The Japan Society for Precision Engineering

Introduction of JSPE Young Researcher Award 2015

1. *Hiroki MAEHAMA*

Dimension driven Deformation of Tetrahedral Meshes of Mechanical Parts for Parameter Survey Analysis
J. JSPE, Vol.81, No.4, pp.368-375

For realizing efficient CAE process, dimension-driven deformation of the FEM mesh models is required. In this paper, we propose a dimension-driven deformation of tetrahedral mesh models of mechanical parts. At first, in order to extract dimensions of the mesh models, a new surface segmentation method of tetrahedral mesh models is proposed. In our segmentation method, planar, cylindrical, conical, spherical, and torus surfaces are sequentially extracted by region-growing based on principal directions, normal vectors, and surface fittings. Secondly, a dimension-driven mesh deformation method in which vertices of the mesh models are moved using a space embedding method and the surface information obtained from the segmentation results is proposed. Our mesh deformation method can change parameters of form features of the mesh models such as radius of the fillet, angle of the chamfer, and so on. Finally, Phased Optimal Delaunay Triangulation (ODT) smoothing which improves element shape qualities from the boundary to the inside of the mesh model is extended. The extended Phased ODT smoothing can improve the surface mesh of the conical, spherical, and torus surface using local 2D parameter spaces.

2. Ryota KUDO

Super-Resolution Optical Measurement for Ultra-Precision Machined Surface Defects by Using Structured Light Illumination Shift(4th report) – Experimental Verification of Super-resolution Method with Coherent Image Iterative Reconstruction –
J. JSPE, Vol. 81, No.7, pp.684-691

Demands for ultra-precision machined surface such as semiconductor wafer are rapidly growing. However, because of shrinking design rules of the semiconductor, it is uprising the difficulty of detecting nano-defects. To keep process yield in manufacture line, we must develop a defect measurement system with higher resolution, throughput, non-destructiveness and robustness. As such a measurement system, we have proposed the application of the structured light illumination (SLI) microscopy. The proposed method is optical inspection system and that resolving power exceeds the diffraction limit. Conventionasl proposed method has a difficulty about imaging system. Despite the imaging system is coherent system, the imaging system required in conventional super-resolution algorithm is incoherent system. We proposed algorithm based on coherent system, and three-light-flux interference standing wave illumination that enables new algorithm usage. In the fourth report, to verify super-resolution method with coherent image iterative reconstruction experimentally, we develop the experimental apparatus. As the result of basic experiment, 230nm structure which can't be resolved by conventional method is resolved by proposed method, under the condition of Rayleigh limit 541nm.

3. Naoto IENAGA

Combination Photometric Stereo Using Compactness of Albedo and Surface Normal
J. JSPE, Vol.81, No.12, pp.1154-1161

In this paper, a method of a novel combination photometric stereo which can estimate surface normals precisely even for images including shadows and specular reflection is proposed. Assuming that the number of input images for photometric stereo is more than three, the proposed method can exclude pixels affected by shadows and specular reflection by analyzing distributions of albedos and normal vectors computed from ${}_nC_3$ combinations for n input images. In these distributions, the proposed method define a novel value “compactness”. The compactness indicates the degree of concentration of albedos and surface normals, which should be the same values if all pixel intensities of input images perfectly obey Lambertian model without any error. Finally pixels which are included in neither shadows nor specular reflection are chosen by voting using the compactness. The proposed method is experimentally verified that it can provide accurate surface normals in the presence of shadows and specular reflection and it is superior to with better accuracy than previous works. Moreover a small device have been developed which supplies eight images varying in light positions and can be attached to smartphones. A possibility of practical use of the proposed method with the device is also verified.

4. Jianguo Zhang

Ultra-Precision Nano-Structure Fabrication by Amplitude Control Sculpturing Method in Elliptical Vibration Cutting

Precision Engineering, Vol.39, pp.86-99

This paper studies the nano-structure fabrication on hardened steel by means of elliptical vibration cutting equipped with the ultra-precision amplitude control sculpturing method. Machining performance of the amplitude control sculpturing method is investigated, and the limitation in nano-scale machining is explored. In this proposed method, machinable part geometry is essentially restricted by vibration conditions and tool geometry. In addition, a considerable error between the amplitude command and the envelope of the tool trajectory is generated when the slope of the machining part geometry becomes steep. To overcome this error, a compensation method for the amplitude control command is proposed. In order to clarify the machining performance of the proposed technology, a series of analytical and experimental investigations are conducted. Furthermore, by applying the proposed command compensation method, nano-structures with a large ratio of structure height to wave length are machined accurately. The proposed sculpturing method is subsequently applied to the machining of nano-textured grooves and a three-dimensional grid surface, which verifies the feasibility of the proposed amplitude control sculpturing method.

5. Tomoo KITAMURA

Observation of relationship between bubbles and discharge locations in EDM using transparent electrodes

Precision Engineering, Vol.40, pp.26-32

This paper describes the observation of EDM gap phenomena through a transparent electrode from the direction normal to the machining surface using a high-speed video camera. To visualize the gap, SiC single crystal was used as the electrode material since it is optically transparent and electrically conductive. In consecutive pulse discharges, the proportion of area occupied by bubbles over the working surface was obtained. In addition, the probabilities of occurrence of discharge in liquid, through bubbles, and at the boundary between liquid and bubble were measured. Then, the correlation between the locations of subsequent discharges was investigated. It was found that more than 70% of the working surface was occupied by bubbles generated by a few hundred pulse discharges after the start of machining. Electrical discharge occurs not only in liquid but also in bubble and at the boundary between liquid and bubble. The distribution of discharge locations is not random even when machining is stable. The probability of discharge occurrence per unit area of each atmosphere was highest at the boundary between liquid and bubble. Furthermore, the probability of discharge occurrence through debris particles located at the boundary of the bubble generated by the last discharge was highest.

Introduction of the 37th Machine Tool Engineering Foundation Award

[Paper Award 2015]

Study on Design Method of Absorber for Controlling Chatter Vibration in Thin Plate Machining

Koji UTSUMI, Ippei KONO, Hideaki ONOZUKA, Tomu KATO and Hiroyuki SASAHARA

J. JSPE, Vol.81, No.2, pp.187-192

Observation of Crack Propagation Behavior and Visualization of Internal Stress Field during Wheel Scribing of Glass Sheet

Souta MATSUSAKA, Genta MIZOBUCHI, Hirofumi HIDAI, Akira CHIBA, Noboru MORITA and Takashi ONUMA

J. JSPE, Vol.81, No.3, pp.270-275

High-precision and high-speed positioning of 100 G linear synchronous motor

Kaiji SATO

Precision Engineering, Vol.39, pp.31-37

Observation of relationship between bubbles and discharge locations in EDM using transparent electrodes

Tomoo KITAMURA, Masanori KUNIEDA and Khozo ABE

Precision Engineering, Vol.40, pp.26-32