Robotic manipulanda as haptic interfaces

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Haptics is the science of applying tactile sensation to human interaction with computers. A haptic device is one that involves physical contact between the computer and the user, usually through an input/output device, such as a compliant manipulandum that senses the body's movements and reacts with force . By using haptic devices, the user can not only feed information to the computer but can receive information from the computer in the form of a felt sensation on some part of the body. This is referred to as a haptic interface. For example, in a virtual reality environment, a user can pick up a virtual tennis ball using a data glove. The computer senses the movement and moves the virtual ball on the display. However, because of the nature of a haptic interface, the user will feel the tennis ball in his hand through tactile sensations that the computer sends through the data glove, mimicking the feel of the tennis ball in the user's hand. I this case, however, the sensation is limited to the tactile part and what is missing is the actual force and the exchange of energy between the hand and the object. A robotic manipulandum, on the other hand, can exchange forces with the user which can mimic any kind of physical interaction with objects or force fields of any kind.
The theory of robotic haptic manipulanda is derived from the modelling of the neuromuscular system and from the measurement of the mechanical impedance of the hand. This is reviewed in the lecture which will summarize the application of such methods for analyzing the organization of motor control and addressing the issue of motor learning as well as the use in the field of robot-aided rehabilitation of motor impaired patients.

Outline

1. Introduction
2. Kinematics and dynamics of human arm movements
3. Measurement of the hand mechanical impedance
4. Motor learning in dynamic environments
5. Application in neurorehabilitation