The Japan Society for Precision Engineering

Introduction of JSPE Young Researcher Awards 2017

1. Takuya MATSUNAGA

Development of Five DoF HEM^2 using Parallel Link Mechanism

J. JSPE, Vol.83, No.8, pp.802-810

In this paper, Haptic End-effector for Medicine and Manufacturing (HEM^2) with five degree of freedom (DoF) motion is developed for safer and more intuitive robotic surgery. In resent years, multi DoF forceps robots have been studied and developed to support surgeons. However, conventional multi DoF forceps robots cannot transmit force sensation to surgeons adequately. Force sensation is important for safe and accurate teleoperation. In this paper, a master-slave five DoF HEM^2 is developed as a haptic forceps robot. Five DoF motion corresponds with the motion of human hand which can realize complex tasks. By implementing acceleration based bilateral control, force sensation can be transmitted. Spherical joint driven by parallel link mechanism realizes the bending motion of the end-effector. The coaxial driving power transmission mechanism is used to decrease the weight of movable part and improve backdrivability. Besides, the mechanism is composed of rigid parts. The performance of the five DoF HEM^2 is validated by experiments.

2. Tsubasa GOTO

3D-2D Matching of Line Features for Spherical Camera Localization in Man-made Environment

J. JSPE, Vol.83, No.12, pp. 1209-1215

In this paper, a novel method for 6 degrees of freedom (DoF) localization of a single spherical camera in a man-made environment is proposed. Taking advantage of the various line features that are usually present in such an environment, a technique to match the 2D line feature information inside a spherical image to the 3D line segment information available in a known 3D model of the environment is developed. There are two main challenges to be overcome. First is the detection of the line feature information in a spherical image and its abstraction into a descriptor that is compatible with the 3D line feature information in the model. Second is to evaluate similarity of the line feature information from the 2D image and that from arbitrary 6 DoF poses in the 3D environment model in order to localize the camera. To deal with the former, a randomized hough transform with spherical gradient-based filtering is used to accurately detect line features in the image and create a line feature descriptor. The same descriptor is created from arbitrary 6 DoF poses in the 3D model. Then, to deal with the latter, the Earth Mover's Distance (EMD) is used to evaluate their similarity. The proposed method was evaluated in a real environment with its 3D model. The results demonstrated that it can effectively estimate the 6 DoF pose of a spherical camera using a single image.

3. Takehiro HAYASAKA

Generalized design method of highly-varied-helix end mills for suppression of regenerative chatter in peripheral milling

Precision Engineering, Vol.48, pp.45-59

Peripheral finishing of hardened steel by milling has recently been introduced to the machining field, but often causes severe chatter vibration due to high specific cutting force and low stiffness of slender end mills. It was shown in the previous papers that highly-varied-helix end mills were effective for the suppression of regenerative chatter, and a low radial immersion was applied to avoid the effect of mode coupling. Especially for the highly-varied-helix end mills, it was proved experimentally that they were effective across a wide range of cutting conditions, making it possible for cutting with a relatively large axial depth of cut to be carried out and thus realizing a high surface generation rate in peripheral milling of hard materials. However, the milling tests were carried out under just one specific condition, i.e., tool diameter 8 mm, projection length 36 mm, and workpiece of 60 HRC hardened steel, etc., and the helix angles of the tool were varied large enough to suppress regenerative chatter but with no quantitative discussion for their determination. In this paper, a generalized design method for varied-helix end mills to suppress regenerative chatter is proposed. Namely a design index ($\frac{a_p}{a_{\lim}}$), in which a_p is the distance between 2 adjacent regenerative effect cancellation lines and $a_{\lim}$ is the asymptotic stability limit in the targeted cutting process, is introduced to design the helix angle difference of a tool, and milling experiments are carried out in several conditions to verify the validity of the proposed index.

Kudan Seiwa Building, 1-5-9 Kudan-kita, Chiyoda-ku, Tokyo 102-0073, Japan
Phone: 81 3 5226 5191, Fax: 81 3 5226 5192, http://www.jspe.or.jp

4. Zhenglong FANG

Cooling performance of micro-texture at the tool flank face under high pressure jet coolant assistance

Precision Engineering, Vol.49, pp.41-51

Micro-texture at the tool face is a state-of-the-art technique to improve cutting performance. In this paper, five types of micro-texture were fabricated at the flank face to improve the cooling performance under the condition of high pressure jet coolant assistance. By using micro-textures consisted of pin fins, plate fins and pits fabricated 0.3 mm away from the cutting edge, heat transfer from the tool face to coolant was enhanced. The conditions of tool wear, adhesion and chip formation were compared between the micro-textured and non-patterned tools in the longitudinal turning of the nickel-based superalloy Inconel 718. As a result, micro-textured tools always exhibited the reduced flank and crater wear compared with the non-patterned tool, and the rate of tool wear was influenced by the array and height of fin. The energy dispersive spectroscopy analysis of worn flank faces and the electromotive forces obtained from the tool-work thermocouple supported better cooling performances of micro-textured tools. In addition, coolant deposition at flank face evidenced that heat transfer could be promoted by micro-texture near the border of the contact area between the flank wear land and machined surface. Finally, the changes of flow patterns with pit depth are analyzed for pit type tools by computational fluid dynamics. This investigation clearly showed the function of micro-textures for increasing the turbulent kinetic energy and cooling the textured tool face.

5. Mehdi HEIDARI

Ultraprecision surface flattening of porous silicon by diamond turning

Precision Engineering, Vol.49, pp.262-277

Porous silicon is receiving increasing interest from a wide range of scientific and technological fields due to its excellent material properties. In this study, we attempted ultraprecision surface flattening of porous silicon by diamond turning and investigated the fundamental material removal mechanism. Scanning electron microscopy and laser Raman spectroscopy of the machined surface showed that the mechanisms of material deformation and phase transformation around the pores were greatly different from those of bulk single-crystal silicon. The mechanism of cutting was strongly dependent on the direction of cutting with respect to pore edge orientation. Crack propagation was dominant near specific pore edges due to the release of hydrostatic pressure that was essential for ductile machining. Wax was used as an infiltrant to coat the workpiece before machining, and it was found that the wax not only prevented chips from entering the pores, but also contributed to suppress brittle fractures around the pores. The machined surface showed a nanometric surface flatness with open pores, demonstrating the possibility of fabricating high-precision porous silicon components by diamond turning.

Call for papers ASPEN 2019

Asian Society for Precision Engineering and Nano-technology (ASPEN) was organized as an union of academic and industrial societies in Asian nations and regions. **ASPEN 2019** will be 8th international conference of ASPEN, hosted by the Japan Society for Precision Engineering (**JSPE**) on **November 12−15, 2019 in Kunibiki Messe, Matsue, Japan.**

Conference Topics

- Additive Manufacturing System
- Automation and Robotics
- Bio/Medical Applications
- Die Manufacturing Processes
- Green Manufacturing
- High Speed and Precision Machining
- IoT/AI/Big data
- Manufacturing Systems and Machine Tools
- Mechatronics
- MEMS/NEMS
- Metrology
- Micro/Nano Fabrication Processes
- Molding and Forming Technology
- Nano/Bio Technology
- Non-traditional Manufacturing Processes
- Optical Applications
- Precision Machine Design
- Service Engineering
- Surface Properties and Characterization
- Other Topics Related to Precision Engineering

Important Dates

Abstract submission	**Apr. 30, 2019**
Notification of abstract acceptance	May 30, 2019
Extended abstract submission	Jul. 15, 2019
Notification of final acceptance	Aug. 31, 2019
Early registration	Sep. 15, 2019
Conference	**Nov. 12-15, 2019**

(Nov.12: Welcome reception, Nov.15: Technical tour)