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GREY SYSTEM BASED REACTIVE NAVIGATION OF MOBILE ROBOTS USING REINFORCEMENT LEARNING

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Abstract. *A reactive navigation approach for autonomous mobile robots in unknown dynamic environments is presented using grey theory and reinforcement learning techniques. Reactive navigation is one of the basic tasks for mobile robots to achieve memoryless intelligence. In this paper, a grey system is designed for the sensor-based reactive control of mobile robots with several primitive behaviors, i.e., obstacle-avoidance, goal-seeking, local-trap escaping and emergency behavior. The uncertainties in the sensory information and decision making are represented and operated using frequency grey numbers. A grey reinforcement learning method is proposed for the learning of grey rules and behavior decisions to coordinate the primitive behaviors. The experimental results show that this approach is effective for reactive navigation and learning control with incomplete environmental information in unknown dynamic environments.*
Keywords: Mobile robot, Reactive navigation, Grey system, Reinforcement learning

1. **Introduction.** Autonomous mobile robots have been widely studied in artificial intelligence and industrial automation. Navigation of autonomous mobile robots in large unknown environments is a challenging task since the environment may be unpredictable and the sensory information may be incomplete or not accurate enough for decision making. Recently there has been an increasing attention to effective approaches of robot navigation. The navigation approaches are generally classified into two categories: local navigation and global navigation [1-5]. Local navigation is an important basic task for the robot to constantly monitor its environment with onboard sensors. Several reactive control approaches have been proposed to implement local navigation. For example, occupancy maps have been built using sonar sensors to model the environment and have led to a series of localization and path planning methods [6]. The potential field and virtual force field have been used for navigation in a local environment, respectively [7]. These methods are mainly employed to deal with stationary obstacles. In the middle of 1990s, some researchers presented behavior-based control methods such as the subsumption architecture [8]. Various soft computing and machine learning methods have been applied to reactive navigation to improve the control performance [2,3,9-11]. Reinforcement learning