The Japan Society for Precision Engineering

Introduction of JSPE Best Paper Awards 2015

1. 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

The crack propagation behavior and the internal stress field during mechanical cleavage of non-alkali glass sheets (thickness : 0.7mm) were visualized by high-speed imaging techniques. At first, the effect of scribing conditions on the fractured surface quality was investigated when the scribing wheel with surface asperities was used. It was found that the surface quality was strongly influenced by an applied load. In the case of low load conditions (~ 11N), the fractured surface exhibited rugged patterns known as 'hackle', and it gradually changed to regular striped pattern known as 'ribmark' with the increase of applied load (12N~). In order to understand the reason why the surface quality changed with the applied load, the crack propagation behavior was observed using a high-speed camera. The results showed that the generated crack hardly propagated to thickness direction when the applied load was low, in contrast to the rapid propagation under the high load conditions. Because the crack propagation behavior was likely determined by the stress field around the generated crack, the phase difference measurement, which was proportional to the principal stress difference, was conducted using a high-speed polarization camera. The results showed that the phase difference gradually vanished, i.e. the stress relaxation occurred, with the crack propagation especially in the high load conditions. By the image analysis for obtained phase difference from the polarization camera, an in-process estimation method of fractured surface quality was proposed.

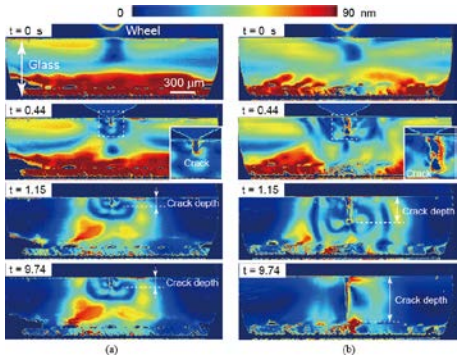

Fig.1 Phase Difference distribution just under scribing wheel, (a)Applied load: 8N, (b) 15N

2. Development of a Stitch Algorithm Using the Approximated Reference Shape

Mahito NEGISHI, Kotaro HOSAKA and Kotaro AKUTSU

J. JSPE, Vol.81 No.6 pp.555-561

For the mass production of large, severe aspherical optics, we have developed a new stitch algorithm named ARSA (Approximated Reference Shape Algorithm) which can be used for free-form measurement machines. The stitching measurement, which combines plural partial measurements into a whole shape, has been developed based on interferometry and is now widely used. The well known algorithm calculates the stitching parameters so as to minimize the mismatch in the overlapping area. However, with a free-form measurement machine using a scanning probe, the measured data are sparse and contain 3D points, causing significant calculation errors such as interpolation errors in the overlapping area. ARSA is based on minimizing the error of estimating the approximated reference shape. This algorithm has the unique feature that the calculation error is smaller in the case of severer asphericity and the interpolation error is also small for the same reason as in the case of interferometry. We classify the workpiece's shape into three spatial frequency domains and assess the performance for each case by simulation. The simulated measurement data are three sets of 3D points in fan-shaped partial measurements, and the workpiece's shape is a convex hyperboloid whose asphericity is 1.282mm for the full aperture of 1200mm. In all three domains the calculation results coincide with the theoretical values to within nanometer level. These results show the validity of this new algorithm.

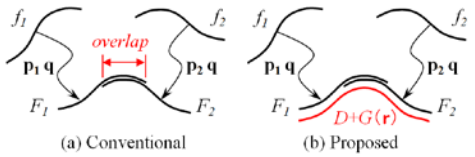

Fig.2 Principle of the stitching algorithms

3. Three-Dimensional Measurement of Underwater Objects in a Rectangular Vessel by Bi-Path Stereoscopy

Hirotoshi IBE, Yuichi KOBAYASHI Toru KANEKO and Atsushi YAMASHITA

J. JSPE, Vol.81 No.12 pp.1093-1101

It is important to measure shape of objects in a transparent vessel for 3D digital preservation of underwater creatures. We propose a measurement method using a bi-path stereoscopic image of the objects acquired with a monocular camera via rectangular vessel planes. The method estimates the posture of rectangular planes based on bundle adjustment considering light refraction, and

measures the 3D shape of underwater objects using ray tracing. Experimental results demonstrated the effectiveness of the proposed method.

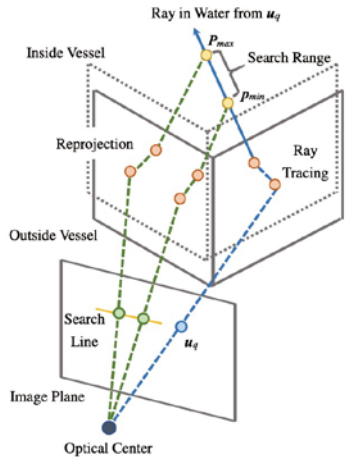

Fig.3 Stereo Matching

Introduction of JSPE Numata Memorial Paper Awards 2015

1. Large Height Micro-Lens-array Fabrication by Projection Optics with Adjustable NA

Seiro MURAKAMI, Shohei YAMAZAKI and Chizuru MIYAZAKI

J. JSPE, Vol.81 No.10 pp.951-956

In optical lithography, the projection optics is known as the high accurate exposure tool for 3-dimensional device patterning such as MEMS (Micro Electro Mechanical Systems). Required optical performances of the projection optics are resolution capability of pattern density and depth of focus (*DOF*) on step-heights. Generally, larger numerical aperture (*NA*) of projection optics is quite effective on higher resolution, but loses *DOF* on the contrary. The capability of micro-lens-array (MLA) patterning has the resolution limit around 20-30μm in Sag (lens height) by the conventional high *NA* projection lens. Therefore, projection optics with lower *NA* and deeper *DOF* is required for the MLA patterning with 100μm Sags for various applications. This paper reports the effectivity of the combination of the newly developed projection lens with adjustable *NA* of 0.06-0.22 and a photo-mask with quasi-continuous intensity distribution by a density control of scattered square micro-dot-patterns. By experiments, this method has been proved to realize the MLA patterning with 100μm Sags with errors less than surface roughness of 2μm *RMS* and Sag shape deviation of 5μm.

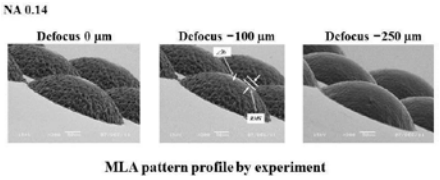

Fig.4 SMLA pattern profile by experiment

2. Fringe Pattern Analysis Using Two-step Fourier Transform Method

Kazuhide KAMIYA, Kimihisa MATSUMOTO, Takashi NOMURA, Hatsuzo TASHIRO and Shinya SUZUKI

J. JSPE, Vol.81 No.5 pp.459-465

The Fourier transform method is a method of analysis to extract a phase from a fringe pattern. However, when noise and shape components overlap each other in the Fourier domain, it is difficult to eliminate only the overlapped noise components using conventional filtering techniques, such as bandpass filtering. In this paper, to solve this problem of the filter, the two-step Fourier transform method is proposed by using two interferograms with slightly different carrier frequencies. The proposed method has been applied to the grating projection method using gratings with different colors according to the carrier frequency and the validity of the proposed method was investigated.

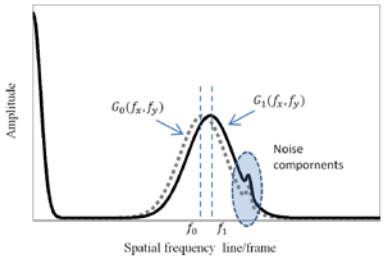

Fig.5 Spatial frequency line/frame

16th International Conference on Precision Engineering ICPE2016

14(Mon.)-16(Wed.), November 2016 @ Hamamatsu, Japan

ICPE2016 will be held on 14-16th November 2016 at Hamamatsu, Shizuoka, Japan. The conference will be held at ACT CITY HAMAMATSU, surrounded by traditional culture.

Conference Topics

ICPE 2016 focuses on the following topics and keywords.

- Advanced Precision Machining and Technologies
- Die and Mold Manufacturing
- Additive Manufacturing and 3D Printing
- Machine Tools and Elements
- Digital Design and Manufacturing Systems
- Green and Sustainable Manufacturing and Technologies
- Control and Ultra Precision Positioning
- Precision Measurement and Calibration
- MEMS/NEMS
- Bio-Medical Engineering and application

Venue

Access to Hamamatsu City from Mt. Fuji Shizuoka Airport and Chubu or Narita Int. Airport.

Registration

Early registration (by 30th, April 2016)
Participant: 60,000 JPY, Student: 30,000 JPY
Regular registration
Participant: 70,000 JPY, Student: 30,000 JPY
Registration is through your personal webpage on the ICPE 2016 website:

http://icpe2016.jspe.or.jp/