The Japan Society for Precision Engineering

Introduction of JSPE Best Paper Awards 2012

1. Automatic Film Thickness Measurement System for Inkjet-Based Color Filters Based on Three-Wavelength Single-Shot Interferometry

Katsuichi KITAGAWA, Hiroki SUGIHARA, Tatsuhiko TSUBOI, Kazuyoshi SUZUKI and Masafumi OTSUKI
J. JSPE, Vol.78, No.1, pp.86-91

An automatic thickness measurement system has been developed for ink-jet based color filter manufacturing process. The RGB cell thickness is calculated from surface profile data measured by three-wavelength single-shot interferometry. Since this method is very robust against vibration, the system does not require an expensive anti-vibration mechanism. For this development, the following techniques have been developed : (a) three wavelength illumination system using multi-bandpass optical filter, (b) automatic alignment algorithm using phase images, (c) automatic focusing method using the profile data, (d) parallel computation by GPU, and (e) phase unwrapping using look-up-table method. The speed is 1.5s per FOV(Field of View) and measurement repeatability is approximately 1nm.

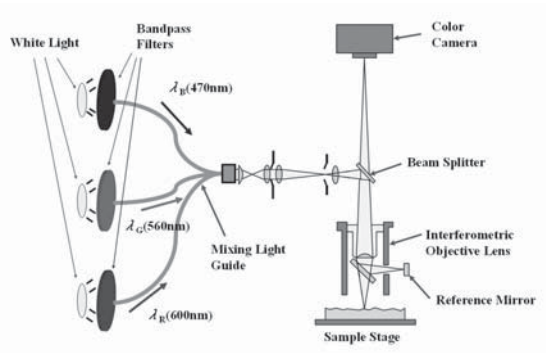

Fig. 1 Optics of three-wavelength single-shot interferometry

2. Automatic Recognition of Piping System from Large-scale Terrestrial Laser Scanned Point Cloud

Kazuaki KAWASHIMA, Satoshi KANAI and Hiroaki DATE
J. JSPE, Vol.78, No.8, pp.722-729

Recently, changes of plant equipments become more frequent, and the construction of as-built models of the existing plant from laser scan data is expected to make the reconstruction processes more efficient. The purpose of this research is to propose an algorithm which can recognize a piping system from terrestrial laser scan data of plant equipments. The straight portion of pipes, connecting relationship of the piping system can be recognized in this algorithm. Eigenvalue analyses of the point clouds and of the normal vectors enable the recognition. Using only point clouds, the recognition algorithm can be applied to registered point clouds and can be performed in a fully automatic way. The recognition results of real plants have shown the effectiveness of the algorithm.

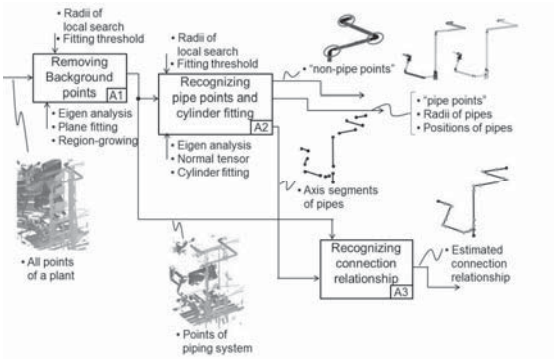

Fig. 2 Top-level process of piping system recognition

3. Development of CAM system for Ultraprecision Micromachining - Process Planning Corresponding to 5-axis Machining of High-aspect-ratio Structure -

Yasuaki KOYAMA, Keiichi NAKAMOTO and Yoshimi TAKEUCHI
J. JSPE, Vol.78, No.10, pp.912-917

Ultraprecision machine tools can exert its performance together with CAD/CAM system. However, CAM systems generally focus on NC data generation. Consequently, operators have to make the process planning by considering the features of machine tools, cutting tools and workpieces. The process planning, which calculates suitable cutting conditions and generates tool paths, is more important when micro-parts are fabricated. Moreover, the setting error may cause the interference between the cutting tool and the workpiece and result in the low machining accuracy. Therefore, this study deals with the development of CAM system in ultraprecision micromachining to generate tool paths by considering high-aspect-ratio structures and to assist operators in setting operation. The effectiveness of the developed system is experimentally confirmed.

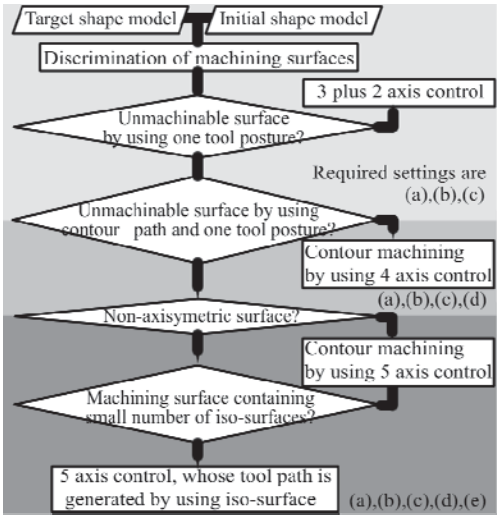

Fig. 3 Flowchart of the process determining the number of the control axes of the machine tool

Introduction of JSPE Numata Memorial Paper Awards 2012

1. Improving anti-adhesion in aluminum alloy cutting by micro stripe texture

Tatsuya SUGIHARA and Toshiyuki ENOMOTO

Precision Engineering, Vol.36, No.2, pp.229-237

Demand for aluminum alloy composites has rapidly increased, especially in the transport industry. This demand is due to such key advantages as a high strength to mass ratio and high corrosion resistance. However, aluminum alloy cutting has some serious problems. Aluminum chips readily and severely adhere to the surface of the cutting tool, often leading to tool failure, above all, in dry cutting. To address this problem, we have developed DLC-coated cutting tools with nano/micro-textured surfaces formed using femtosecond laser technology in our previous research. Face-milling experiments on aluminum alloys showed that the textured surface significantly improves the lubricity and the anti-adhesive properties at the tool-chip interface, but the problem associated with the tool-chip adhesion in dry cutting still remains. In this study, to overcome the problem, we designed new textures of cutting tool surface based on a mechanism for the formation of the chip adhesion and developed a cutting tool with micro stripe textured surface. As a result, it was revealed that the surface significantly improves cutting performances including the anti-adhesive properties both in wet and dry cutting without any coating technologies.

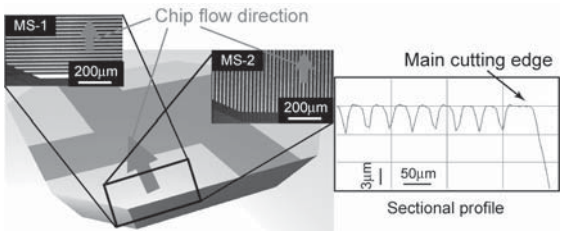

Fig. 4 Newly developed cutting tool with micro stripe texture

2. A newly developed STM-based coordinate measuring machine

Hiroshi SAWANO, Toshimichi GOKAN, Hayato YOSHIOKA and Hidenori SHINNO

Precision Engineering, Vol.36, No.4, pp.538-545

Demands for precision measurement of three dimensional micro-geometries over a large area have recently increased in a variety of industries. In order to meet such requirements, it is necessary to develop a novel coordinate measuring machine (CMM) which has high resolution together with larger than 10 mm scale measuring range. This paper presents a newly developed CMM with nanometer spatial resolution based on a scanning tunneling microscopy principle. The developed CMM is composed of a planar nano-motion control system driven by voice coil motors and a vertical nano-motion system driven by a hybrid actuator. Furthermore, in order to achieve long-term stability and repeatability, the machine is installed on an active vibration isolating system inside a temperature-controlled enclosure. Performance evaluation results confirm that the CMM has nanometer spatial resolution, large measuring range and high structural stability.

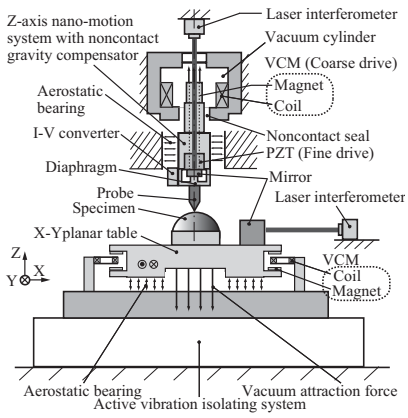

Fig. 5 Structural concept of an STM-based CMM