Abstract of Main Thesis

Title of Thesis

Dynamic Modeling of Microparts Motion along Asymmetric Saw-tooth Surface with Symmetric Vibration

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Abstract on the Content of the Applicant's Thesis

The objective of this thesis is to investigate the dynamic motion of micro-parts such as small electronic devices on symmetrical vibratory saw-tooth patterned surfaces by experiment and simulation, providing the guidelines for the development efficient micro self-assembly systems. This approach depends only upon the contact condition between the feeder surface and the microparts to carry out microparts one direction. So, the driving system is simple and uses an open loop system for feeding.

To move micro-parts in a desired direction is attractive issue since it has wide applications in electronics industry, micro-logistics, and micro-robot industry. In the micro world, friction dominates in the force applied on microparts rather than its inertia due to adhesion and electrostatic force, van der Waal's force, intermolecular force, and surface tension. However, the effect of these forces on the motion of micro-parts has rarely studied with the variation of the driven system and micro-parts parameters. Therefore, this thesis investigates deeply on the effect of geometry parameters of asymmetric surfaces and microparts, actuator parameters of a feeding system, and environment parameters on the motion of micro-parts by both experiment and simulation techniques. The comparison between experiment and simulation that can model above forces allows identifying the important forces and parameters. Thesis is organized as follows:

Chapter 1 provides a review of the existing micro-feeder systems.

Chapter 2 introduces the available experiment systems as well as demonstrating fabrication technologies of experimental saw-tooth surfaces. In this chapter we also introduce particle tracking velocimetry (PTV) method to track micro-parts position with time.

Chapter 3 describes basic principle of one-directional feeding of micro parts along an asymmetric surface driven by symmetric vibration.

Chapter 4 investigates the effect of the saw-tooth profile of surface and exciting frequencies on the motion of micro-parts by experiment. The obtained results show that micro-parts can move faster on the surfaces which have the patterned profiles closest to the saw-tooth shape.

Chapter 5 studies the effect of relationship between geometry parameters of surfaces and micro-parts on the motion of micro-parts. We found that the velocity profiles of the micro-parts against characteristic velocity of the surface are similar for the same relative length of micro-part to the saw-tooth pitch.

Chapter 6 describes the simulation model of the micro-parts on saw-tooth surfaces. The model includes the effect of surface roughness, relative micro-parts geometry parameters to the surface geometry parameters, adhesion, and environment parameters. The contact between the micro-part and saw-tooth surface is assumed to be at the contact between a number of hemisphere on the micro-part and the surface, resulting in either a point contact or slope contact. The surface roughness is modeled as a random normal vector with a pre-described distribution. The model describes well the motion of micro-parts.

Chapter 7 provides the concluding remarks the thesis and future works.