Abstract of Main Thesis

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LOCALIZED DISPLACEMENT PHENOMENON INTERPRETED BY BEAM BUNDLE MODEL OF A SOFT FINGERTIP AND ITS APPLICATION TO ASSESSING SLIP PERCEPTION OF SOFT TACTILE SYSTEMS

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Abstract on the Content of the Applicant's Thesis

This thesis presents an approach for assessing slip perception of soft fingertip through dynamic simulations, and its application to stick-slip detection of robotic fingers. In the field of robotic dexterous manipulation there has been a great deal of work on how to model slip motion. In addition, in the field of robotic anthropomorphic hand there has been a great deal of work on how to propose stick-slip detection methods in companion with embedded specific designs of sensory systems. However, most of this work cope with both quasi-static and analytic issue; while a little work introduces partly friction on the contact surface. Therefore, proposed slip detection methods are still far from human ability. In order to address remained issue, we propose a *hybrid* model of the sliding soft fingertip with virtual beam model and Finite Element (FE) model. While the former represents normal and tangential deformations of the soft fingertip, the latter can brings micro movements on the contact surface when sliding. We call this model as *Beam Bundle Model* (BBM). We also introduce dynamic friction model into each contact nodes to fully describe sliding motion. In this research, we especially focus on initial phase of movement, *i.e.* pre-slide phase, whereby we have found out a so-called *Localized Displacement Phenomenon* (LDP) that represents micro movements of contact points during pre-slide of the object, which is considered important to assess the stick/slip states, and crucial in stable grasp/manipulation tasks. Utilizing this phenomenon, we have propose several methods to detect incipient slip of tactile fingertip using fabricated micro force/torque sensor, and robotic skins developed from special yarns and tactile-arrayed sensor. Finally, we show our attempt to enhance tactile sensing so that it would be comparable in term of popularity to that of vision, by utilizing LDP idea. Our approach is generalized to slippage of other types of soft fingertip with known shapes, as well as application in haptic devices.