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ADVANCED CONTROL ALGORITHMS FOR DYNAMIC ENVIRONMENT NAVIGATION AND OBSTACLE AVOIDANCE

Nour Alsayed (ИТМО)

Scientific supervisor – Candidate of Technical Sciences, Professor.Aleksandr Y. Krasnov (ИТМО)

Introduction. Mobile robots have become indispensable across various domains such as agriculture, military, medicine, education, mining, space travel, and entertainment. Equipped with advanced artificial intelligence, these robots autonomously navigate environments, comprehend surroundings, plan paths, and avoid obstacles without human intervention[1]. Pathfinding is a critical aspect of robot navigation, seeking optimal routes while bypassing obstacles[2]. Neural networks (NNs) play a pivotal role in signal processing, forecasting, and grouping tasks, offering nonlinear, multi-layered, parallel regression capabilities[3]. Fuzzy logic addresses scenarios marked by ambiguity, complexity, and nonlinearity. Integration of neural networks and fuzzy logic yields neural-fuzzy technology, capable of processing fuzzy information alongside self-learning neural networks [4].Researchers have explored various navigation techniques for mobile robots, often combining multiple algorithms for efficiency. Reactive approaches excel in dynamic environments, surpassing static ones in adaptability[5]. This work focuses on reactive algorithms for dynamic obstacle avoidance, initially employing the Artificial Potential Field (APF) method for pathfinding. Subsequently, a fusion of neural network classification and fuzzy logic facilitates obstacle avoidance, with NNs categorizing zones and fuzzy logic regulating robot speed to evade both static and dynamic obstacles in unknown environments. The proposed system is implemented using MATLAB integrated with V-REP simulation environment.

Main part. The proposed system for autonomous mobile robot navigation involves a multi-step approach. Initially, the environment is initialized, and the path planning is performed using the Artificial Potential Field (APF) algorithm. APF generates attractive forces towards the goal and repulsive forces from obstacles, guiding the robot along a safe trajectory while avoiding collisions. Dynamic obstacles are continuously monitored, and a Bayesian Regressing Neural Network (BRNN) classifies them into safe or dangerous zones based on speed and distance information. If an obstacle is classified as dangerous, the fuzzy logic is employed to adjust the robot's speed, preventing collisions. After obstacle avoidance, the robot returns to the initial path determined by the APF algorithm to continue navigation towards the target.

Conclusions. The proposed system successfully addresses the challenges of dynamic obstacle avoidance in unknown environments. By employing the APF algorithm for path planning and integrating neural network classification and fuzzy logic control, the system effectively navigates the robot while avoiding obstacles. The integration of MATLAB with V-REP simulation environment provides a robust platform for testing and validating the system's performance.

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