which the planner will search for the best solution.odes play a crucial part in determining the robot's needed course. The method is employed discover the shortest route from the robot's starting point to its final location; the roadmap is created using Voronoi and visibility graphs.The four cyclic processes of planning, motion, perception, and extraction are incorporated into the structure the authors created for robot route map learning and navigation, allowing robots to continuously learn from their experiences on the road as well as acquire and improve their environment's route map. In addition, a self-organizing neural network learning algorithm that grows on demand is suggested. This algorithm depends on the growing neural gas automated system, but it does not necessitate presetting the internet backbone scale. Instead, it can control the increase scale of the network online in a self-adaptive and self-organized manner to produce stable learning results when the input data is growing adaptively, figure 4, [8].This approach is used to continuously learn routes with progressively expanding information as a robot roam around an environment, extract the topological structure of the raw road data in feature space, and create an environment route map. The route map is used by the mobile robot to determine an appropriate path, direct the robot as it travels along the route, and accomplish navigation tasks. Physical tests conducted outside are used to verify the existence and viability of the theory.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.165 |

|| Volume 10, Issue 6, June 2022 ||

| DOI: 10.15680/IJIRCCE.2022.1006128 |

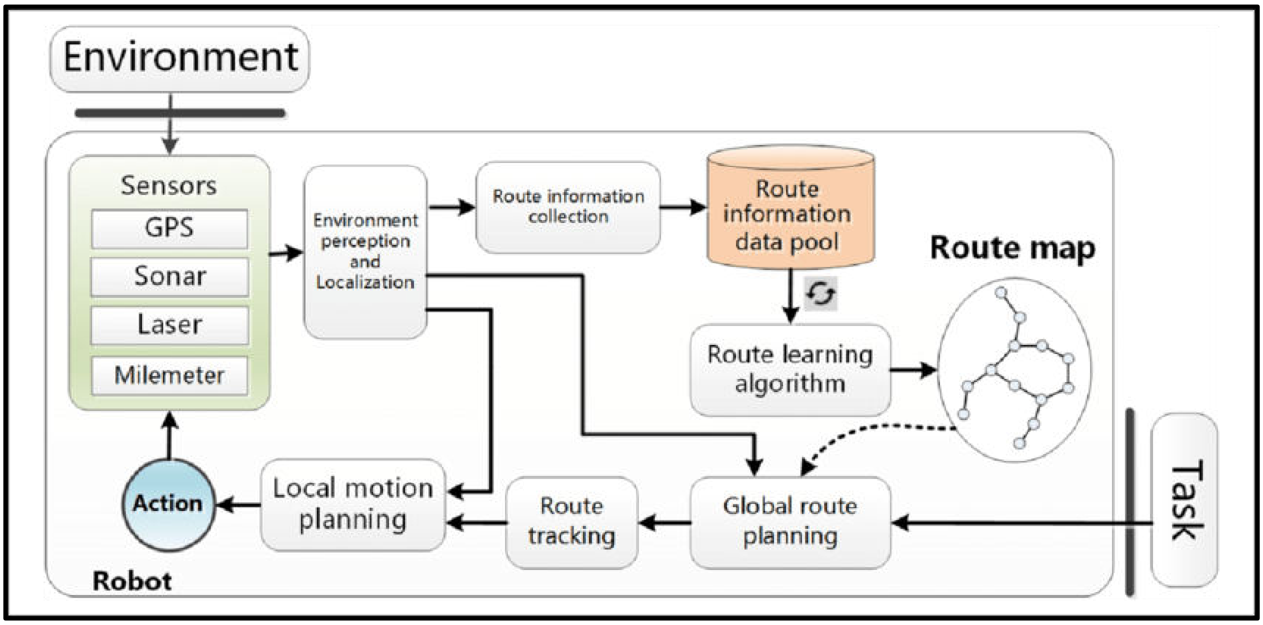


Fig 4: Roadmap method of Robot Navigation

APF (ARTIFICIAL POTENTIAL FIELD) METHODOLOGY

The goal and impediments, he claims, act as stimulating surfaces, and the overall potential exerts an illusory force on the robot. As demonstrated in Figure 5, [9], this unreal force pulls the robot towards the goal while keeping it away from an impediment. To escape the obstruction and reach the goal point, the robot follows the negative gradient. Authors in [10] offer a usage of this approach for navigation of robot. Authors in [11] use APF to propose a new obstruction evasion approach in an unidentified surrounding.

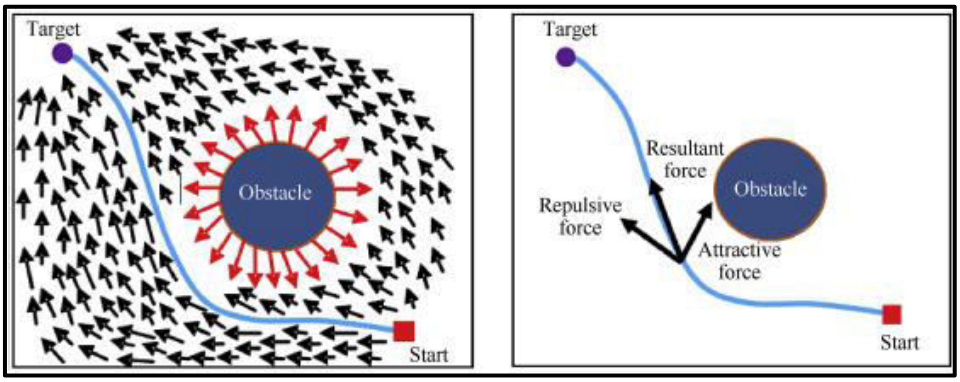


Fig 5: APF based Robot Navigation

Genetic Algorithm (GA)

It is involved with the optimization of multifaceted circumstances in which the objective function value must be maximised or minimised under certain constraints. The population should be assigned for the given problem, and each member of the population is allocated a fitness value based on the objective function. These individuals are chosen based on their fitness value and are permitted to cross-breed their genes to a subsequent generation. The mutation keeps the population diverse and prevents early convergence.

Afterwards, if the population has converged, the process is ended. Though the GA is randomized to certain extent, it performs better than a random local search because it can take advantage of historical data as well. For a static place, [12] offered an application of GA for the mobile robot navigation process. Only in the presence of a polygonal impediment is the analysis offered through simulation results.

It is a prevailing exploration method for an unknown location that requires every minute knowledge about the backgrounds to explore next point competently. Authors in [13] use this plan to complete navigational targets such as route length, flatness, and obstruction evasion. In challenging locations, [14] addresses the non-linear design issue of

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.165 |

|| Volume 10, Issue 6, June 2022 ||

| DOI: 10.15680/IJIRCCE.2022.1006128 |

navigation for a last destination. They have established an online training framework for obtaining the fittest chromosomal in order to avoid becoming stuck in such circumstances and to discover a way out.

FUZZY LOGIC (FL)

It is perfect for set-ups involving a lot of vagueness, complexity, and nonlinearity.The FL context's hypothesis is supported by the notable human capacity to course awareness based knowledge. It takes the rules provided by humans and transforms them to scientific counterparts. This ease the function of the design planner and computer by delivering extra accurate details on how systems accomplish in the actual situation, and it is thus utilized for robot path planning.In [15], authors offer a fuzzy (Sugeno) based navigation for an omnidirectional mobile robot.

Authors in [16] developed an independent fuzzy rule producing technique for obstacle avoidance for effective steering. FL is employed to illustrate a navigation system in a shapeless still and live surrounding that avoids navigation problems such as continuous looping, retracing, steering from tight passages and curved trajectory. Nowadays, FL is utilized in conjunction with sensor-based navigation techniques to increase gradual learning of a novel environment, as well as reinforced centered navigation to reduce angular and radial indecision in the environment, fig 6.

NEURAL NETWORK (NN)

Authors in [17] proposed an automation learning technique to avoid human guiding during the navigation process. The NN regulates the insertion and removal of new hidden layers during the training without human assistance, depending on the complexity of the environment, to complete the navigation job. The use of NN to the Fast SLAM was described by authors in [18] to prevent the error gathering caused by an improper odometry framework and faulty linearization of the SLAM nonlinear function. The usage of the NN in conjunction with Fast SLAM improves the mobile robot's ability to circumnavigate in an unfamiliar environment without colliding with obstacles.

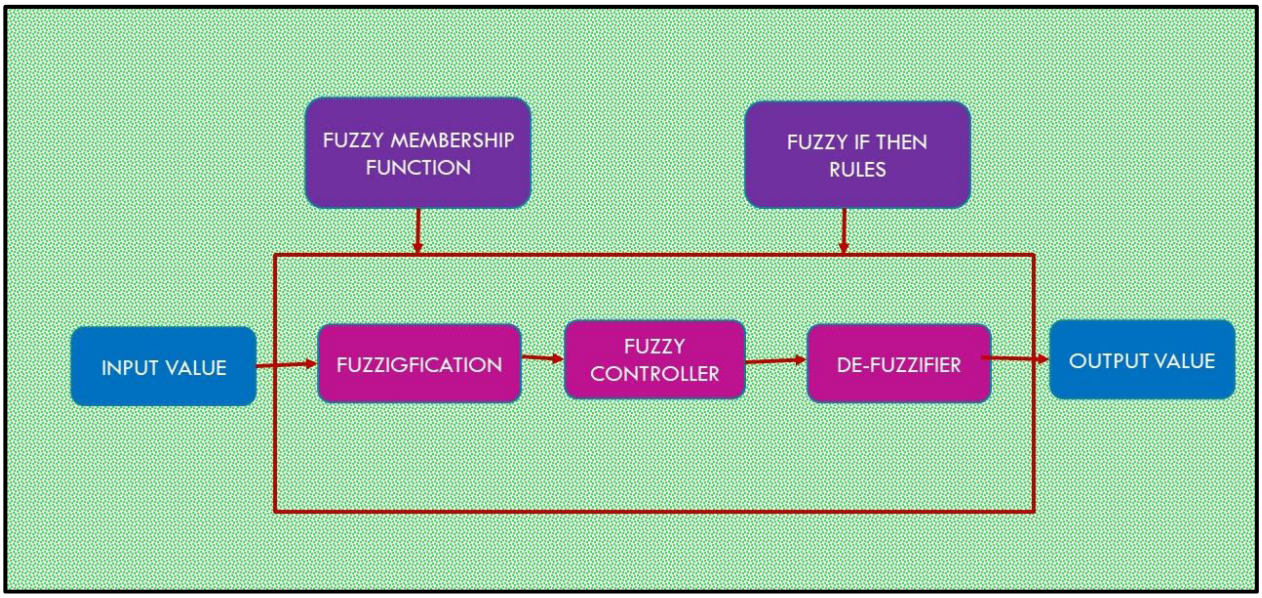


Fig 6: FL Based Robot Navigation

FIREFLY ALGORITHM (FA)

In the context of a static barrier, authors [19] developed an FA-centered mobile robot navigational technique. The 3 main navigational goals of path length, smoothness, and safety have all been met in the proposed system. In a simulation setting alone, authors in [20] reported the FA for the least collision lessroute for single mobile robot navigation. The FA was shown by [21] for underwater mobile robot navigation. In 3D marine conditioning, they created a slating method for swarm robots to prevent intrusion and congestion. In the same context [22], they use the same light-firefly based technique to solve another actual world underwater navigation issue in a moderately recognised environment.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.165 |

|| Volume 10, Issue 6, June 2022 ||

| DOI: 10.15680/IJIRCCE.2022.1006128 |

PARTICLE SWARM OPTIMIZATION (PSO)

Through a multi-agent particle strainer, authors in [23] solved the mapping and localization challenges of robot navigation in an uncertain context. To obtain a precise trajectory and prevent becoming trapped in local optima [24] used a PSO method in conjunction with the MADS method. Using the PSO MADS algorithm in conjunction with the GA and EKF yields a more efficient output. To solve the dynamic and time-based limitations of mobile robot navigation, authors in [25] designed the AEPSO approach as an expansion of the elementary PSO.

ANT COLONY OPTIMIZATION (ACO)

The utilization of an ACO for real route planning of mobile robots was presented by [26]. Authors in [27] employ the ACO to present navigation for many mobile robots. In a static environment, they showed a collision evasion method for various robot systems. To improve the selection method, they used a precise function. If an ant encounters a dead end, a penalty function is applied to the trail strength to evade the robot's route becoming stuck.

Cuckoo Search (CS) Method

When combined with other navigational techniques, the CS-based algorithm performs well. Mohanty et al. [28] propose one such strategy, in which a combination of CS and ANFIS is used to improve navigation results in an uncertain environment. Wang et al. [29] propose a hybrid path planning strategy for an unidentified 3D setting by merging the differential evolution technique with cuckoo search to hasten overall convergence speed. The airborne robot's exploration of the 3-D environment is aided by the higher convergence speed.

III. CONCLUSION

This study can be utilised as a theoretical foundation for subsequent research in a variety of topics. This article explains different approaches that can be used for robot mobile navigations. Fuzzy logic, neural network, ACO and PSO etc. can be used to avoid obstacles in the navigating path of the Robot.

REFERENCES

[1]Dowling, Kevin. "Power Sources for Small Robots" (PDF). Carnegie Mellon University. Retrieved 11 May 2012.
[2] Roozing, Wesley; Li, Zhibin; Tsagarakis, Nikos; Caldwell, Darwin (2016). "Design Optimisation and Control of Compliant Actuation Arrangements in Articulated Robots for Improved Energy Efficiency". IEEE Robotics and Automation Letters. 1 (2): 1110–1117.
[3] https://www.roboticstomorrow.com/article/2016/06/types-of-robotic-actuators/8253
[4] Wettels, Nicholas; Santos, Veronica J.; Johansson, Roland S.; Loeb, Gerald E. (January 2008). "Biomimetic Tactile Sensor Array". Advanced Robotics. 22 (8): 829–849.
[5] Filliat, David, and Jean-Arcady Meyer. "Map-based navigation in mobile robots: A review of localization strategies." Cognitive Systems Research 4.4 (2003): 243-282.
[6] Abu-Dakka, Fares, Trajectory planning for industrial robot using genetic algorithms, Thesis, 2011.
[7] Choset, Howei, Burdick, and Joel, (2000). "Sensor-based exploration: The hierarchical generalized Voronoi graph," The International Journal of Robotics Research, vol. 19, no. 2, pp. 96-125.
[8] Chaoliang Zhong et al., Continuous learning route map for robot navigation using a growing-on-demand self-organizing neural network, International Journal of Advanced Robotic Systems 14(6):172988141774361, 2017.
[9] Ganesh BABU Loganathan et al., A review: On path planning strategies for navigation of mobile robot, Defence Technology · April 2019.
[10] G. Garibotto and S. Masciangelo, (1991) "Path planning using the potential field approach for navigation," Fifth International Conference on Advanced Robotics, Pisa, Italy, vol. 19-22, pp. 1679-1682, June 1991.
[11] J. O. Kim and P. K. Khosla, "Real-time obstacle avoidance using harmonic potential functions," IEEE Transactions on Robotics and Automation, vol. 8, no. 3, pp. 338-349, 1992.
[12] T. Shibata and T. Fukuda, "Robot motion planning by genetic algorithm with fuzzy critic," Proc. 8th IEEE International Symp. On Intelligent Control, pp. 565-570, Aug 1993.
[13]M. Brand and Xiao-Hua Yu, "Autonomous robot path optimisation using firefly algorithm," International Conference on Machine Learning and Cybernetics, Tianjin, vol. 3, pp. 14-17, 2013

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.165 |

|| Volume 10, Issue 6, June 2022 ||

| DOI: 10.15680/IJIRCCE.2022.1006128 |

[14] X. Kang, Y. Yue, D. Li and C. Maple, “Genetic algorithm based solution to dead problems in robot navigation,” International Journal of Computer application in technology, vol. 41(¾), pp. 177-184, 2011.
[15]P. G. Zavlangas and S. G. Tzafestas, “Motion control for mobile robot obstacle avoidance and navigation: a fuzzy logic-based approach,” Systems Analysis Modeling Simulation, vol. 43, no. 12, pp. 1625-1637, 2003.
[16] B. Erin, “Navigation of mobile robot in presence of obstacles,” Advances inEngineering Software, vol. 41, no. 10, pp. 1179-1186, 2010.
[17] J. Qiao, R. Fan, H. Han and X. Ruan, “Q-learning based on dynamical structures neural network for robot navigation in unknown environment,” Advances in Neural Network, vol. 5553, pp. 188-196, 2009.
[18] Q. L. Li, Y. Song and Z. G. Hou, “Neural network based Fast SLAM for automobile robots in unknown environments,” Neurocomputing, vol. 165, pp. 99-110, 2015.
[19] A. Hidalgo-Paniagua, A. Miguel, Vega–Rodriguez, J. Ferruz and N. Pavon, “Solving the multi-objective path planning problem in mobile robotics with a firefly-based approach,” Soft Computing, vol. 1-16, 2015.
[20] M. Brand and Xiao-Hua Yu, “Autonomous robot path optimisation using firefly algorithm,” International Conference on Machine Learning and Cybernetics, Tianjin, vol. 3, pp. 14-17, 2013.
[21] D. Sutantyo and P. Levi, “Decentralized underwater multi robot communication using bio-inspired approaches,” Artificial Life Robotics, vol. 20, pp. 152-158, 2015.
[22] D. Sutantyo, P. Levi, C. Moslinger and M. Read, “Collective-Adaptive Levy Flight for Underwater multirobot exploration,” International conference on mechatronics and automation, pp. 456-462, 2013.
[23] X. Tang, L. Li and B. Jiang, “Mobile robot SLAM method based on multi-agent particle swarm optimized particle filter,” The Journal of China Universities of Posts and Telecommunications, vol. 21, no. 6, pp. 78-86, 2014.
[24] V. H. Xuan, H. Cheolkeun and L. Jewon, “Novel hybrid optimisation algorithm using PSO and MADS for the trajectory estimation of a four track wheel skid-steered mobile robot,” Advanced Robotics, vol. 27, no. 18, pp. 1421-1437, 2013.
[25] A. Atyabi, S. Phon-Amnuaisuk and C. K. Ho, “Applying area extension PSO in robotic swarm,” Journal of Intelligent Robot System, vol. 58, pp. 253-285, 2010.
[26] T. Guan-Zheng, HE Huan and S. Aaron, “Ant colony system algorithm for real time globally optimal path planning of mobile robots,” Acta AutomaticaSinica, vol. 33, no. 3, pp. 279-285, 2007.
[27] S. Liu, L. Mao and J. Yu, “Path planning based on ant colony algorithm and distributed local navigation for multi-robot systems,” Proceedings of the 2006 IEEE International Conference of Mechatronics and Automation, pp. 1733-1738, 2006.
[28] P. K. Mohanty and D. R. Parhi, “A new hybrid optimization algorithm for multiple mobile robots navigation based on the CS-ANFIS approach”, Memetic Computing, 7(4), 255-273, 2015.
[29] G. Wang, L. Guo, H. Duan, H. Wang, L. Liu and M. Shao, “A hybrid metaheuristic DE/CS algorithm for UCAV three-dimension path planning”, The Scientific World Journal, 2012.