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Development of Realistic Pressure Distribution and Friction Limit Surface for Soft-Finger Contact Interface of Robotic Hands

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Abstract Various models have been presented for pressures distribution in the contact interface of a soft finger and object in the literature. These models have been proposed without considering the effect of the tangential forces which are usually exerted in the contact interface of a soft finger and object during grasping and manipulation. Having an accurate pressures distribution model across the contact interface is important for designing tactile sensors and improving the modeling of the friction limit surface (LS). In this paper, a new and more accurate model is proposed to describe the asymmetry of the pressure distribution in the contact interface of a hemispherical soft finger under both normal and tangential forces. This model is derived based upon observations in the previous literature stating that the contact interface would move and skew toward the direction of the tangential force. According to the proposed pressure distribution model in this study, an improved and more accurate LS is presented. The LS profile obtained by this model is compared with the corresponding results based on the previous models. The new results show that the consideration of the skewness or asymmetry in the pressure distribution (due to the tangential force) causes the LS profile to shrink compared with that constructed with symmetric pressure distribution assumption. This shrinkage, as a result of the skewness and asymmetry of the pressure distribution, makes the contact interface more vulnerable. Furthermore, this new model can also provide a more accurate tool for the analysis of grasping and manipulation involving soft contact interface.

Keywords Soft finger · Contact modeling · Friction limit surface · Grasping and manipulation · Haptic perception

1 Introduction

Human hands can grasp and manipulate different objects without having knowledge about the weight of objects and the friction coefficient between the contact interface of objects and fingers. Indeed, human hands can sense the incipient of slip on the contact surface of the fingertip by detecting micro-vibrations using the mechanoreceptors (i.e., sensory cells that respond to mechanical forces) and control the grasping force unconsciously using the nervous system to have a stable grasp without damaging the objects

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