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# Modeling Search-And-Rescue Operations by Autonomous Mobile Robots at Sea

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**Abstract :** During the last decades, research interest in planning, scheduling, and control of emergency response operations, especially people rescue and evacuation from the dangerous zone of marine accidents, has increased dramatically. Until the survivors (called ‘targets’) are found and saved, it may cause loss or damage whose extent depends on the location of the targets and the search duration. The problem is to efficiently search for and detect/rescue the targets as soon as possible with the help of intelligent mobile robots so as to maximize the number of saved people and/or minimize the search cost under restrictions on the amount of saved people within the allowable response time. We consider a special situation when the autonomous mobile robots (AMR), e.g., unmanned aerial vehicles and remote-controlled robo-ships have no operator on board as they are guided and completely controlled by on-board sensors and computer programs. We construct a mathematical model for the search process in an uncertain environment and provide a new fast algorithm for scheduling the activities of the autonomous robots during the search-and rescue missions after an accident at sea. We presume that in the unknown environments, the AMR’s search-and-rescue activity is subject to two types of error: (i) a 'false-negative' detection error where a target object is not discovered (‘overlooked') by the AMR’s sensors in spite that the AMR is in a close neighborhood of the latter and (ii) a 'false-positive' detection error, also known as ‘a false alarm’, in which a clean place or area is wrongly classified by the AMR’s sensors as a correct target. As the general resource-constrained discrete search problem is NP-hard, we restrict our study to finding local-optimal strategies. A specificity of the considered operational research problem in comparison with the traditional Kadane-De Groot-Stone search models is that in our model the probability of the successful search outcome depends not only on cost/time/probability parameters assigned to each individual location but, as well, on parameters characterizing the entire history of (unsuccessful) search before selecting any next location. We provide a fast approximation algorithm for finding the AMR route adopting a greedy search strategy in which, in each step, the on-board computer computes a current search effectiveness value for each location in the zone and sequentially searches for a location with the highest search effectiveness value. Extensive experiments with random and real-life data provide strong evidence in favor of the suggested operations research model and corresponding algorithm.

**Keywords :** disaster management, intelligent robots, scheduling algorithm, search-and-rescue at sea
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