STUDY ON SOFT-FINGERED HANDLING VIA MINIMUM DOF ROBOTIC HAND FOR ROBUST MANIPULATION

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I have provided a static elastic model of a hemispherical soft fingertip in a physically reasonable and straightforward form, which is suitable for theoretical analysis of robotic handling motions. I have proposed that the elastic energy formula has a minimum point on the contact with the soft fingertip, and we call it "Local Minimum of Elastic Potential Energy", which is abbreviated as LMEE. Furthermore, I have shown that each of the energy and its corresponding force formulae is a function of two variables: the maximum displacement of the fingertip and the orientation angle of a contacting object.

I have first focused on quasi-static handling motions to reveal the LMEE effect on the handling, and demonstrated the LMEE-based soft-fingered manipulation by means of minimum degrees of freedom robotic hand. In this analysis, I have shown that a simple two-fingered hand is able to accomplish the stable grasping and manipulation.

Finally, I have extended the elastic force equation to a laterally deformable soft fingertip model in order to analyze the dynamic behavior of an object grasped by two soft fingers. In the process, I have represented two types of constraint: holonomic and nonholonomic equations that appear on the pinching motion by a pair of deformable soft fingertips. I have applied CSM (Constraint Stabilization Method) including the both constraints to computing the dynamic motions of whole handling system from equations of motion. Through the simulation, I have shown that robust manipulation can consistently be achieved in soft-fingered handling as long as the grasped object is physically in contact with soft fingers.