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Understanding and applying human grasping to artificial manipulators

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Though a small part of the body, the human hand is complex and remarkably versatile and multipurpose. Much work has gone into understanding the hand, such as understanding the physical capabilities of the human hand, how humans develop manipulation skills throughout the lifespan, how people translate task requirements into grasping strategy, and so on. Despite this effort, human manipulation is still not well understood. For example, how many grasps or manipulation actions do people use in daily life? How often and under what circumstances do people use both hands simultaneously instead of one? A better understanding of how humans grasp can improve our ability to control robotic hands, which are still far behind human hands in dexterity.

In our work we have used a variety of methods to observe how humans grasp and manipulate in natural, everyday settings. We have used photos taken throughout a normal day; high-framerate video in a specific setting (that of a convenience store); and cameras and motion capture systems in the context of a controlled experiment involving transporting a bowl from one location to another. In these studies we found that a single grasp pose can be used for a variety of actions, were able to observe the grasping process in detail, and found that minimizing body rotation plays a large role in the use of one hand vs. two in transport tasks.

We apply some of the main findings of these studies to the goal of improving the success of grasping performed by robotic hands and virtual characters. In particular, we used the detailed grasping behavior found in the high-framerate video to design a simple soft hand potentially capable of executing several ways of turning precision grasps into power grasps. This work thus presents the results and insights from investigations of human manipulation and lays out ways in which those insights can be used to improve the capabilities of artificial manipulators.

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