Adjustable Torque Limit Variable Compliance Decoupling Joint

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One of the most challenging features of service robotics is physical Human-Robot Interaction (pHRI), [1] because of the safety hazards involved in interaction. In order to increase safety, mechanics, software and electronics issues should be addressed but in this paper our focus will be on the mechanical structure. Such choice is motivated by the fact that systems which rely on their physical structure rather than on active control, those which have a passive compliance system, can provide faster and more reliable responses for dynamic impacts than an active one[2]. Also, a passive system has claims to inherent safety, which ensures that a system is behaving in a safe way even if sensors and control fail. The inherent-safety approach dictates the use of flexible, shock-absorbing joints that can sustain sudden collisions. The designed joint, Figure 1, passively decouples the arm link from the motor in case of a collision. Its design is inspired by the work of Park et al. [2] but has a major advantage over it: its torque threshold can be actively regulated depending on the operational situation. For example, it would be possible to stiffen the joint when the arm has to cope with a high load in a given task but the decoupling joint could be made more compliant in the presence of fragile obstacles (objects or humans), reducing the harm potential. However, once the torque threshold has been adjusted, the decoupling joint resumes its completely passive behaviour. The variable torque threshold is obtained by changing angle theta, equation 1. This is obtained by moving the “arms” of an ad hoc designed and built system which transfers the movement given by the linear actuator through the decoupling joint.

\[ T_{th} = \frac{d_0k \times s_0}{\tan\psi_{ising}} \] (1)

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Figure 1. The first version of the decoupling joint, in acrylic, and the second version, in steel.

The decoupling joint has been mounted on a purposely built 2 degrees of freedom arm which is meant to be used on the Robulab10 mobile platform, in order to perform fetch and carry tasks in a everyday environment.

References