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HUMAN SPACE ENDEAVOURS SYMPOSIUM (B3)
The Role of Humans and Machines in the Future of Space Endeavours (6)

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TOWARD ROBUST DEADLOCK AVOIDANCE METHOD AMONG MULTIPLE ROBOTS: ANALYZING COMMUNICATION FAILURE CASES

Abstract

An assembly of large-scale structures in space requires multiple robots instead of astronauts, but it causes a serious problem, i.e., robots easily get into deadlock situations where robots cannot move due to other robots. To avoid this situation, we proposed the deadlock avoidance method for multiple robots and validated its effectiveness through simulations on assembling space solar power satellite (SSPS) as the first step toward our goal. For the next step, this paper aims at analyzing the robustness of our proposed method in the case of communication failure among robots. We focus on such failure because robots have to complete their given tasks even when robots cannot get enough information due to communication failure among the surrounding robots. For this purpose, we investigate the robustness of our proposed method by changing the information sharing degree, i.e., by shutting off the information of how much the structure is assembled and where the robot should go to next. To analyze an influence of such communication failure, we conduct the following three cases which have different information sharing degree: (1) robots can acquire the almost global information by assuming that all robots can communicate with the nearest modules that also communicate with other modules. This case enables the robots to have the higher information sharing degree than other cases described below; (2) the robots can exchange the information each other, which means that they can get less information than the situation (1) (because robots in this case do not exchange the information by modules); and (3) robots can neither exchange the information each other nor exchange with modules, which means that the robots have only information acquired by their own sensors, i.e., they have the lowest information sharing degree. Through intensive simulations which evaluate the assembly completion rate of the structure and the number of steps required to assemble the structures, the following implications have been revealed: (1) the assembly completion rate of the structure in our proposed method did not drastically change in any of three information sharing degree; and (2) the number of steps required to assemble the structure increases as the information sharing degree decreases. These implications suggest that our proposed method is robust to the communication failure, i.e., robots with our proposed method can assemble the structure with 100% completion rate, even though the completion speed depends on the information sharing degree.