Naturalistic Vibrotactile Feedback Could Facilitate Telerobotic Assembly on Construction Sites

Yijie Gong1, Bernard Javot1, Anja P. R. Lauer2, Oliver Sawodny2, and Katherine J. Kuchenbecker1,2

1 Max Planck Institute for Intelligent Systems, 2 University of Stuttgart

Research goal: determine how naturalistic feedback of a construction robot’s end-effector vibrations affects a viewer’s understanding of telerobotic assembly tasks performed both autonomously and manually.

Haptic feedback system AiroTouch being used with a mini-crane robot assembling wooden cassettes onto the FIT Pavilion in Freiburg, Germany. A high-bandwidth accelerometer measures the end-effector vibrations, which are wirelessly transmitted to the user observing the mini-crane.

Study Procedure:
1) Session 1: watch the assembly process with the haptic feedback for 10 minutes
2) Session 2: watch the assembly process without the haptic feedback for 10 minutes
3) Fill in the questionnaires and be interviewed by the experimenter

Results:
Signals measured during a sample assembly process. The user felt the summed acceleration, which highlights impacts between the robot end effector and other objects, such as the cassette and the pavilion.

• All of the participants liked this technology, saying, for example, “I like it”, “useful to understand the work”, and “could feel tiny changes that could not be observed by eyes”.
• They all agreed that haptic feedback made them more aware of the robot’s contacts with other objects.
• They all agreed that haptic feedback could be useful for construction tasks, as it is important for the robot operator and observers to precisely understand contacts with building materials and the structure itself.
• Given these positive results during observation, we will next evaluate AiroTouch during teleoperation.

The results of the questionnaire about the naturalistic vibrotactile feedback provided by AiroTouch. Participants rated it positively.

Acknowledgments: This work was partially supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany’s Excellence Strategy – EXC 2120/1 – 390831618. The authors thank the International Max Planck Research School for Intelligent Systems (IMPRS-IS) for supporting Yijie Gong. The authors also thank Joey Burns for technical support and Yujin Hakim and Fatemeh Sayehshahabi for helps run the user study.

A full version of the research shown on this ICRA workshop poster will be presented as a technical paper at the 2023 IEEE World Haptics Conference.