DESIGN METHODOLOGY FOR HAPTIC INTERFACES AND REHABILITATION SYSTEMS

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Introduction. Designing the actuation system for a robot is a crucial step during the machine development. This phase is even more critical if the robotic system is represented by a haptic interface or a rehabilitation system that are meant to operate in near contact with the human body. Generally, the design process takes into account a realistic model of the limb interacting with the interface [1,2] and includes as set of simulations intended to study the coupled interface-limb system. The result of these simulations allows fixing important requirements necessary to design the interface. Among them the number of Degrees of Freedom (DOF), the joints type and configuration, and the links dimensions. When the kinematic of the interface is ready a proper dynamic model [3] needs to be formalized and computed. This is demanded to find out other important design elements like the optimal actuators displacement and dimensioning.

Materials and methods. The method we developed is mainly intended to optimize the actuation system of a haptic interface (Fig. 1). The optimization operates in discrete domain and starts from an initial hardware configuration D_i. After a trajectory is the defined in the interface's Cartesian workspace [P(t),P˙(t),P"(t)] or in the joint space [qi (t) (q_i)" (t),q'. (t)], the software computes the required torque $T_i(t)$ for each J_i, and finally evaluates the chosen cost function E_i (t) (in our specific case the energy consumed to actuate the reference trajectory).

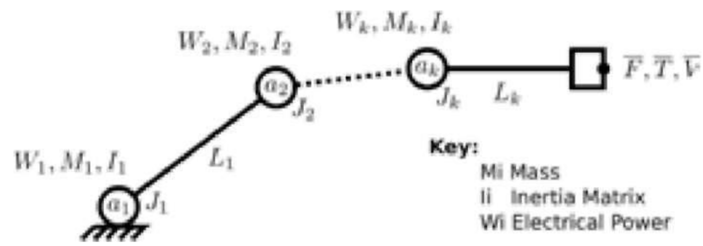

Figure 1. An example of hardware solution.

Conclusions. This work introduces a methodology and a software framework intended to optimize and speed up the design process of a haptic interface or a rehabilitation system. Starting from an initial mechanical design the procedure allows exporting the kinematic and dynamic properties of the robotic system in a simulation environment. The software receives as additional input the Cartesian or joints trajectories and generates as output the required torques at the joints. From the recorded measurements the program extracts the torque ranges necessary to choose a suitable actuation system for the robot.

References.

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