Precision Mechatronics Laboratory (OIWA Lab., Shizuoka Univ.)

We aim at realization of machine system with perfect 6-Degree-of-Freedom motions.

To realize ultra-precise measurement machine and machine tool, stiff and accurately moving mechanism is strongly required. Actually, it is so difficult to keep the relative position between the workpiece and the end-effector precise because of positioning and motion errors of the mechanism, and thermal fluctuation. We are trying to realize the mechanism with perfect 6-degree-of-freedom (6-DOF) motions by adopting some basic principles of precision mechanism, and using proper advanced measurement and control technologies.

Current Research Topics

★Ultra-precise Machine System with 6-DOF Perfect Motion between Tool and Workpiece

This study proposes a compensation system for 6-DOF motion errors between the end-effector and the workpiece. A hexapod-type parallel mechanism with 6 passive connecting chains measures these motions for compensating the end-effector's position independently of the temperature fluctuation and external forces.(T. Oiwa , *Int. J.Prec. Eng. Manuf.* 8, 2 (2007) 3-8.)

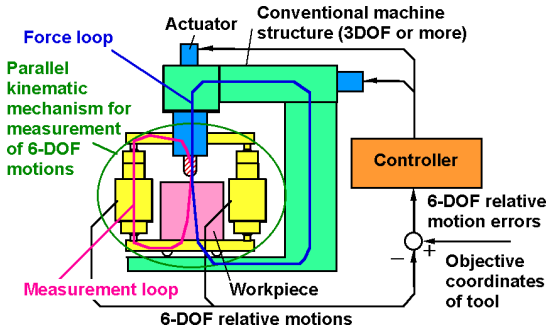

Fig. Ultra-precise machine system with Hexapod-type measurement device

★Studies on Precision Mechanism Based on Parallel Kinematics Mechanisms (PKMs)

The 6-DOF PKM which offers greater accuracy can provide 6-DOF motions to the end-effector and also measure its 6-DOF motions.

- •Coordinate measuring machine
- •Calibration methods using 3D ball plate and redundant passive connecting chain
- •Compensation methods for elastic and thermal deformations of links, joints and machine Frame

(T. Oiwa , *Int. J. Robotics Research*, 24, 12, (2005) 1087-1102)

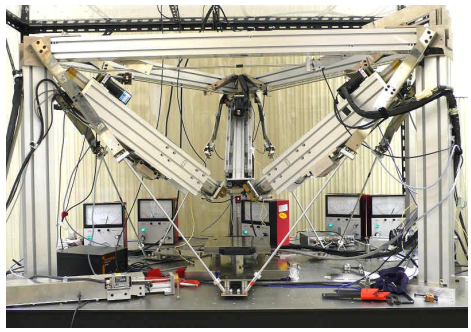

Fig. CMM based on 3-DOF PKM

★Friction Control using Ultrasonic Oscillation for rolling-element linear-motion guide

In general, static friction at very low velocity generates stick-slip motion and deteriorates the positioning accuracy. When the ultrasonic oscillation reduces the static friction to the same level as the dynamic friction, the stiction will be successfully prevented.
(T. Oiwa , *Rev. Sci. Instrum*, 77, (2005) 016107)

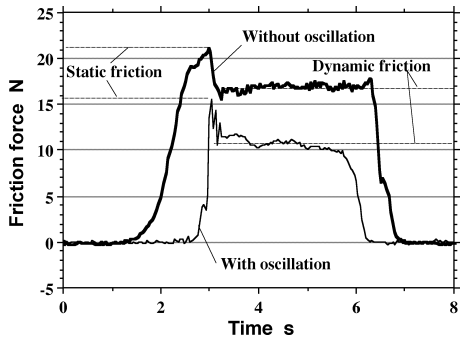

Fig. Static and dynamic frictional forces with/without ultrasonic oscillation

★3D Touch Probe Using Optic fibers

In conventional touch probe system, its sensor detects the tip ball's displacement through a long stylus shank. Sensors of proposed probe system measure directly ball's 3D position in order to minimize the Abbe's offset. Consequently, the probe performance has been improved on the sensitivity and pretravel.
(T. Oiwa et al., *Meas.Sci. Technol*., 15, 1(2004)84-90, and 16 (2005) 1574-81)

★ Digital Displacement Sensor Based on Surface Acoustic Wave

This study developed a new displacement sensor or digital encoder. SAW is an acoustic wave traveling along the material surface, even on curved surface. The standing wave generated on a scale substrate is detected by the interdigital electrodes. Then, change in amplitude of the signal is counted for measuring the displacement of the detector.

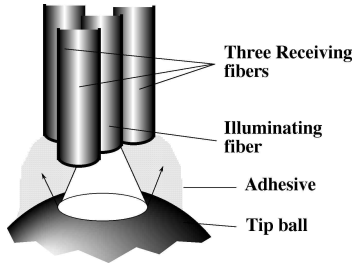

Fig. The simplest 3D touch probe consisting of one illuminating fiber and three receiving fibers

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