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Task-Constrained Motion Planning Considering Uncertainty-Informed Human Motion Prediction for Human-Robot Collaborative Disassembly

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While the disassembly of high-precision electronic devices is a predominantly labor-intensive process, collaborative robots provide a promising solution through human-robot collaboration (HRC). To ensure efficient yet safe collaboration, this paper presents a new way to generate task-constrained and collision-free motion for a collaborative robot operating in a dynamic environment involving human movement, which is traditionally challenging due to the high degree of freedom of the co-robot and the uncertainty nature of human motion. We first establish a neural human-motion prediction model with quantified uncertainty, and then optimize the configuration of the robot online by taking the human motion and uncertainties into consideration. While such rationale is straightforward in nature, our method (1) explicitly quantified the uncertainty of the neural human prediction model to further enhance the collaboration safety, and (2) integrated the quantified uncertainty into the task-satisfied motion planning in real-time to efficiently conduct tasks. Extensive experimental tests and comparison studies have been conducted to validate the efficiency and effectiveness of the proposed planning method.