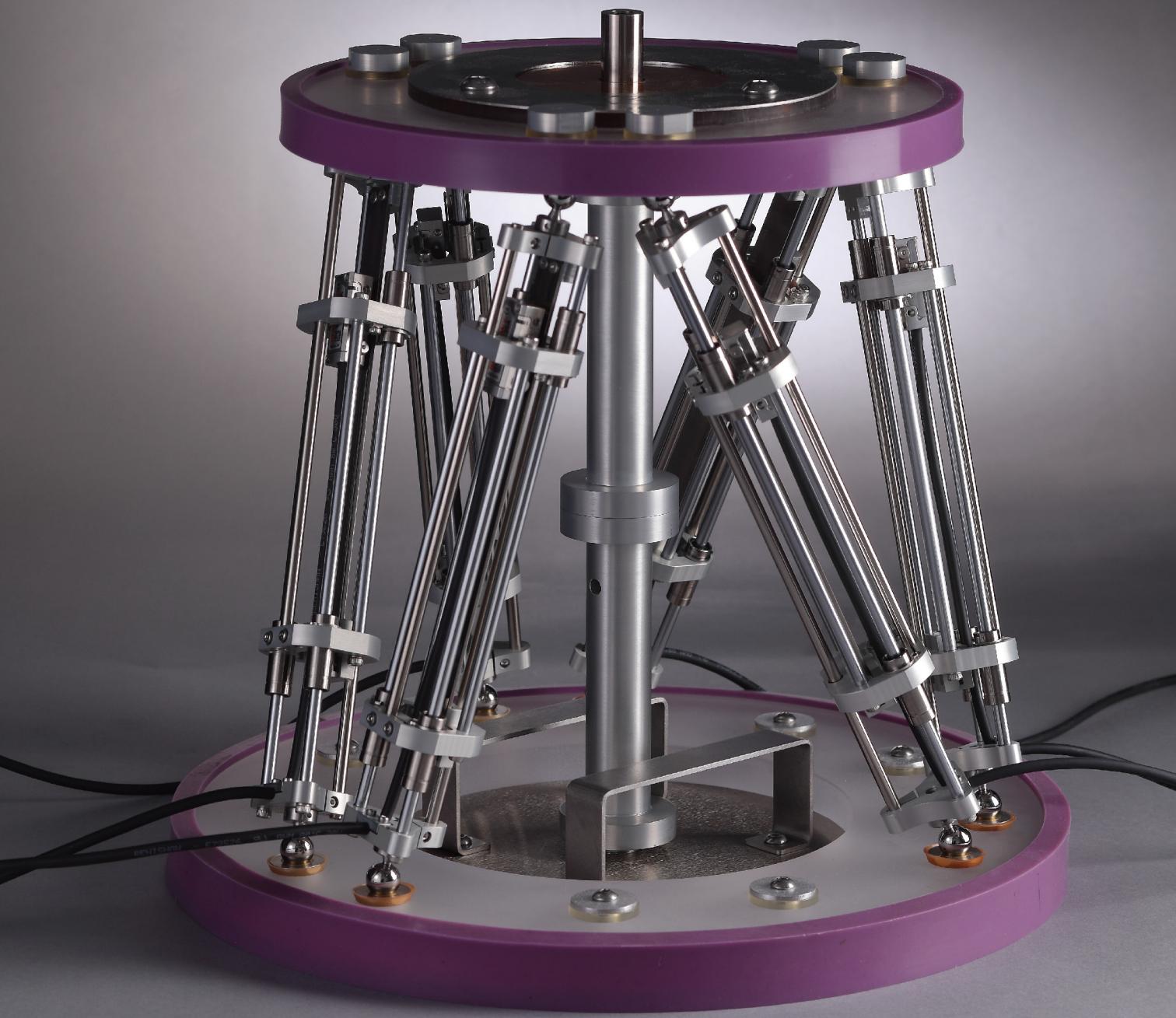




LEI & SO Co., Ltd.

MMD-200

Six-Dimensional Motion Measurement Device



Installation and Measurements Once and for All



Introduction

The Six-Dimensional Motion Measurement Device (MMD) is an innovative product of the LEI & SO Co., Ltd. The MMD is designed to measure the motion of the tool relative to the workpiece on a machine in shop floor. The measured motion is six-dimensional, including three translations and three rotations. Once the MMD is installed on a machine, it can be used for all kinds of measurements and inspections such as the calibration of DH kinematic parameters of a industrial robot, the calibration of link parameters of the two rotary axes of a five-axis machine tool, the tracking of dynamic motion errors and the measurement of thermal errors of a main spindle.

Six-Dimensional Motion Measurement Device

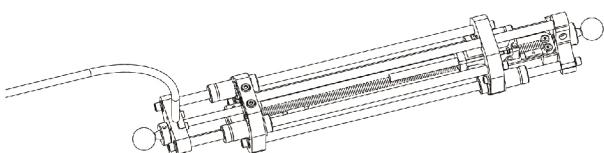


MMD-200

Features

High rigidity optical scale ball bar

The three parallel rods of the optical scale ball bar form a spatial structure with excellent rigidity against bending. The parallel rod is made of material INVAR, which is well known for its low CTE. The use of optical scale as displacement sensor for the ball bar has the advantages of high accuracy and large measuring stroke.



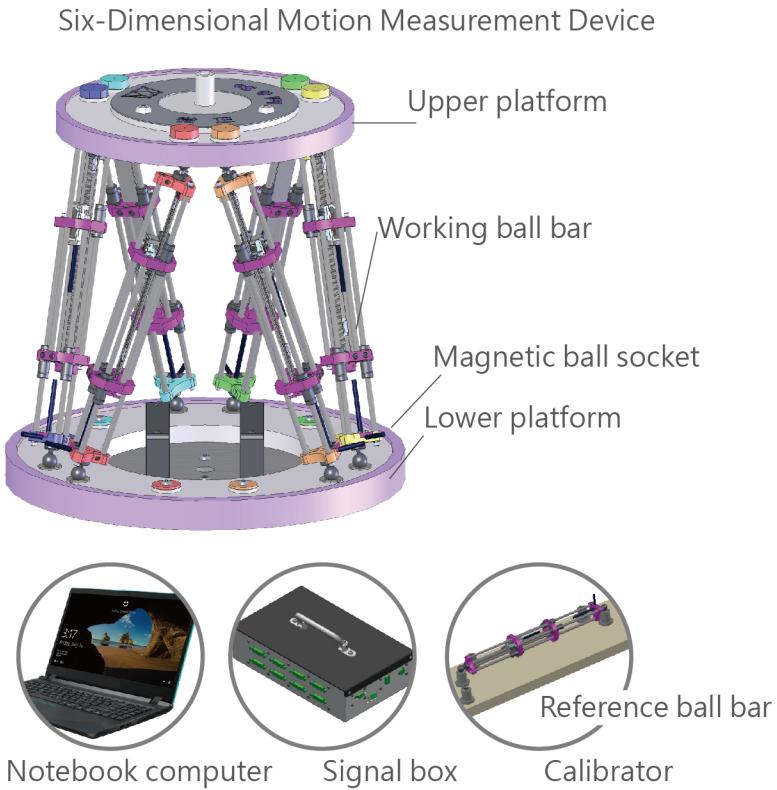
Thermally stable platforms

The upper platform and the lower platform have multi-layer design. The quartz glass layer provides thermally stable locations for the centers of the ball joints under changing ambient temperature. The quartz glass layer is supported by the INVAR metal layer, which bears loads resulting from transport and installation.



System description

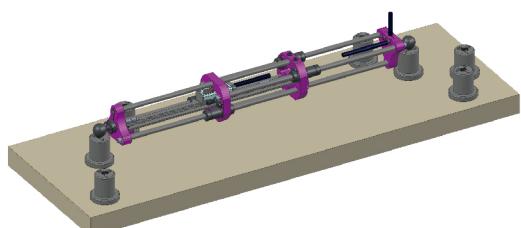
The MMD has the parallel kinematics of a Stewart platform, consists of one upper platform and one lower platform. Each platform has six magnetic ball sockets on it. Six working ball bars connect the two platforms and form the parallel measuring kinematics. Each working ball bar is equipped with an optical scale of the highest accuracy. The near-zero CTE calibrator is used to initialize the lengths of the working ball bars. During the measurement, an extra reference ball bar is placed on the calibrator, which enables an accurate compensation of thermal errors of the working ball bars. The signal box gathers the displacement signals of all ball bars and communicates with a notebook computer via the USB interface. A powerful motion measurement system runs on the notebook computer and provides user with friendly interface.



Thermal errors compensation

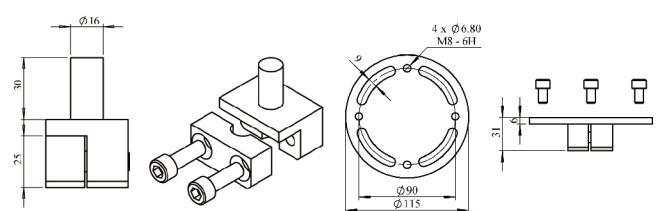
A challenge of MMD is to maintain its measuring accuracy under changing ambient temperature in shop floor. The patented method* uses a reference ball bar to measure and compensate dynamic thermal errors. The reference ball bar is placed on a calibrator having near zero CTE, so that its readings are the real thermal errors induced by the changing ambient temperature. Since the working and the reference ball bars have the same structure, their thermal errors are nearly equal. The compensation of thermal errors of all working ball bars is thus very efficient.

*US10209048B2, TWI585363, CN201611091440.8



Interfaces for installation

The MMD can be used for different kinds of machines, including machine tools and industrial robots. To make the mount of the upper platform on the target machine quickly and easily, two standard interfaces are provided, which include a cylindrical shaft and a circular plate.



Measurement functions

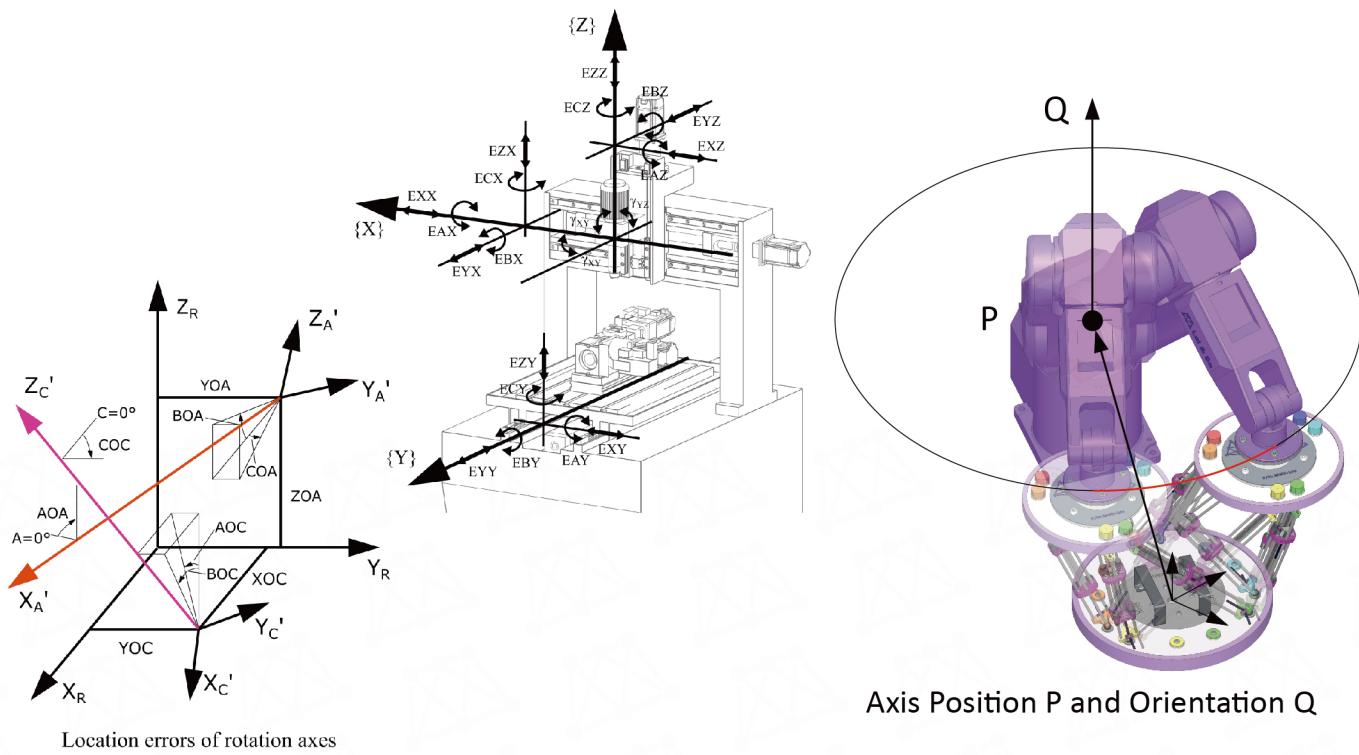
The MMD is useful for various applications, including the measurement of positioning errors of a single linear or rotary axis in machine tool, the measurement of axis position and orientation in 3D space, the measurement of squareness between axes, the measurement of 6D circular tracking errors, the measurement of dynamic motion, the measurement of thermal errors of machine components, the measurement of stiffness of a main spindle, the calibration of DH kinematic parameters of a robotic arm, the measurement of machine rigidity and vibration.

Geometric errors measurement for machine tools

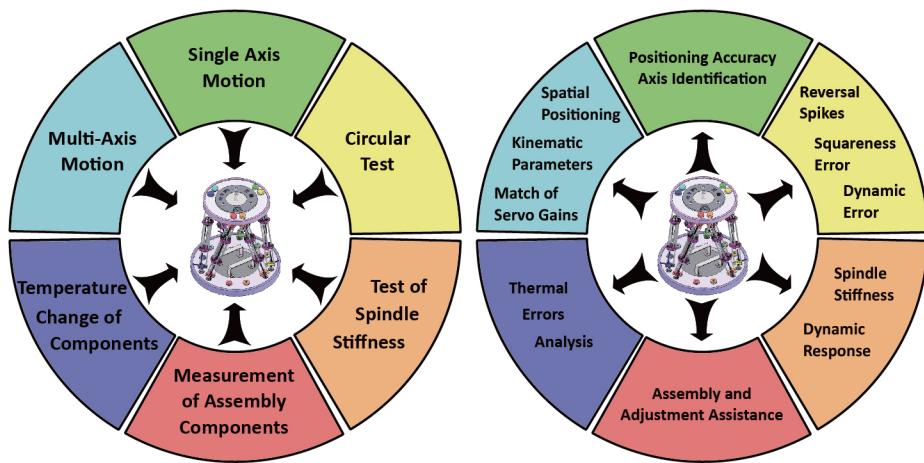
All MMD measured data are defined in a single reference coordinate system. A processing of the data can obtain the 21 geometric errors of a three-axis machine tool, the 8 link parameters of the two rotary axes of a five-axis machine tool.

Identifying kinematic parameters of a six-axis robotic arm

It is advantageous to use the MMD to identify the position and orientation of each joint axis in a robotic arm. By driving the joint motors one after another, all DH kinematic parameters can be identified accurately.



Applications

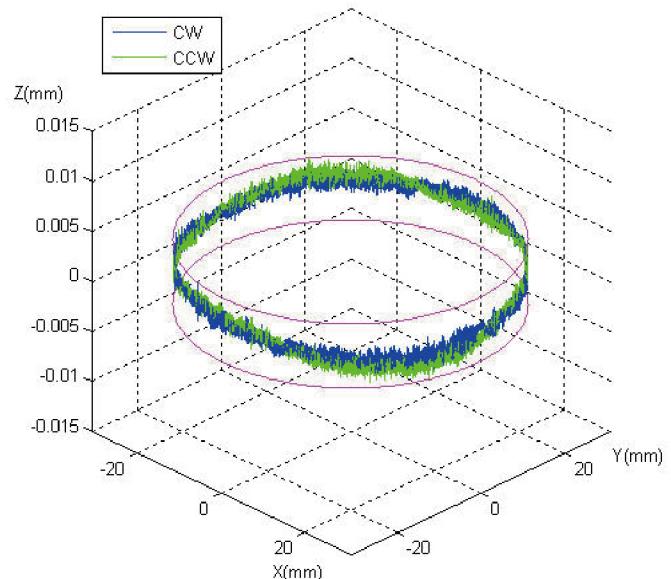
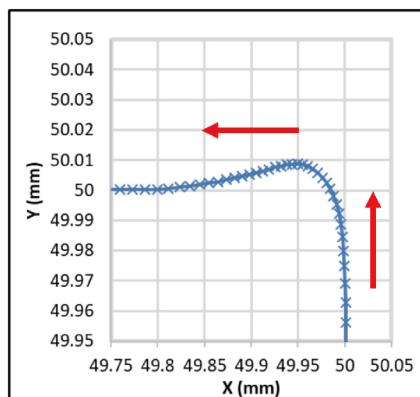
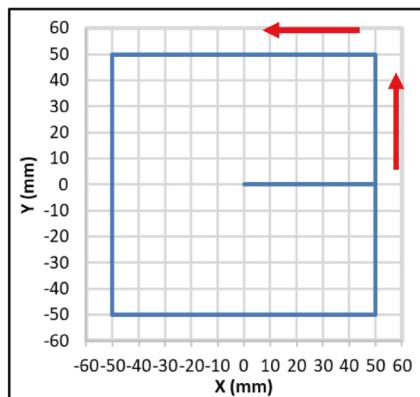


Measurement of dynamic motion

The MMD can measure dynamic motion errors of any continuous or non-continuous motion. The type of motion includes point-to-point, linear, circular, spline, NURBS and any combination of them.

6D Circular tracking

In case the MMD is used for a circular tracking, the measured results show not only the change of radius, but also the three translational and three rotational motion errors during the circular tracking.

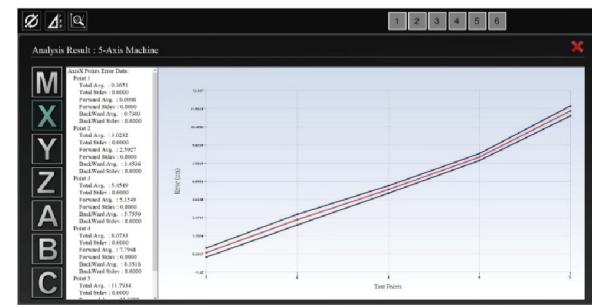
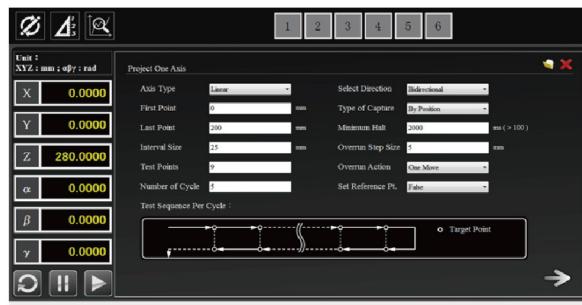




Motion Measurement System MMS

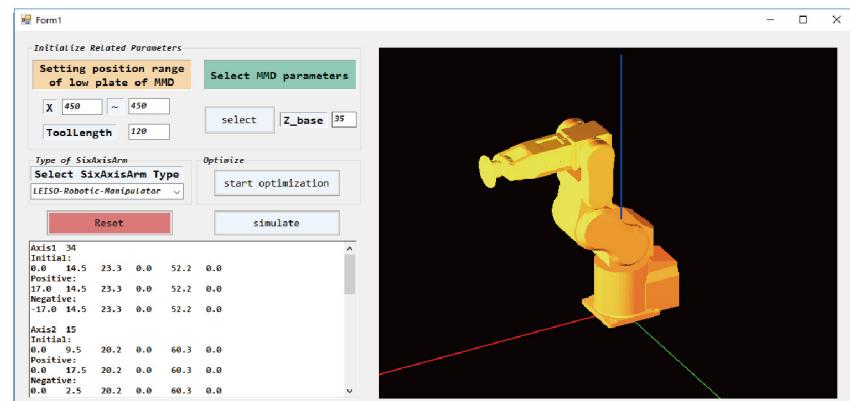
The powerful 6D motion measurement system MMS has very simple and friendly user interfaces. The MMS helps user installing the MMD, setting parameters for the measurement, performing measurement functions step by step, and finally outputs the results in desired formats.

Software system



Intelligent test paths generation

This APP helps user generating optimal test paths for the measurement of DH parameters of a robotic arm. User inputs the kinematic parameters and position of the lower platform, the APP outputs optimal test paths. Before starting the test, a visual simulation helps reducing the risk of collision.



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Specifications

Motion space	X	200 mm
	Y	200 mm
	Z	100 mm
Degree of measurement		6 (3 linear+3 rotational)
Accuracy	Linear	XY : 2 μ m, Z : 1 μ m
Sampling frequency		1 KHz
Operating temperature		0°C-40°C
EMG stop	voltage	12/24 VDC
	current	85 mA
Resolution of optical scale		50 nm
Notebook interface		USB 2.0 or above
System requirement		Windows 7 or above (includes .NET 4.0 Client)
Power		100~240 VAC
Max. speed of ball bar		100 mm/s



About LEI&SO

Lei & So Co., Ltd. is an innovation driving company. We deliver highly reliable, accurate optical scale ball bars and measurement devices based on it, such as 6D motion measurement device (MMD) and 2D ball bar box (BBB).



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