Layered imaging for tiny objects with a volume holographic imaging system

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In a conventional optical imaging system, the three dimensional information will be partly missing during the transmission. The reconstruction of the deep information of the three-dimensional objects has always been the focus of discussion among the optical researchers. In this paper we concentrate on the reconstructing images of 3D objects with a volume holographic spatial-spectral imaging systems. Volume holographic grating lens have a nature called Bragg selectivity which make volume holographic grating lens more sensitive to change of the three-dimensional information of the interested object than the ordinary lens, so a holographic imaging system with volume gratings has the potential to carry out the 3D reconstruction of the object. In our experiments, the volume holographic grating lens is recorded by illuminating a recording medium with a spherical wave signal beam and a plane wave reference beam at the wavelength of 532 nm, in which angle between the signal beam and the reference beam is 30°. The recording material is a 2-mm-thick $LiNbO_3$:Fe:Cu crystal which is located at a working distance of 75 mm. Two lenses L_1 and L_2 are used in the signal arm to form a point source and then to adjust its position relative to the recording material. The position of the point source is controlled by moving the first lens L_1, while holding the second lens L_2 fixed. The angle of the reference beam is changed by 0.5° after each holographic recording, to record the hologram corresponding to the different angles of reference beam with respect to each point source location of the signal beam. The position of the point source is moved a small distance after each recording. Thus, several holographic gratings can be recorded in the same volume recording material. These gratings can reconstruct the images of 3D objects at different depths, respectively, and the images can be collection by the CCD camera simultaneously. The experimental result demonstrates the ability of the volume holographic filter in an imaging system to reconstruct depth-resolved image of objects. In our experiment, two holographic gratings are recorded in the same material, and the resolution target is used to simulate a 3D object by locating it at the different longitudinal positions, When the object is at the Bragg match position, it can be reconstructed clearly, but it is blurred for the second volume holographic lens because it is Bragg mismatch, shown as in Fig 1.

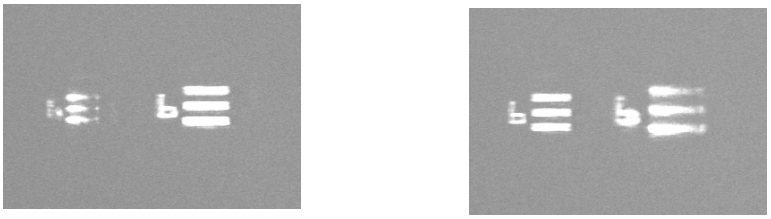

Fig 1 (a) The point source is at the first position and the right image is Bragg. match (b) The point source is at the second position and the left image is Bragg match.