The Japan Society for Precision Engineering

Introduction of JSPE Young Researcher Awards 2019

1. Takuya KANAYAMA

Segmentation and LOD model generation of buildings from MMS point clouds of urban area

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Currently, laser-scanned point clouds in urban areas can be obtained efficiently by Mobile Mapping Systems (MMS). The purpose of this study is to develop an automatic generation method of building models from point clouds in urban area acquired by MMS for city planning and disaster simulations. In this paper, we propose a point cloud segmentation method and a Level-Of-Detail (LOD) modeling method of buildings. First, an accurate building segmentation method is proposed based on overlap evaluation of occupied regions in each floor of the building. The method realizes accurate building segment extraction from complex urban areas where buildings are often very close to each other, and some buildings are connected by attached objects such as fences and sign boards near or at ground level. Then, an automatic building modeling method considering LOD and regular pattern of windows and verandas is proposed based on point projection and regular line fitting. The LOD of the resulting models can be controlled depending on the applications, and the models have regular pattern windows and verandas, which can support compact model representation. The building segmentation and modeling methods are evaluated using MMS point clouds in dense and complex urban areas.

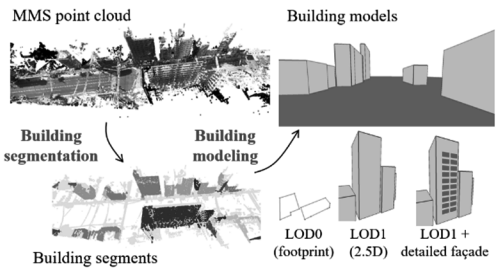

Fig. 1. Building segmentation and modeling.

2. Isamu NISHIDA

High speed computational algorithm in voxel based milling process simulation for minute time and minute space resolution analysis

J. JSPE, Vol. 84, No. 2, pp. 175-181

In order to improve machining efficiency, it is required to recognize machining status and optimize cutting conditions. Cutting force is meaningful information to recognize machining status. In the instantaneous rigid force model, which is the most popular model for milling force prediction, milling force is calculated based on the geometrical intersection between cutting edge and workpiece for each feed per tooth. In this model, both of static tool deflection and tool dynamic vibration are not considered. In order to overcome this problem, a new high speed computational algorithm in our voxel based milling process simulation is proposed. The proposed algorithm permits to consider both of static tool deflection and tool dynamic vibration in our voxel based milling process simulation. In the proposed algorithm, the intersection between cutting edge and workpiece is calculated in each minute time interval or minute tool rotational angle interval. Furthermore, the proposed algorithm permits to shorten the computational time of detecting removal voxels to calculate uncut chip thickness discretely. Therefore, high precision analysis can be performed in minute space resolution. The effectiveness of the proposed algorithm is validated by experimental 3-axis milling tests. Predicted milling forces under several cutting conditions have good agreement with the measured milling forces.

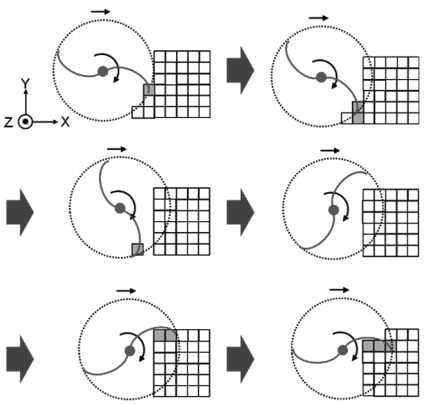

Fig. 2. Extraction of removal voxels in the new simulator for each minute tool rotational angle analysis.

3. Hirofumi KAWAMURA

Formation of an embedded electrical circuit in glass substrate by solid-state ion exchange with application of a forward/reverse voltage

Precision Engineering, Vol. 55, pp. 240-247

Solid-state ion exchange with an applied voltage enables metal doping of alkali-silicate glass surfaces.

When the silver is used as the doping agent, application of a reverse voltage produces a silver layer buried in the glass substrate. The silver layer consists of a network of silver nanowires that have high electrical conductivity. In this work, we experimented with forming fine electrical paths in a glass substrate using silver nano-ink, an organic solvent containing dispersed silver nanoparticles printed on the glass surface, as the silver ion source. As a result, silver precipitation line of fine width/pitch (89/16.8μm on average) were formed by sequentially applying forward and reverse voltages. We carried out a two-dimensional numerical analysis of the ionic diffusion behavior under an electric field to calculate the minimum line interval that would prevent two adjacent lines from overlapping. In this method, the buried silver layer is, in principle, connected to the glass surface via some precipitations, and we found an arrangement for the cathodes that confines the connection paths to the designed areas.

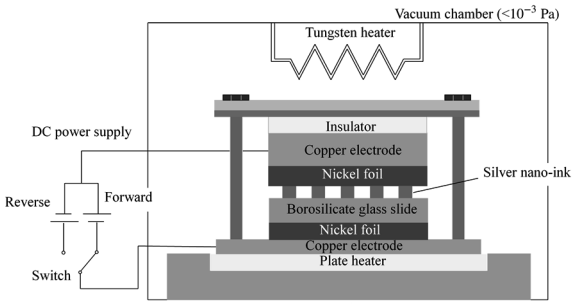

Fig. 3. Schematic illustration of experimental apparatus: Vacuum chamber for field-assisted solid-state ion exchange.

4. Ryosuke KATAOKA

Influence of vibration in cutting on tool flank wear: Fundamental study by conducting a cutting experiment with forced vibration in the depth-of-cut direction

Precision Engineering, Vol. 55, pp. 322-329

In this research, we developed special vibration tools, in which a simple harmonic vibration is generated with controlled frequency and amplitude, and experimentally clarified the influence of vibration in cutting on the tool flank wear. The results of the tool wear experiment show that the wear increasing rate (increment in the flank wear width with respect to the cutting length) increases depending on the vibration speed, whereas wear is not affected by the frequency if the vibration speed is the same. Moreover, the observations reveal that the tool flank face interferes with the workpiece as the vibration speed increases, thereby increasing the abrasive wear.

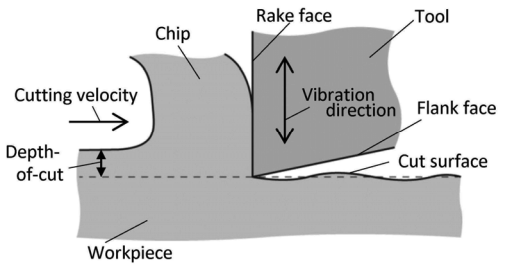

Fig. 4. Desired excitation cutting state.

5. Shiwei YE

Quantitative depth evaluation of microgrooves on polymer material beyond the diffraction limit

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The demand for dimensional micro and nano metrology is evident, and with the miniaturization process of microstructures and the trend towards using polymer material, the available technologies are imperative. This paper proposes a quantitative depth evaluation method for microgrooves with width less than the diffraction limit and a measurement system capable of depth detection on polymer materials. The depth of microgrooves can be quantitatively related to the near-field optical phase difference, which cannot be practically observed but can be computed from practical far-field observations by proposed depth evaluation method. The developed measurement system uses low-coherence illumination to reduce the spatial speckle noise and multiple interference noise on transparent polymer materials. Microgrooves (nominal width = 300 nm, Rayleigh Criterion of measurement system = 772 nm) on a transparent polymer surface (thermoplastic COC 5013L molded sample) were measured, and the results were compared with AFM measurements. It is demonstrated that the proposed method is instrumental in evaluating the depth of microgrooves beyond the diffraction limit with an accuracy of less than 10% of the test depth.

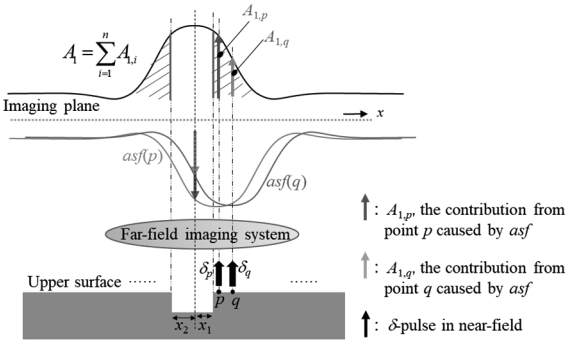

Fig. 5. Schematic of calculation method for amplitude from upper surface (A_1).