Stability and Singularities of Continuum Robots

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Abstract

Compared to traditional rigid robots, currently used in many manufactories, continuum robots (CRs) are not more composed of an assembly of rigid components connected by lower mobility joints, but are made of flexible bodies encountering large deformations. The motions of their end-effector, the organ where the tool is placed, are carried out by the controlled deformations of the different flexible links composing them.
Their intrinsic flexibility allows their use in many fields where soft interaction with the external environment is required, such as minimally invasive surgery, collaborative tasks or even inspection of confined environments. Various CRs designs exist. Initially, serial-like designs have been proposed, among which we may note tendon-actuated or concentric tube robots. Later, in order to increase the payload capacity of such types of systems, or to obtain higher positioning accuracy, parallel designs were proposed. These CRs, also called continuum parallel robots, are made by the parallel assembly of several passive flexible link together.

All such robots are interesting for their safe-interaction properties, however, they may meet certain configurations where their physical is degraded: unstable areas or singular configurations. Singularities may lead to controller instability, and instability areas to unstable-stable transitions motions dangerous for the external environment.
In this presentation, we will present our most recent work in the analysis of the singular and/or unstable configurations, both from a statics and a dynamics mechanical point-of-view.

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