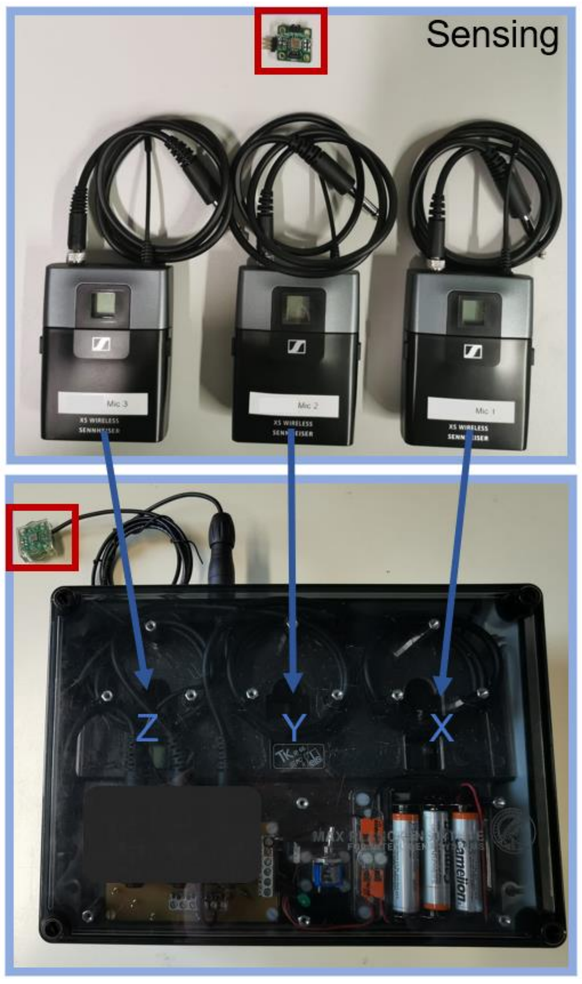
Naturalistic Vibrotactile Feedback Could Facilitate Telerobotic Assembly on Construction Sites

Yijie Gong[1], Bernard Javot[1], Anja P. R. Lauer[2], Oliver Sawodny[2], and Katherine J. Kuchenbecker[1,2]

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

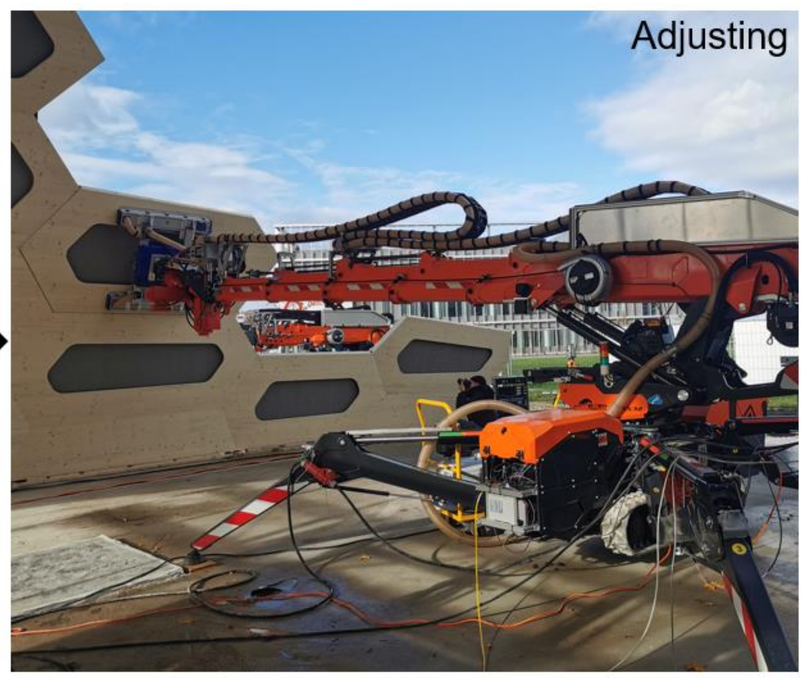
Research goal: determine how naturalistic feedback of a construction robot's end-effector vibrations affects a viewer's understanding of telerobotic assembly tasks performed both autonomously and manually.

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.

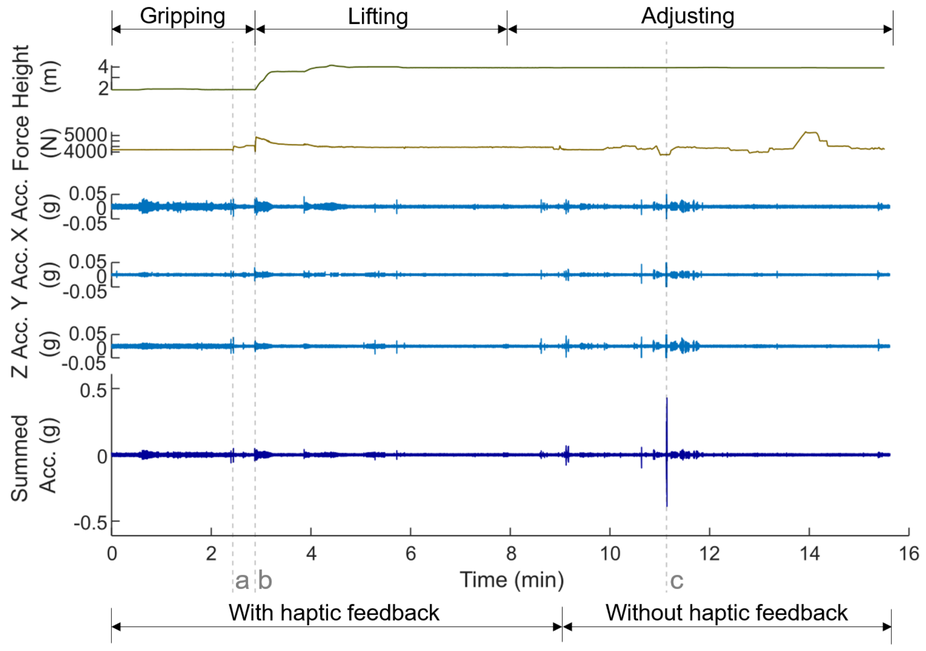


Study Procedure:

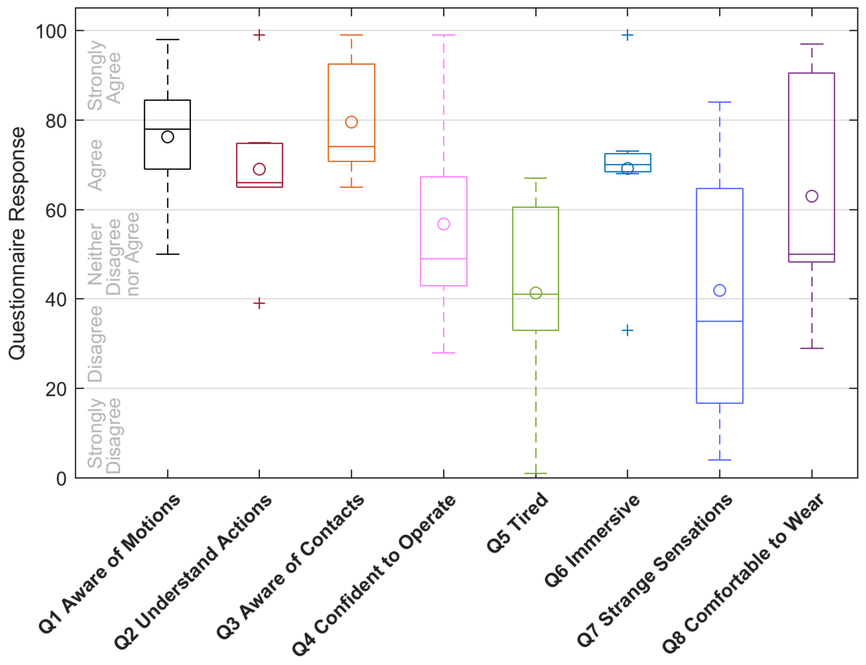
1) Session 1: watch the assembly process **with** the haptic feedback for 10 minutes
2) Session 2: watch the assembly process **without** the haptic feedback for 10 minutes
3) Fill in the questionnaires and be interviewed by the experimenter



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.



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

- 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.

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 Yejin Hahm and Farzaneh Seyedshahi for helping 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.

gong@is.mpg.de
kjk@is.mpg.de