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RESEARCH ON TASK ALLOCATION METHOD FOR MULTI-AGENT SYSTEMS ON THE MOON WITH A DISTRIBUTED ARCHITECTURE

Abstract

As human lunar exploration continues to advance, Multi-Robot System (MRS) play an important role in lunar transportation, construction, exploration and so on. However, resources on the lunar surface are exceedingly scarce, a rational task allocation strategy is particularly vital in the complicated lunar environment. Current task allocation strategies for MRS on the lunar surface are limited, considering only basic constraints. Without addressing complex factors such as loads, collisions, and terrains, leading to limited allocation effectiveness. Most of them are based on centralized approaches, which struggled to poor communication conditions and topologies with low robustness. To address these issues, an improved Consensus-Based Auction Algorithm (CBAA) is proposed which is a distributed and decentralized task allocation algorithm. Robots are seen as independent agents, performing local calculations first to assess the cost of task completion. Communication and information exchange for consensus occur only during the consensus process, proceeding until all tasks are auctioned. This method accounts for the impact of payload on robot speed and energy consumption that robots have a payload limit, and the higher the load they carry, the slower they move and the more energy they consume. Then, task priority constraints must also be considered. The principle that higher-priority tasks precede those of lower priority inherently dictates their greater cost assignment in the algorithm. Should constraints go unmet, consensus breaks down, requiring a revision of the bid function that allocates robots to tasks, thus reshuffling the auction order. The collision radius of a robot is adjusted to accommodate the varying sizes of the robots or their carried loads. Lunar phases, geographical features, and calamities, all distinct to the lunar environment, likewise affect task performance and, consequently, the algorithm's bidding function. Robots may switch to low-power or hibernation modes during lunar nights due to insufficient solar energy. Natural moon disasters also necessitate evasive actions, affecting bidding. The algorithm uses a turn-in

strategy for complex tasks to determine cooperative robot participation based on existing bids. A new bidding function is thus created. In the bidding stage, task duration and energy usage are determined following the Collision-Based Search (CBS) algorithm's path, with weight factors applied to skew results towards either time savings or energy reduction. To evaluate the proposed method, we established various traditional constraints in simulations, using task completion time and energy consumption as metrics. Results indicate that our method can offer solutions with reduced time or energy requirements under identical conditions.