Design and Optimization of a Finger-Surface Tribometer with Constant Normal Load Control

CATEGORY OR KEYWORD

Biotribology, Contact Mechanics

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INTRODUCTION

The finger-device interaction has been an area of interest among researchers in haptics. Due to the dependence of friction force and friction coefficient on the normal load, it is essential to maintain a controlled constant normal load when studying the effect of other parameters including humidity and surface texture on friction. Typical practices for normal load include visual feedback [1] and placing dead weights [2]. These approaches can lack precision in the control of normal load. In this paper, a novel reciprocating tribometer was designed that controls the normal load using a precision vertical stage and force sensor feedback loop. The performance of normal load control is compared with visual feedback method.

EXPERIMENTAL RESULTS

The tribometer setup is shown in Fig. 1. A control algorithm was developed to drive the vertical stage based on the feedback from the force transducers. A desired normal load was set for one set of experiments, and it was compared with the real-time normal force measured by the force sensor. A PID control mechanism was designed and optimized to maintain constant normal load with the vertical stage.

Experiments were performed where the desired load was set to 0.2N, 0.5N, 0.7N and 1N, and the normal load was measured for both the force feedback and visual feedback controls. Comparison between them showed that the tribometer could achieve a normal load with a standard deviation of 7.5% - 18.7%, whereas the standard deviation of visual feedback based normal load control is measured to be 16.3% - 33.1%. Comparison for a set desired normal load of 0.7N is shown in Fig.2.

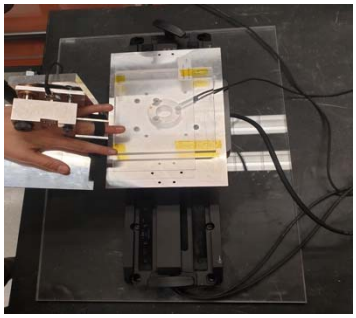

Fig.1 Tribometer design

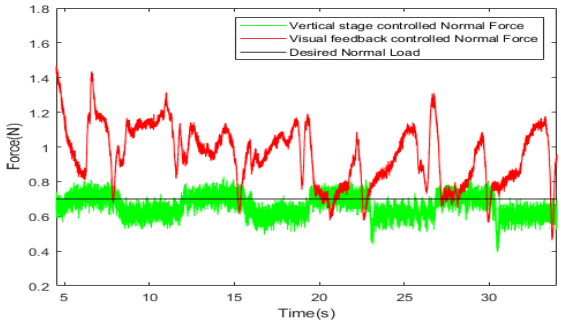

Fig.2 Comparison between vertical stage controlled normal load and visual feedback

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