



# The Japan Society for Precision Engineering

## Introduction of JSPE Young Researcher Awards 2009

### 1. Sachio KOBAYASHI

*A Method for Constructing Surfaces with Smooth Curvature Variations Based on Discrete Geometry Models*

This paper presents a new scheme for construction of a piecewise  $G^2$  surface which interpolates a rectangular curvature continuous quintic Bezier curve mesh. For application to practical CAD/CAM, a parametric surface with a controlled curvature distribution can be generated based on a discrete surface with a smooth curvature distribution. First, a discrete surface is constructed by minimizing an integral of square of the 2nd derivative of principal curvatures. The discrete surfaces have good curvature distributions, because they have a high degree of freedom. A  $G^2$  quintic Bezier curve mesh is constructed by curves that minimize an arc length integral of square of the 2nd arc length derivative of curvature binormal, based on the discrete surface. After estimating twist and cross-boundary derivatives from geometric properties of the discrete surface, a  $G^2$  surface interpolates the curve network by minimizing an energy function that measures the variation of principal curvatures. The generated surface elements are bi-quintic Gregory patches.

### 2. Shujie LIU

*Profile measurement of a wide-area resist surface using a multi-ball cantilever system*

In the semiconductor industry, a device that can measure the surface profile of thin film like photoresist with high accuracy and high speed is needed. Since the surface of photoresist is very smooth and deformable, a device is required that will measure vertically with nanometer resolution and not damage the film during the measurement. We developed an apparatus using a multi-ball cantilever and white light interferometer to measure the surface profile of thin film. However, this system, as assessed with a scanning method, suffers from the presence of a moving stage and systematic sensor errors. Therefore, this paper describes an approach using a multi-ball cantilever as coupled distance sensors together with an autocollimator as an additional angle measuring device, which has the potential for self-calibration of a multi-ball cantilever. Using this method, we constructed an experimental apparatus and made measurements on resist film. The results demonstrated the feasibility of the constructed multi-ball cantilever system with the autocollimator for measuring thin film with high accuracy.

### 3. Shunsuke TOMURA

*Analysis of electromagnetic force in wire-EDM*

This paper clarifies the mechanism of how electromagnetic force applied to the wire electrode in wire electrical discharge machining (wire-EDM) is generated. This electromagnetic force is caused not only by DC component but also by AC components of the discharge current supplied to the wire. We therefore developed and used a two-dimensional finite element method (FEM) program to analyze the electromagnetic field taking into account electromagnetic induction. Assuming that trapezoidal pulse current is supplied to the wire, distributions of the current density and magnetic flux density were analyzed and changes in the electromagnetic force applied to the wire were calculated. Wire movement when the electromagnetic force alone was applied to the wire was also calculated. The calculated wire movement agreed with the measured wire movement when pulse current actually used in WEDM was supplied to the wire, clarifying the mechanism of electromagnetic force generation.

### 4. Tatsuya SUGIHARA

*Development of a cutting tool with a nano/micro-textured surface – Improvement of anti-adhesive effect by considering the texture patterns*

Demand for lightweight aluminum-based composites is rapidly increasing in the transport industry. Generally it is considered that aluminum alloys are easy-to-cut materials due to their low hardness. However, it is noted that some serious problems exist. Because of low lubricity against the cutting tool surface during deep-hole drilling, milling, and tapping, aluminum chips may adhere strongly to the cutting edge of the tool, leading to tool breakage. To solve this problem, a cutting tool with a nano/micro-textured surface utilizing femto-second laser technology was proposed in our previous research. A series of face-milling experiments for aluminum alloy showed that a nano/micro-textured surface promoted anti-adhesive effects at the tool-chip interface, although adhesion remained a problem. In this study, the ways to improve the anti-adhesive effect with nano/micro-textures were studied. Based on this, a cutting tool with a banded nano/micro-textured surface was newly developed and it was revealed that the surface significantly improved the anti-adhesiveness and lubricity.

## Introduction of JSPE Young Engineer Awards 2009

### 1. Megumi KITA, Takayo KOTANI (Yushin Precision Equipment Co., Ltd)

### ***Design Optimization of Take-out Robot End Effectors for Injection Molding Machines***

The achievement for which the award has been given is the development of a new optimum design method for the attachment head of handling robot for injection machines. The optimum design method has been developed using the topology optimization method and shape optimization method in order to obtain a lighter attachment head and to improve the position accuracy during robot operation. This new design method is expected to contribute to the future expansion of the industry as it simplifies the process of designing the attachment head, which has been difficult in the past, and can be used effectively in field sites. Therefore, the JSPE Young Engineer Award is presented for this achievement.

### ***2. Ryouichi FUKUNAGA (TAIHEIYO CEMENT CORPORATION)***

#### ***A new type rectangular plate type linear ultrasonic motor using a double mode piezoelectric vibrator of first longitudinal and second flexural modes***

The achievement for which the award is given is the derivation of a new aspect ratio for an ultrasonic transducer that can be included in the ultrasonic motor operating in the 1st longitudinal and 2nd flexural modes. It has been verified that the ultrasonic motor with the newly developed configuration reduces the stress generated in elements, provides thrust force that is equal to that in conventional ultrasonic motors, and improves fatigue durability. This development is expected to contribute to the future expansion of the industry as it will result in an improvement in the reliability of ultrasonic motors and facilitate practical application in semiconductor and liquid crystal manufacturing. Therefore, the JSPE Young Engineer Award is presented for this achievement.

### ***3. Tatsuya IMAI (THK CO., LTD.)***

#### ***Load distribution theory of Linear Motion Ball Guide applying finite element analysis***

The achievement for which this award is given is the development of technology that helps to improve the accuracy of theoretical analysis for determining the characteristics of a linear motion ball guide way. The theoretical analysis of the linear motion ball guide way is based on load distribution theory, a coupled analysis method that can be used along with FEM to analyze components such as a carriage has been developed, and the accuracy of the analysis has been validated by comparing the actual measured stiffness and the values obtained by conventional stiffness analysis method. This technology is expected to contribute to the future expansion of the industry as it helps to improve the reliability of products through an improvement in the accuracy of the stiffness analysis of the linear motion guide way. Therefore, the JSPE Young Engineer Award is presented for this achievement.

### ***4. Koji UTSUMI (Hitachi, Ltd.), Toshiaki YONEDA***

### ***(Hitachi Plant Technologies, Ltd.)***

#### ***Development of Damper for Chatter Vibration control in Machining***

The achievement for which this award is given is the development of a damper for use in the process of cutting sheet metal machining parts. The use of this damper for parts processing helps to reduce chatter vibration in order to improve the processing efficiency and processing accuracy. The developed damper facilitates greater control of chatter vibration since it helps to improve the damping performance and is easy to install because of its configuration. This development is expected to contribute to the future expansion of the industry as this damper is used in sheet metal part machining etc., offers processing stability, and helps to improve the manufacturing efficiency. Therefore, the JSPE Young Engineer Award is presented for this achievement.

### ***5. Daisuke IJIMA (Nano Corporation)***

#### ***A Development of Automatic Tool Changer / Automatic Work Changer Using Serial Link Manipulator Handling BT-05 Shank for Micro Automatic Production Systems***

The achievement for which this award is given is the achievement of a standardized tooling device for use in the production automation of a micro machine tool; this device includes a shank for attachment. By developing the ultracompact automatic tool changer customized for this shank, the flexibility of a micro machine tool has been improved and the size of the machine tool has been decreased, which is a change that benefits the environment. The standardized tooling device is expected to contribute to the future expansion of the industry as it facilitates the production of tools in production automation lines and will result in an increase in the use of the micro machine tool. Therefore, the JSPE Young Engineer Award is presented for this achievement.

---

## **Introduction of FANUC FA and Robot Foundation Award**

[Paper Award 2009]

### **Study on the Cogging Torque Reduction Method of the Motors Using a Rotary Lamination Process**

*Hiroyuki AKITA, Yuji NAKAHARA, Kimiyasu FURUSAWA, Takashi YOSHIOKA, Yasuhiro TAKAYA*  
*J. JSPE, Vol.74, No.5*

---

## **Introduction of The 31st Machine Tool Engineering Foundation Award**

[Paper Award 2009]

### **Analysis of electromagnetic force in wire-EDM**

*Shunsuke Tomura and Masanori Kunieda*  
*Precision Engineering, Vol.33, No.3*