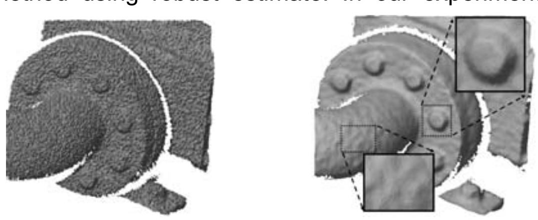
The Japan Society for Precision Engineering

Introduction of JSPE Best Paper Awards 2010

1. A Study on Smooth Surface Reconstruction from Large-Scale Noisy Point-Clouds (1st Report) − Smoothing Operators Based on Robust Estimate —

Hiroshi MASUDA and Kenji MURAKAMI

It is widely recognized that task planning based on 3D CAD can reduce the rework of maintenance and renovation of facilities. Therefore, it is very important to acquire 3D shapes of existing facilities. The state-of-the-art phase-based scanner is suitable for this purpose, because it can acquire hundreds of millions point data in several minutes. However, point data captured from the phase-based scanner tend to include quite a lot of outliers. This paper introduces robust smoothing operators for noisy point-cloud. We propose two smoothing methods using robust estimate. One is based on Lorentzian distribution, and the other is based on Tukey's bi-weight estimation. We modified a conventional smoothing method using robust estimate. In our experiments,



(a)Original data (b) Tukey's biweight estimation

Fig. 1 Results of smoothing

our two methods could produce good smoothed surface even if point-cloud include a lot of outliers.

2. Phase Modulation Homodyne Displacement Measuring Interferometer using Tunable Laser Diode as Light Source − 1st Report : Development of Elementary Techniques—

Masashi ISHIGE, Fumio MATSUURA, Masaaki KAWASUGI, Yuuta HOSHINO, Tuan BANH QUOC and Masato AKETAGAWA

Since an ultra precision technology, e.g. a lithography, have been progressing rapidly, displacement measuring methods with resolution of sub-nanometer or less are required. Displacement measuring interferometers are widely utilized in precision engineering industries. However, they suffer from problems of an imperfect interpolation error of nanometer order and an air refractive index fluctuation. In this paper, we propose and discuss a displacement measurement method with no interpolation error by combining a phase modulation homodyne interferometer with a tunable laser diode and the null method. We also discuss the capability to measure the air refractive index fluctuation.

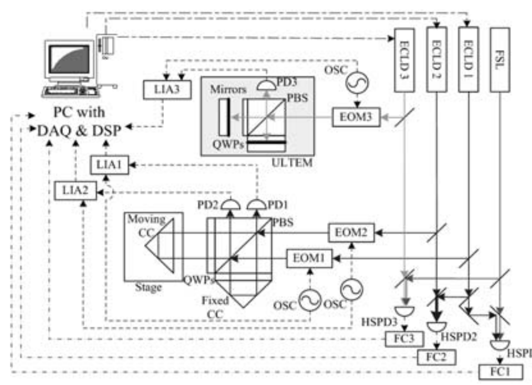


Fig. 2 Total configration of measurement system

3. Evaluation of Adhesion on Tool-Chip Interface with Dynamic Components of Cutting Force

Ryo TEZUKA, Katsuhiko SEKIYA, Keiji YAMADA and Yasuo YAMANE

A new method for evaluation of adhesion in cutting is proposed. Adhesion of chip induces fluctuation in chip flow or stick-slip movement of chip, so that dynamic component of cutting forces depends on the cutting conditions and properties of the work materials. Continuous turning of a medium carbon steel, a titanium alloy and a nickel-based super heat resistant alloy were carried out. Dynamic components of cutting force were measured by piezoelectric dynamometer. In cutting of a medium carbon steel, the dynamic components below 500Hz increased under the condition of build-up edge (BUE) formation, and gradually decreased with increase of cutting speed. Deposits of work piece on tool face were also observed under conditions in which the power spectrum of cutting force showed peaks. Authors defined friction-coefficient vector on rake face of cutting tool. Fluctuation in the friction-coefficient vector was calculated as for a range of cutting speeds under dry condition and emulsion supply in order to investigate the relationship between adhesion and fluctuation of the dynamic components. Tendency to adhesion was evaluated with newly defined index among a carbon steel S45C, a titanium alloy Ti-6Al-4V and a nickel-based super heat resistant alloy Inconel718, yielded good agreement.

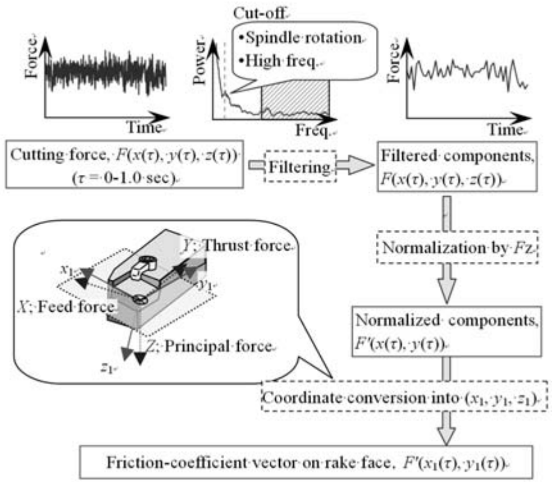


Fig. 3 Processing of dynamic components of cutting force with empirical rules.

Introduction of JSPE Numata Memorial Paper Awards 2010

1. Design and construction of a two- degree- of-freedom linear encoder for nanometric measurement of stage position and straightness

Akihide Kimura, Wei Ga, Yoshikazu Arai and Zeng Lijiang

This paper presents a two-degree-of-freedom (two-DOF) linear encoder which can measure the position along the moving axis (X-axis) and the straightness along the axis vertical to the moving axis (Z-axis) of a precision linear stage simultaneously. The two-DOF linear encoder is composed of a reflective-type scale grating and an optical sensor head. A reference grating, which is identical to the scale grating except the scale length, is employed in the optical sensor head. Positive and negative first-order diffracted beams from the two gratings are superposed with each other in the optical sensor head to generate interference signals. The optical configuration is arranged in such a way that the direction of displacement in each axis can also be detected. A prototype two-DOF linear encoder is designed and constructed. The size of the optical sensor head is about 50 mm (X) × 50 mm (Y) × 30 mm (Z) and the pitch of the grating is 1.6 µm. It has been confirmed that the prototype two-DOF linear encoder has sub-nanometer resolutions in both the X- and Z-axes.

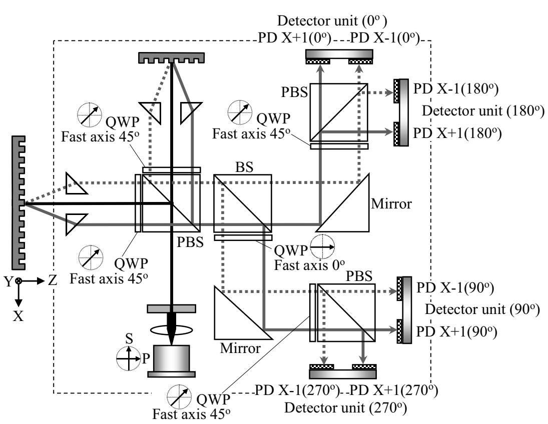


Fig. 4 Configuration of the optical sensor head

2. Machining tests to identify kinematic errors on five-axis machine tools

Soichi Ibaraki, Masahiro Sawada, Atsushi Matsubara and Tetsuya Matsushita

The machining of a cone frustum as specified in National Aerospace Standard (NAS) 979 is widely accepted as a final performance test for five-axis machining centers. Although it gives a good demonstration of the machine's overall machining performance, it is generally difficult to separately identify each error source in the machine from the measured error profile of the finished workpiece. This paper proposes a set of machining tests for a five-axis machine tool to identify its kinematic errors, one of its most fundamental error sources. In each machining pattern, a simple straight side cutting using a straight end mill is performed. The relationship between geometric errors of the finished workpiece and the machine's kinematic errors is formulated based on the kinematic model of a five-axis machine. The identification of kinematic errors from geometric errors of finished workpieces is experimentally demonstrated on a commercial five-axis machining center, and the estimates are compared to those estimated based on ball bar measurements.

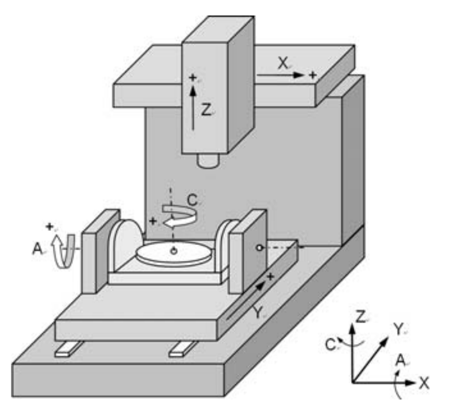


Fig. 5 The configration of a five-axis machine tool