ISSN (e): 2250 – 3005 || Volume, 08 || Issue, 4|| April – 2018 ||
International Journal of Computational Engineering Research (IJCER)

Navigation Path Analysis of Mobile Robot Using Hybrid Neuro-Invassive Weed Optimization Technique

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Abstract: *In this current paper a hybrid Neuro-IWO technique has been analyzed for navigation of mobile robot in a cluttered environment. The inputs to the neural network segment are ODF (obstacle distance from front), ODL (obstacle distance from left), ODR (obstacle distance from right), TA (target angle) and the output is interim steering angle. The inputs to the invasive weed optimization segment are ODF (obstacle distance from front), ODL (obstacle distance from left), ODR (obstacle distance from right), interim steering angle and the output from the invasive weed optimization technique is final steering angle. In the current research several papers have been reviewed and analyzed based on different artificial intelligence techniques. In this paper several simulation and experimental results are given using hybrid Neuro-IWO technique for navigation of mobile robots from start position to destination position. During comparison a suitable agreement between experimental and simulation results are found. It is observed that using hybrid Neuro-IWO technique the robot can navigate successfully from start position to the goal position.*

Key words: invasive weed optimization technique (IWO), obstacle, mobile robot, simulation result, experimental result, Neuro-IWO

I. INTRODUCTION

Kim [1] have discussed about algorithm and fuzzy methodology for path planning of mobile robot in a cluttered environment. They have given several results to show the effectiveness of their paper. Papers [2-10] discussed about fuzzy dynamic system, Fusion of probabilistic algorithm, GA technique for finding out optimal path of robotic agents in obstacle prone zone. Papers [11-20] discussed about fuzzy-neuro, Neuro-fuzzy, ant colony optimization technique, IWO for navigation of mobile robots. In these papers navigation of multiple mobile robots along with single mobile robots are addressed. The paper [15] discusses about kinematic model of a wheeled mobile robot. Papers [21-32] discuss about ant colony optimization technique, artificial neural network techniques, MLP & RBF NN techniques, firefly algorithm. Paper [33-42] discussed about takagi-sugeno, MANFIS, GA algorithms to address the mobile robot path planning. Papers [43-54] discusses about MANFIS controller , neural network controller, innate immune base system , artificial immune system techniques for application in various robotic path planning problem and other engineering problems. In these papers simulation and experimental results are given to find the effectiveness of the proposed techniques.

II. ANALYSIS OF AI TECHNIQUES

Papers [55-67] discusses about finite element method, genetic algorithm, immunized navigational controller, ANFIS method for navigation of wheeled mobile robot in a partial known and unknown environment. The authors try to find out optimum methodology for solving the path planning problem related to robots. Frog leaping algorithm, genetic algorithm, RBFNN, artificial neural network, PSO techniques self adaptive fuzzy methodology have been discussed in papers [68-84]. Papers [85-100] discuss about various papers on navigation of mobile robots. Some of these papers have also discussed to solve other engineering problems using artificial intelligence techniques. The stable and precision motion control of multiple mobile robots, navigation strategy of mobile robots, efficient neural network path planning of mobile robots, PSO based path planning of mobile robots and CS-ANFIS approach are discussed in papers [101-112]. During discussion these authors have also exhibited several results in the form of graphs and tables to corroborate the methodologies those have been discussed by them. Fuzzy wind-driven optimization algorithm, neural network approach, neuro-fuzzy , genetic algorithm, wavelet neural network methods are discussed by various authors in papers [113-124]. Some of these papers have also discussed inverse kinematic models of mobile manipulators. Paper [124] has discussed about time optimal collision free navigation of carlike mobile robot using neuro-fuzzy approach. Papers [125-140] discuss about fuzzy-logic approach, potential field method, target seeking behavior. neural network method, vector field method for path planning control of mobile robots. Papers [141-160] describe navigation of under-water robot, multi robot path planning, WNN, RBFN methodology, petri-GA optimization method, swarm intelligence method for autonomous car parking of mobile robots. In these papers the authors have discussed and shown experimental results along with simulation results. These results were compared with each other to show the effectiveness of the proposed methodology. Papers [161-184] discuss about fuzzy logic controller, control and balancing of two wheel mobile robots using fuzzy logic, frog leaping algorithm, genetic algorithm, cuckoo search algorithm , path planning of humanoid robots, particle swarm optimization techniques, ANFIS technology for control of single and multiple mobile robots in obstacle prone zone. Comparison of GA,PSO for path planning of mobile robots in unknown environments, use of artificial potential field approach and simulated annealing for robot navigation, genetic algorithm for various engineering problems and robot path planning, fuzzy logic controller, invasive weed optimization algorithm are discussed in papers [184-200]. The above discussed methodologies are utilized for navigation and control of multiple mobile robots. Papers[201-221] discuss about meta-heuristic rule based hybrid neural network method, IWO method , ANFIS network controller , type-2 fuzzy logic controller,, artificial bee colony, cuckoo search method , particle optimization method for handling mobile robots in various known and unknown scenarios. Papers [222-241] discuss about fuzzy influence techniques, genetic algorithm technique, deferential evaluation algorithm, genetic methodology, artificial bee colony, probalistic fuzzy controller , particle swarm optimization methods for embedded implementation in mobile robot navigation subjected to various environment conditions. Mamdani fuzzy controller, Neuro-fuzzy influence system, numerical potential field method, multiple adaptive Neuro-fuzzy influence system, fuzzy controller, immune based motion planner are discussed in [242-256] and are used for application in various engineering problems and control of mobile robots. Papers [257-280] discuss about control of humanoid robots using genetic algorithm, genetic regression analysis, RBF neural network method. In these papers navigation of mobile robots using firefly algorithm for various engineering problem, bee algorithm, fuzzy logic techniques for mobile robot navigation and navigation of underwater mobile robots are also discussed.

III. METHODOLOGY NEURO-IWO TECHNIQUE

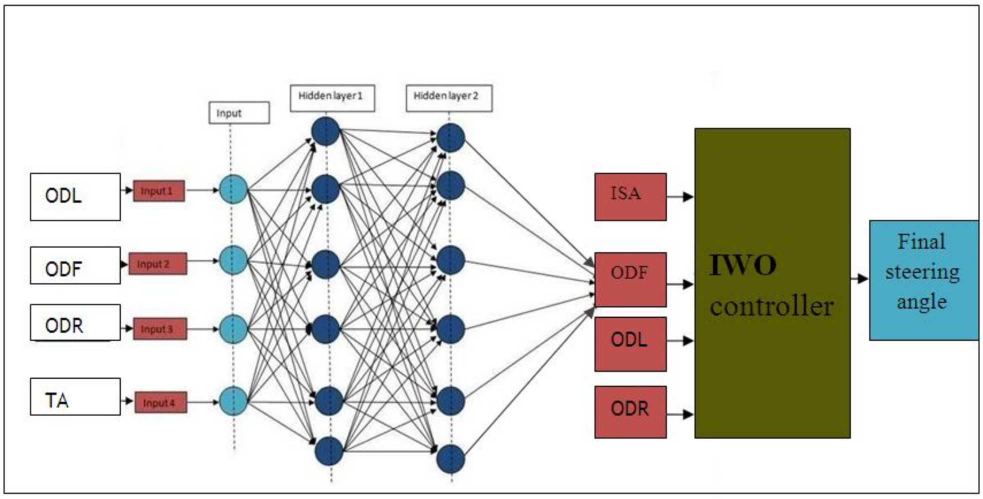

Fig.1. Hybrid Neuro-IWO technique architecture for mobile robot navigation

The inputs such as obstacle distance from left, obstacle distance from right, obstacle distance from front, target angle are given to the neural network. The output from the neural network is interim steering angle (ISA). The flow chart for hybrid Neuro-IWO is given below.

IV. FLOW DIAGRAM OF HYBRID NEURO-IWO METHOD

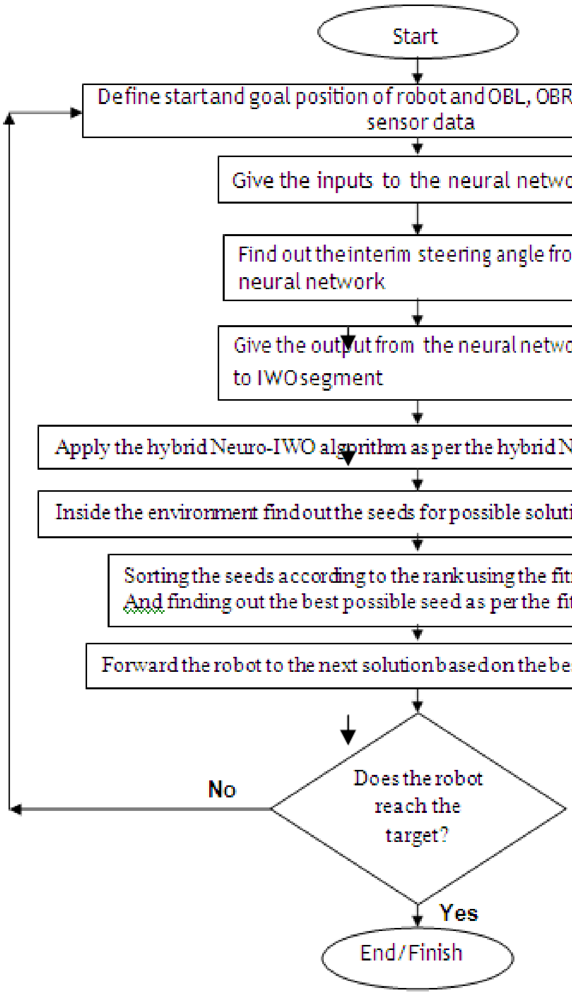

Fig.2. Flow chart for hybrid Neuro-IWO technique for mobile robot navigation

V. SIMULATION RESULT

Fig.3 (a) shows the initial position in simulation mode. Fig.3 (b) to fig.3 (e) shows the intermediate position of the robot in simulation mode. Fig.3 (f) shows the final position of robot while reaching the target and also shows the path in the simulation mode.

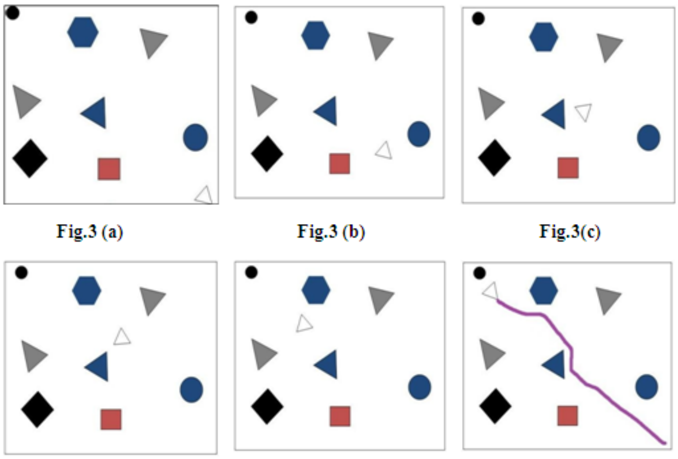

Fig.3 (a) Fig.3 (b) Fig.3(c) Fig.3(d) Fig.3(e) Fig.3(f)

VI. EXPERIMENTAL RESULT

Fig.4 (a) shows the start position of the robot in experimental mode. Fig.4 (b) to fig.4 (e) shows the intermediate position of the robot in experimental setup when the robot navigates in a cluttered environment avoiding obstacles. Fig.4 (f) shows the final position while reaching the target also shows the path of robot in experimental setup.

Fig.4 (a) **Fig.4 (b)** **Fig.4(c)**

Fig.4(d) **Fig.4(e)** **Fig.4(f)**

Table 1 shows the time taken by the robot for 10 scenarios from start position to end position and the deviation is found to be below 6%

No. of Exercise	Time Taken in Simulation (TTS) from start to goal in milliseconds	Time Taken in Experiment (TTE) from start to goal in milliseconds	Deviation (|TTS −TTE|) TTS × 100	Average Deviation
1	4152.42	4312.08	3.84	5.102
2	4112.64	4304.16	~~4.65~~	
3	4079.71	4292.10	5.20	
4	4175.28	4424.22	5.96	
5	4184.28	4371.48	4.47	
6	3755.72	3946.51	5.07	
7	3702.42	3896.15	5.23	
8	3807.36	4055.94	6.52	
9	3881.76	4113.72	5.97	
10	4038.35	4204.44	4.11	

Table 2 shows the path length covered by the robot from start position to goal position for simulation and experimental setup and the path deviation is found to be below 6%

No. of Exercise	Path Length in Simulation (PLS) from start to goal in centimetres	Path Length in Experiment (PLE) from start to goal in centimetres	Deviation $\frac{(\lvert PLS - PLE \rvert)}{PLS} \times 100$	Average Deviation
1	230.69	239.56	3.84	5.103
2	228.48	239.12	4.65	
3	226.65	238.45	5.20	
4	231.96	245.79	5.96	
5	232.46	242.86	4.47	
6	208.65	219.25	5.08	
7	205.69	216.45	5.23	
8	211.52	225.33	6.52	
9	215.65	228.54	5.97	
10	224.35	233.58	4.11	

VII. CONCLUSION

In the current research hybrid Neuro-IWO hybrid technique has been used for navigation of the three wheeled mobile robots from start to goal position in a cluttered environment. In the proposed technique analysis has been learned using hybrid Neuro-IWO technique. The inputs to the hybrid Neuro-IWO techniques are obstacle distance from front, obstacle distance from right, obstacle distance from left and target angle. The output from the neural network technique is interim steering angle and the final output from the hybrid Neuro-IWO technique is final steering angle. Several theoretical and experimental verifications are given in graphical and tabular form. It has been observed that during comparison between experimental and simulation result the deviation is found to be within 6%.using hybrid Neuro-IWO technique it is also conclude that robots can successfully navigate in a highly cluttered environment.

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