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An "Elastica Robot": Tip control in tendon-driven elastic arms

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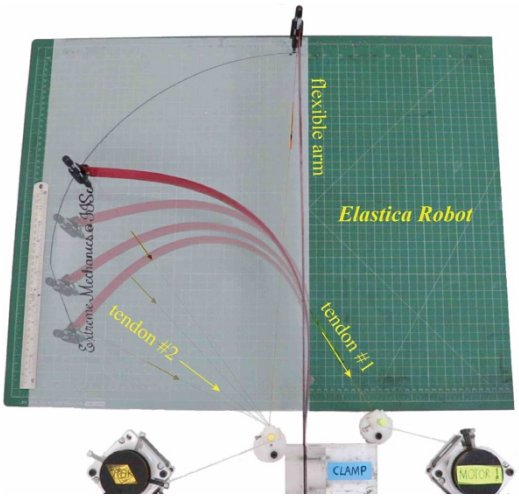

An emerging class of robots are composed of flexible elements and function by exploiting the compliances of their constitutive elements. Such robots are aimed at applications that demand high maneuverability for navigation in closed or cluttered environments, that require interaction with compliant substrates, and at applications where energy-efficiency is critical.

The figure above shows of a slender flexible arm clamped at one end and loaded by a pair of cables. Controlling the tip of the arm by tuning the tension in the cables is a challenging inverse problem--- the arm undergoes large deflections, its sections undergo large rotations, cable loads are configuration-dependent, cables can slacken, and the relationship between cable tensions and tip deflection is highly nonlinear. We demonstrate that by modeling the arm as an elastica, by posing control as a problem of optimizing tensions in the cables and resolving it by computing sensitivities of configuration-dependent forces, the tip of the arm can be accurately positioned within a feasible workspace.

At the talk, we will discuss key aspects determining the workspace of the robotic device, its generalization to a shape-control problem inspired by manipulating surgical instruments, as well as interesting aspects of instabilities in load and length-controlled settings.

REFERENCES

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