A Game-Theoretic Approach for Adaptive Action Selection in Close Distance Human-Robot-Collaboration

With the integration of Human-Robot Collaboration (HRC) in industrial assembly scenarios, robot systems face numerous challenges. In contrast to classic robot systems which follow a pre-programmed and fixed sequence of actions, an interaction scenario with humans in the loop requires mutual adaptation. In this paper a framework based on game theory is presented that allows robots to choose appropriate actions with respect to the action of human coworkers when collaborating in close proximity. The proposed framework models HRC scenarios as iterative games and selects action-strategies for the Human-Robot Team (HRT) by finding the Nash-Equilibria (NEs) of these games. In contrast to most common approaches, our proposed HRC-game treats the decision-making behavior equally for all agents involved. Therefore, the concept of game theory is applied to evaluate the mutual interference of all actions on the HRT to obtain pareto-optimal NEs, i.e. team-optimal action-allocations. The general framework of the
proposed HRC-game is realized on an interactive pick-and-place scenario in close proximity. This exemplary HRC-game is tested in a human subject experiment of a KUKA LWR 4+ robot and a human coworker assembling toy-bricks in close proximity. The experimental measurements and statistically significant improvements in the subjective feedback hold as a proof-of-concept of the proposed HRC-game model.

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