Invitation à la soutenance publique de thèse
Pour l'obtention du grade de Docteur en Sciences de l'Ingénieur

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Design and Study of a new Continuously Variable Transmission with Potential Application to Lower Limb Prosthesis

Series elastic actuators (SEA) are very popular in rehabilitation robotics. Among other advantages, elastic elements between the actuator and the load permit to store and release energy during the task completion, such that the energy balance is improved and the motor power peak is decreased. In rhythmic tasks like walking, this reduces to design the spring stiffness such that it works at resonance. To comply with different gaits and cadences, it is therefore necessary to design Variable Stiffness Actuators (VSA).

The first part of the thesis investigates lower limb prostheses concepts. A particular concept of VSA is applied to active transtibial and transfemoral prostheses. The model of an original actuation concept is reported, relying on the combination of a power motor, a compliant element (a spring), a mechanical differential, and Continuously Variable Transmissions (i.e., a mechanical transmission whose ratio can be continuously varied). It allows to manage the mechanical power flows through the device in both directions (i.e., when energy should be produced or absorbed by the knee and/or ankle), so that the power motor does not face the sharp load power fluctuations. A preliminary approach to synthesize a closed-loop controller for this device, and simulation results of this closed-loop behavior are reported. These results illustrate the capacity of this actuation principle to filter the load power profile, and further highlight the necessity to maximize the mechanical efficiency of each part of this actuation scheme.

The second part investigates a new kind of Continuously Variable Transmissions (CVT) principle which can achieve ratio variations at rest, i.e. with zero velocity of the shaft. This feature is mandatory for the concept developed in the first part. The presented design is a modified planetary gear, whose planets are conical and mounted on inclined shafts, and ring is made of contiguous diabolo-shaped rollers. This configuration allows moving the contact point radius on the cones and then modifying the transmission ratio. Importantly, this movement relies on rolling and not on sliding, such that it requires virtually no actuation energy.

Membres du jury :
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Mercredi 15 novembre 2017 à 16h30
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