Modeling Capillary Behavior in Finger-Device Interfaces

CATEGORY OR KEYWORD

Biotribology, Contact Mechanics

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INTRODUCTION

Understanding the tribology of the finger-device interface is crucial for the field of haptics, which finds substantial application in consumer electronics, virtual reality and Internet of Things [1]. Many experimental and theoretical analyses has been carried out to characterize the friction force of the finger and its relationship with other factors including topography, deformation, adhesion and electro-adhesion [1-3]. While it has been argued in previous studies that capillary can potentially affect friction force, there have been limited reports on quantifying or modeling the capillary in the finger-device interface, partially due to the complicated geometry of the contact interface [2-3]. In this paper, a multi-physics model of the finger-device interface is built, incorporating both mechanical deformation and capillary distribution due to sweating. The simulation result demonstrates how water redistributes in the contact interface after sweat secretion and furthermore, explains why different surfaces feel different when touched by fingers.

CAPILLARY DISTRIBUTION IN THE FINGER-DEVICE INTERFACE

Capillary formation is sensitive to the geometry of the interface. It has been experimentally observed that glass surfaces with different microscale textures feel differently. To accurately model the capillary bridges in the interface, topographies of textured glass surfaces are scanned with AFM. The finger is currently modeled as a flat, deformable layer to better reflect the effect of glass texture on capillary formation. The contact deformation is simulated with Finite Element Method and the glass and finger surface geometry after contact are plotted in Fig.1 and Fig. 2. Formation of capillary is simulated through Monte-Carlo Method. Within the post-contact interface, random water droplets are formed and the optimum location of each drop is calculated based on their surface energy state (capillaries are marked as light blue circles in Fig. 3). From Fig. 3, it can be observed that capillary tends to form near contact locations and the capillary force will affect friction between finger and glass surfaces.

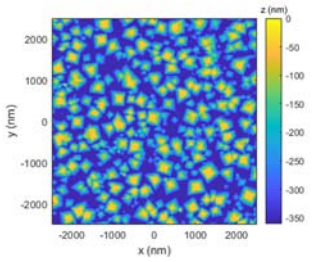

Fig. 1 Glass surface

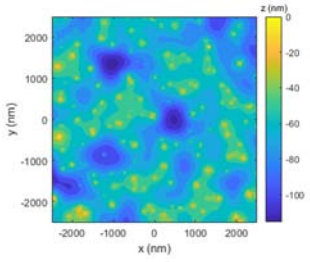

Fig. 2 Finger surface after contact

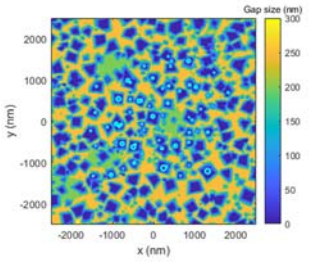

Fig. 3 Capillary distribution in the interface

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