

Claims

1. — A method for optical three-dimensional topography measurement of a surface of an object, the method comprising the steps:
projecting patterned illumination through an objective onto the surface of the object;
performing a relative movement between the object and the objective, wherein a direction of the relative movement includes an oblique angle with an optical axis of the objective, and wherein the surface passes through a focal plane of the objective during the relative movement;
recording a plurality of images of the surface through the objective during the relative movement;
deriving height information for a respective position on the surface of the object from the variation of the intensity recorded from the respective position in the plurality of images.
2. — The method of claim 1, wherein each of the plurality of images is recorded as an array of pixels, each of the images being shifted such that a given position on the surface of the object corresponds to one and the same pixel in the array of pixels for all images of the plurality of images.
3. — The method of claim 1, wherein the patterned illumination is generated by incoherent illumination of a pattern mask.
4. — The method of claim 3, wherein the pattern mask is a grating.
5. — The method of claim 4, wherein the grating is an amplitude grating or a phase grating.
6. — The method of claim 4, wherein the grating is a line grating or a sinusoidal grating or a cross-line grating.
7. — The method of claim 4, wherein the grating is a blazed grating.
8. — The method of claim 3, wherein the pattern mask has a checkerboard pattern or a pinhole array.
9. — The method of claim 3, wherein for patterned illumination only a 0th diffraction order and one diffracted order, arising from the pattern mask, are used, both diffraction orders having the same intensity.
10. — The method of claim 1, wherein the steps are performed in parallel on a plurality of objects.
11. — A method for optical three-dimensional topography measurement of a surface of an object, the method comprising the steps:
projecting patterned illumination and uniform illumination alternately through an objective onto the surface of the object;
performing a relative movement between the object and the objective, wherein a direction of the relative movement includes a component along an optical axis of the objective, and wherein the surface passes through a focal plane of the objective during the relative movement;
recording a plurality of images of the surface through the objective during the relative movement;

deriving height information for a respective position on the surface of the object from the variation of the intensity recorded from the respective position in the plurality of images.

12. — ~~The method of claim 11, wherein images of the plurality of images recorded under the uniform illumination are used for deriving height information for a specular structure on the surface, and images of the plurality of images recorded under the patterned illumination are used for deriving height information for portions of the surface between specular structures.~~
13. — ~~The method of claim 12, wherein height information for a specular structure is derived from the size of an image of a top portion of the specular structure.~~
14. — ~~The method of claim 11, wherein the direction of the relative movement is parallel to the optical axis of the objective.~~
15. — ~~The method of claim 11, wherein the patterned illumination is generated by incoherent illumination of a pattern mask.~~
16. — ~~The method of claim 15, wherein the pattern mask is a grating.~~
17. — ~~The method of claim 16, wherein the grating is an amplitude grating or a phase grating.~~
18. — ~~The method of claim 16, wherein the grating is a line grating or a sinusoidal grating or a cross-line grating.~~
19. — ~~The method of claim 16, wherein the grating is a blazed grating.~~
20. — ~~The method of claim 15, wherein the pattern mask has a checkerboard pattern or a pinhole array.~~
21. — ~~The method of claim 15, wherein for patterned illumination only a 0th diffraction order and one diffracted order, arising from the pattern mask, are used, both diffraction orders having the same intensity.~~
22. — ~~The method of claim 11, wherein the steps are performed in parallel on a plurality of objects.~~
23. —

1. A system for optical three-dimensional topography measurement of a surface of an object, the system comprising:

a source of patterned illumination;

a source of uniform illumination;

an objective, arranged to direct both the patterned illumination and the uniform illumination to the surface of the object;

a detector arranged and configured for recording a plurality of images of the surface of the object through the objective;

means for performing a relative movement between the objective and the object along a direction including an oblique angle with an optical axis of the objective.

24. — ~~The system~~

a first beam splitter arranged to combine the patterned illumination and the uniform illumination to form a combined illumination path; a second beam splitter arranged in such a way that an imaging path between the objective and the detector and the combined illumination path between the first beam splitter and the objective pass through the second beam splitter, wherein the combined illumination path is received at the second beam splitter

directly from the first beam splitter; wherein the objective is positioned to correct diffraction caused by the beam splitter and

a computer connected to the detector that is configured to determine height information for a position on the surface of the object based on differences in light intensity of the plurality of images, wherein the light intensity changes along a direction including at least a component along an optical axis of the objective.

2. The system of claim 231, wherein the source of patterned illumination includes a light source and a pattern mask.

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3. The system of claim 242, wherein the pattern mask has a checkerboard pattern or a pinhole array.

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4. The system of claim 242, wherein the pattern mask is a grating.

27. —

5. The system of claim 264, wherein the grating is an amplitude grating or a phase grating.

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6. The system of claim 264, wherein the grating is a line grating or a sinusoidal grating or a cross-line grating.

29. —

7. The system of claim 264, wherein the grating is a blazed grating.

30. — The system of claim 23, wherein a beam splitter is arranged in such a way that both an illumination path between the source of patterned illumination and the objective, and an imaging path between the objective and the detector pass through the beam splitter.

31. — The system of claim 30, wherein the objective is corrected to diffraction limited performance, the correction also taking into account the beam splitter.

32. —

8. The system of claim 242, wherein the pattern mask and the detector are in conjugate planes.

33. — A

9. The system for optical three-dimensional topography measurement of claim 1, wherein a surfacedirection of an object, the system comprising:

— a source of patterned illumination;

— a source of uniform illumination;

an objective, arranged to direct both the patterned illumination and the uniform illumination to the surface of the object;

a detector arranged and configured for recording a plurality of images of the surface of the object through the objective;

means for performing a relative movement between the objective and the object along a direction including at least a component along an optical axis of the objective.

34. — The system of claim 33, wherein the source of patterned illumination includes a light source and a pattern mask.

35. — ~~The system of claim 34, wherein the pattern mask has a checkerboard pattern or a pinhole array.~~
36. — ~~The system of claim 34, wherein the pattern mask is a grating.~~
37. — ~~The system of claim 36, wherein the grating is an amplitude grating or a phase grating.~~
38. — ~~The system of claim 36, wherein the grating is a line grating or a sinusoidal grating or a cross-line grating.~~
39. — ~~The system of claim 36, wherein the grating is a blazed grating.~~
40. — ~~The system of claim 33, wherein a beam splitter is arranged in such a way that an imaging path between the objective and the detector and at least one of an illumination path between the source of patterned illumination and the objective, and an illumination path between the source of uniform illumination and the objective pass through the beam splitter.~~
41. — ~~The system of claim 40, wherein both the illumination path between the source of patterned illumination and the objective, and the illumination path between the source of uniform illumination and the objective pass through the beam splitter.~~
42. — ~~The system of claim 40, wherein the objective is corrected to diffraction limited performance, the correction also taking into account the beam splitter.~~
43. — ~~The system of claim 34, wherein the pattern mask and the detector are in conjugate planes.~~
44. — ~~The system of claim 33, wherein the direction of the relative movement~~object and the objective ~~is parallel to the optical axis of the objective.~~