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Review

A New Method for Robot Navigation in Uncharted Spaces Using Average Neuro-Fuzzy Hybrid Control

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ABSTRACT

This study's primary objective is to design and evaluate an innovative Average Neuro-Fuzzy Controller for mobile robot navigation and route planning in densely populated areas. A number of studies pertaining to robots, control, and navigation have been reviewed during the course of the examination. A number of the robot's on-board distance sensors are used for environment mapping purposes. Different sectors (front, left, right, and rear) have been created using the environmental sensor information. While navigating from one location to another, robots use their sensors to detect and avoid impediments. The present study's simulation and experimental findings from a variety of workouts agree to within 3%. The suggested method for robot navigation in complicated situations is successful, as shown by comparisons of outcomes. There are many different types of engineering optimization issues that this method may solve.

Keywords
Average neuro-fuzzy; Robot; Mobile; Artificial intelligence; Navigation control.

INTRODUCTION

The papers covered a range of artificial intelligence methods for controlling robots in complicated settings [1–5]. In the domains of engineering and science, AI approaches are crucial for resolving optimization issues [6-8]. Several researchers have experimented with controlling different kinds of robots using AI methods. In this paper, we look into meta heuristic algorithms for robot trajectory planning in different settings [9–12]. These papers lay down the groundwork for controlling robot navigation via artificial immune systems. One biologically inspired approach used to solve many optimization issues is the Bacteria Foraging technique [13–17]. One technique that dynamic robots utilize for route planning is the Particle Swarm Optimization approach, which takes its cues from nature [18–20]. Using AI approach, Paperhas outlined the operation of a manipulator in unknown settings [21]. When it comes to engineering, the Differential Evolution Algorithm is a top choice for a number of different types of challenges [22]. It may be used with other approaches to create a hybrid strategy that is both efficient and novel. When it comes to handling a wide range of engineering challenges, one of the smartest AI techniques that draws inspiration from biology is the neural network [23–26]. Autonomous robots that use neural networks to navigate complex situations are a reality [27–30]. A neural network is a powerful tool for robots.

managed and for solving various technical issues [31-33].

The Cuckoo Search approach has been the focus of many papers that deal with the navigational control of mobile robots in different environments [34–36]. The article describes the application of a novel kind of artificial intelligence, the Dayani intelligent approach, for managing robots in unfamiliar surroundings [37]. In addition to analysing robot navigational control, the Daykun-Bip artificial intelligence approach can handle a wide range of optimization issues in engineering [38]. The application of neuro-fuzzy controllers for route determination in complicated situations is the main topic of these papers [39–43]. It is also possible to solve a wide range of engineering issues using the neuro-fuzzy method [44–47]. When it comes to artificial intelligence, fuzzy inference methods are a great fit for a number of engineering-related challenges [48–53]. Fuzzy logic strategy for controlling mobile robots during route planning is the subject of many papers [54–57]. Fuzzy inference methods make effective use of difference member-ship functions to handle robot control [58-61].

In addressing a wide range of optimization issues, the Ant Colony AI approach has made substantial advances. An optimal solution may be found in complicated scenarios using the ant colony AI approach, which takes into account the rate of pheromone deposition and degradation [62-64]. Research articles address finite element analysis technique for a wide range of engineering issues. One community-driven method for robot navigation control is the Firefly algorithm [65–71]. A wide range of engineering optimization issues may be addressed with the Firefly method. Damage and defect detection in mechanical and dynamic structures used in robot construction may be accomplished with the help of AI approaches [72–79]. Combining neural networks with fuzzy inference may provide neuro-fuzzy AI controllers [80, 81]. Invasive weed optimization strategy for robot navigation in unfamiliar areas is the subject of this paper [82]. This research delves into the topic of route planning for robots in difficult environments using a nature-driven algorithm called Bat [83]. This work examines and discusses the gait analysis of a dynamic humanoid robot [84]. Genetic algorithms are among the most effective biologically inspired approaches to solving robotic navigation difficulties [85–88]. There are a number of robotic hardware platforms that can be controlled by genetic algorithms [89–90]. As an example, an underwater robot in an obstacle-prone environment has been controlled using the Harmonic Search algorithm [91]. Biologically inspired algorithms, such as artificial immune systems, can handle a wide range of optimization problems [92–94]. Researchers have spoken about robot kinematic analysis, which is necessary for researching robot motions [95-97]. The use of mobile computers for intelligent communication has been the subject of many papers [98–99].

Robots may navigate unfamiliar environments using the artificial potential field approach [100-101]. In their description and analysis, researchers provide real-time robot navigation [102]. Researchers have used rule-based methodologies that are mathematically structured to analyze robot movements and paths [103-104]. A number of papers [105–106] detail the use of the simulated annealing method to the study of robot mobility. Several academics have detailed their work on analysing the vibration signatures of different dynamic elements of robots using AI algorithms in articles [107-120]. Multiple researchers have reported using soft computing techniques to operate different kinds of robots in their published works [121–122]. Scientists are using swarm intelligence and other strong AI methods to solve a wide range of optimization issues [123–127]. Robot navigation and control have been the focus of several regression-based analyses [128–130]. This paper delves into the topic of sensor-based robot navigation in unfamiliar surroundings [131]. This research delves into the topic of mobile robot navigation control in uncharted territories by way of the Average Neuro-Fuzzy Hybrid (ANFH) method. What follows is a discussion of the ANFH controller in depth.

Description and Analysis of Average Neuro-Fuzzy Hybrid Controller

In this section analysis and description of Average Neuro-Fuzzy Hybrid (ANFH) controller (Figure 1) has been carried out. The distance sensors mounted in the robot map the surrounding environment comprising of obstacles and target. The inputs to neural and fuzzy segments in the average neuro-fuzzy hybrid controller are left (LOS), right (ROS) and front FOS) obstacles distances obtained from the sensors. Outputs from the individual fuzzy and neural controllers are Steering-Angle-1(SA1) and Steering-Angle-2 (SA2) respectively. Gaussian membership functions are used in fuzzy segment of the hybrid controller. In neural segment of hybrid controller five layers back-propagation neural network has been used. The input and output layers consist of three and one neurons respectively. The three hidden layers consist of six, twelve and four neurons respectively. The Final Steering Angle (FSA) has been obtained by taking the average of SA1 and SA2. Using the FSA obtained from ANFH, robot negotiates with obstacles while trying to find the target. During the process various simulation and experimental exercises are conducted. Hemisson robot is used for carrying out all experimental exercises for navigational purpose [132]. Comparisons have been done between simulation and experimental results and are shown in Table 1 for five no. of exercises. A comparison is also shown as pictorial form (Figure 2 A-F) in six steps for simulation and experimental exercises.

Conclusion

Additionally, the ANFH AI method may be used to resolve We have developed, analyzed, and implemented a new Average Neuro-Fuzzy Hybrid controller in this study. The ANFH controller takes readings from the robot's sensors as inputs and uses them to calculate an approximate final steering angle, allowing the robot to navigate from its starting location to its destination point while avoiding obstacles. By averaging SA1 and SA2, we can determine FSA. The ANFH controller's Fuzzy and Neural segments are used to determine SA1 and SA2. Robot locates and avoids obstacles with the use of an ANFH controller in both experimental and simulation modes. There is a 3% degree of agreement when comparing experimental outcomes from navigational exercises with simulation results. In conclusion, the findings show that the ANFH controller works well for robot navigation. other optimisation problems in engineering fields. In the future other hybrid techniques will be investigated for solving the robot navigation problem in cluttered and unknown environments.

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