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A New Multi-Target, Multi-Agent Search and Rescue Path Planning Approach

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Abstract : Perfectly suited for natural or man-made emergency and disaster management situations such as flood, earthquakes, tornadoes, or tsunami, multi-target search path planning for a team of rescue agents is known to be computationally hard, and most techniques developed so far come short to successfully estimate optimality gap. A novel mixed-integer linear programming (MIP) formulation is proposed to optimally solve the multi-target multi-agent discrete search and rescue (SAR) path planning problem. Aimed at maximizing cumulative probability of successful target detection, it captures anticipated feedback information associated with possible observation outcomes resulting from projected path execution, while modeling agent discrete actions over all possible moving directions. Problem modeling further takes advantage of network representation to encompass decision variables, expedite compact constraint specification, and lead to substantial problem-solving speed-up. The proposed MIP approach uses CPLEX optimization machinery, efficiently computing near-optimal solutions for practical size problems, while giving a robust upper bound obtained from Lagrangean integrality constraint relaxation. Should eventually a target be positively detected during plan execution, a new problem instance would simply be reformulated from the current state, and then solved over the next decision cycle. A computational experiment shows the feasibility and the value of the proposed approach.

Keywords : search path planning, search and rescue, multi-agent, mixed-integer linear programming, optimization
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