Metainterfaces with specified friction laws : new designs from numerical optimization

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Abstract

Many devices, including touchscreens and robotic hands, involve frictional contacts. Optimizing these devices requires fine control of the interface's friction law. We have recently proposed a generic surface design strategy to prepare dry rough interfaces that have predefined relationships between normal and friction forces (1). Such metainterfaces are made of assemblies of spherical asperities that, collectively, produce an emergent macroscopic friction law. The individual height of each asperity is prescribed through inversion of a suitable upscaling model. In (1), the inversion was analytical, which strongly limited the number of accessible friction laws. Here, we use genetic algorithms to identify complex designs that meet previously unaccessible specifications. For instance, we apply this method to obtain friction laws with a true proportionnality between friction and normal forces at large normal forces. This method therefore offers ways to create metainterfaces with on-demand values of the friction coefficient, without changing the pair of materials in contact. Our new designs are validated experimentally on glass/polydimethylsiloxane (PDMS) metainterfaces. Overall these results lay the foundations for automated ways of designing soft contact interfaces with a large breadth of desired friction behaviour. (1) A. Aymard, E. Delplanque, D. Dalmas, J. Scheibert. Designing metainterfaces with specified friction laws. *Science* **383**, 200-204 (2024)

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