Towards Understanding of Human Kinematic Coordination Patterns in Bimanual Fine Manipulation Tasks

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Skills that require the collaboration of both arms are common in humans' everyday activities, and the coordination of upper limbs is key to human bimanual dexterity. The Skill Acquisition in Humans and Robots (ERC) project aims at obtaining a better understanding of the human skill acquisition process with a special focus on bimanual dexterous manipulation tasks, so as to develop novel robotic controllers resulting in the same level of precision and robustness.

We conduct a longitudinal study of the acquisition of dexterous bimanual skills in watchmaking craftsmanship. We focus on the task of assembling a watch spring, where precise, coordinated, and directionally compliant control of the hands and fingers motions is required. We recorded the motion of subjects and the force/torque applied on the watch face during manipulation tasks.

We compare the performance of 15 subjects participating in our experiments (10 novices and 5 experts). Our analysis shows that experts try to align the direction of force application demanded by the task with the optimal force application direction of the dominant arm. In addition, experts adjust finger placements to improve the dexterity of hands for manipulation. We assume the differences in performance across novices and experts can be explained by the differences in the weights of criteria (manipulability, task compatibility, and discomfort), which are used to evaluate the motion. We develop a computational model to infer the weights. Preliminary results show that novice subjects put higher weight on the task compatibility, while experts have higher weight on motion comfort.