



# The Japan Society for Precision Engineering

## Introduction of JSPE Young Researcher Awards 2012

### 1. Junichi ASAMA

*Reduction of force interference and performance improvement of a consequent-pole bearingless motor*  
Precision Engineering, Vol.36, No.1, pp.10-18

A bearingless motor combines the functions of both magnetic suspension and torque generation together in a single motor. A consequent-pole type of bearingless motor has already been proposed. In contrast to conventional bearingless motors, it is free from the trade-off between suspension force and torque. In addition, stable suspension can be achieved without detecting the rotational angle. However, a part of the X-axis current generates undesirable force in the Y-axis. This force interference influences the performances of bearingless motors; thus, the interference should be eliminated. In this paper, the authors propose an optimal winding design of the consequent-pole bearingless motor to minimize the suspension force interference. Here, the suspension forces in the radial direction are numerically calculated using the magneto-motive force distribution of the bearingless motor, and are compared with the analytical results of finite element method. To verify the theory, static and dynamic performance tests were carried out. It was found that the improved winding configuration significantly reduced the suspension force interference by 90% compared with the previous winding configuration. It was also found that the radial shaft vibration and the power consumption were considerably decreased, by approximately 16% and 44%, respectively.

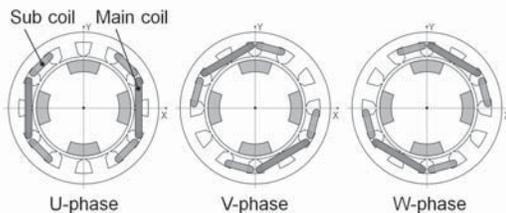


Fig. 1 Configuration of improved suspension windings

### 2. Hirofumi ITAGAKI

*Improvement of Vibration Damping of Linear Roller Guides Using Grease Lubrication Film*

J. JSPE, Vol.78, No.2, pp.168-172

This paper describes a linear roller guide system designed for improving the vibration damping by using grease lubrication film. This linear roller guide has a very narrow gap between the carriage and top surface of the guide rail, as compared to conventional types for gaining moderate amount of friction force of the thin film of grease that provides the feed drive system with higher damping. In this study, the friction characteristics of the linear roller guide were measured and mathematically modeled in order to investigate the friction characteristics of the thin film of lubricants and the influence of friction on the dynamic behavior of the feed drive system. In the measurement of friction force, two kinds of grease with different consistencies and viscosities of base oil are filled into the narrow gap. Step responses in microscopic displacement region were measured and simulated in order to evaluate of vibration damping of the feed direction. As the results, it was confirmed in both experiment and simulation results that the grease flow characteristic affects the nonlinear friction characteristics and the step response of the feed drive system.

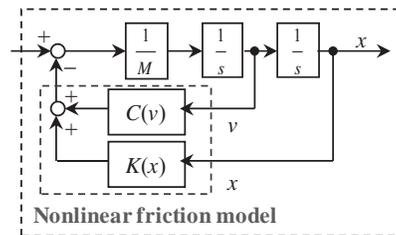


Fig. 2 Simulation model for feed drive system

### 3. Takumi TANDOU

*Improvement of High Aspect Ratio Contact Etching Performance by using Real-Time Wafer Temperature Control (1st Report)*

*-Prototyping of a Basic Equipment and Evaluation of the Temperature Control Effect on Etching Process -*

J. JSPE, Vol.78, No.6, pp.523-527

Novel wafer-cooling system based on direct expansion phenomenon of coolant has been developed in order to improve etching performance for high-aspect-ratio contact (HARC) process. This system provides effective cooling capability and rapid wafer temperature control. In this study, prototyping of basic equipment was performed and etching performance in HARC process was evaluated. As a result, temperature control speed of 0.6 °C/s was achieved over a 300mm-φ wafer. Furthermore,

etching rate and mask selectivity at 100nm-φ, aspect-ratio of 20 HARC sample could be increased by around 6% and 14% respectively without any etching profile deformation by 2-step wafer temperature control from 61°C to 50°C during etching in C<sub>4</sub>F<sub>6</sub>/Ar/O<sub>2</sub> plasma. It is concluded from the results that this system can improve etching performance for HARC.

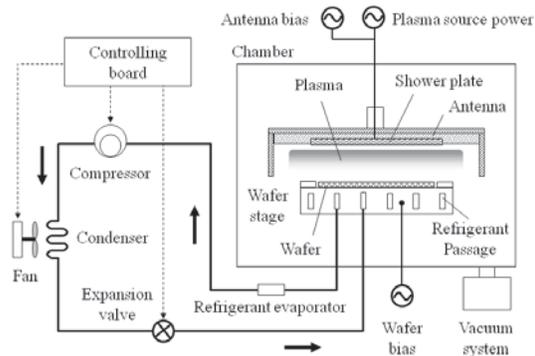


Fig. 3 Schematic diagram of experimental apparatus

## Introduction of JSPE Takagi Awards 2012

### 1. Path Generation Using Linear Curvature and Torsion Segment

Fengli LAN, Hirofumi TAMAI, Kenjiro T. MIURA and Hiroshi MAKINO (Muscle Corporation)

J. JSPE, Vol.78, No.7, pp.605-610

In two-dimensional(2D) space, the clothoid is a preferred trajectory curve because its curvature varies linearly with its curve length. However, in three-dimensional(3D) space, both curvature and torsion must be considered. This paper deals with path generation using linear curvature and torsion segments which can be considered a 3D extension of the 2D clothoid. In our study, the path segments are generated by solving the Frenet-Serret equation. In every path segment, its curvature and torsion varies linearly with its curve length. In order to obtain more

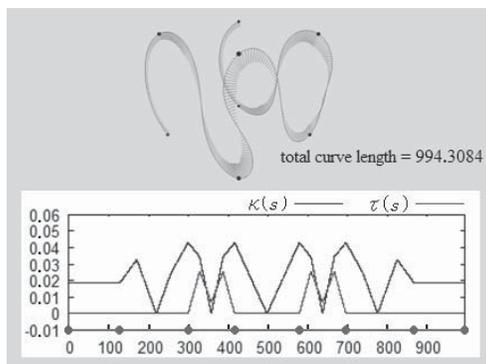


Fig. 4 Path generation with C<sup>2</sup>+τ continuity

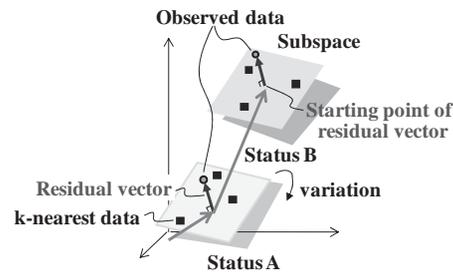
free parameters, plural curve segments are connected in series to make a compound curve. The curve is used to connect two given points which may have given Frenet-Frame, curvature and torsion constraints. These curves are also used to construct a smooth transition passing through an arbitrary point sequence. The resultant path possesses C<sup>2</sup> as well as torsion continuity and matches all given Frenet-frame, curvature and torsion constraints at the given points.

### 2. Study of Anomaly Detection on Tracking of Residual Vector based on Subspace Method

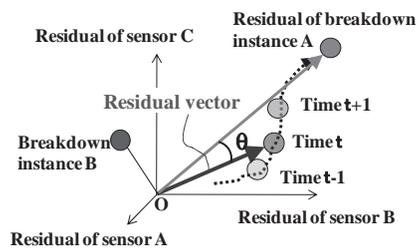
Shunji MAEDA and Hisae SHIBUYA (Hitachi, Ltd.)

J. JSPE, Vol.78, No.12, pp. 1087-1092

Fast and accurate anomaly detection is becoming essential in maintenance services. This paper proposes a novel detection approach based on the subspace method. To achieve high performance of the method, a part of learning data is respectively selected based on the distance between observed data and learning data to form a subspace. Next the residual vector headed from the subspace to the observed data is tracked to identify the anomaly category. To detect anomaly in spite of instability of transient sensing data, the starting point variability of the residual vector is also used to absorb the instability. Experimental results demonstrate that proposed method is beneficial to anomaly detection tasks.



(a) Local subspace and residual vector



(b) Starting point trajectory of residual vector

Fig. 5 Residual vector and anomalous cause identification