Abstract

The force measurement system using zero-compliance mechanism measures force from displacement of the detection point without displacing the point of force. The aim of this study is to confirm the efficiency of zero-compliance mechanism using a double series magnetic suspension system.

Introduction

Conventional micro force measurement

Detector

Laser source

Atomic element

Cantilever

Force measurement from the deflection of the cantilever

Problem

Displaced Point of force affect the force measurement

Zero-compliance Mechanism

Positive stiffness ($k > 0$)

Extend

Force $w$

Zero-compliance ($k_c = \infty$)

Negative stiffness ($k < 0$)

Contract

Detection point

$z_1 = -\frac{w}{k_2}$

Point of force

$z_2 = 0$

Actuator

Realization of negative stiffness causes destabilization of the system

Equivalent negative stiffness by PID control of the point of force

Use of double series magnetic suspension system

Force measurement apparatus using double series magnetic suspension

Electromagnet + Spring + Permanent magnet

Model

Positive stiffness

Detection point (Floator 1)

Negative stiffness

Point of force (Floator 2)

Static force measurement

Detection point : Linearly displaced according to a force

Point of force : Invariant to force

Enable force measurement from detection point displacement

Applications

- Dynamic force measurement
- Multi-DOF measurement
- Force measurement in cantilever
- Torque measurement

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