Robotics and haptic intelligence – the potential for timber construction

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Abstract

Several aspects of robotics hold great potential for supporting the future of timber construction. My team and our collaborators are exploring one promising theme, haptic intelligence, within the framework of the IntCDC Excellence Cluster in Stuttgart. Machines used on construction sites can already perform most of the motions needed to move pre-fabricated building components into location on site. However, it is presently difficult for a human operator to coordinate the simultaneous movement of such a machine's many degrees of freedom. Thus, we have developed a generalizable software algorithm that constantly calculates the desired pose for a robotic arm based on the current pose of the operator's arm (measured through wearable inertial measurement units). This Optimization-based Customizable Retargeting Algorithm (OCRA) gives the user natural control over all of the robot's joints to facilitate teleoperation, which can be used to perform difficult parts of any task or to record examples as the foundation for automation. The second half of our work on haptic intelligence focuses on allowing a human to feel what the teleoperated machine is feeling in real time. For this, we attach a tiny high-bandwidth three-axis accelerometer near the robot's end-effector and use commercial audio equipment to wirelessly transmit, process, and output the vibrations for the operator and/or observers to feel. Testing during assembly of the *liv*MatS Biomimetic Shell @ FIT proved that our AiroTouch system captures rich vibrations, especially during contacts between the end-effector and the structure, and that observers highly appreciated this extra source of information. A controlled experiment on another telerobotic platform also substantiated the value of this naturalistic haptic feedback for use with construction robots. We envision that the same kind of sensor can also be used during future autonomous operation of such machines, so they can quickly react to both intended and unintended contacts.