Four Dimensional Volume Holographic Imaging with Natural Illumination

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Volume holographic imaging is a 3D imaging technique that uses volume holographic lenses. We devised a rainbow volume holographic imaging (RVHI) system, shown in Figure 1. The system projects a rainbow illumination on objects by means of a diffraction grating. Collimated white light is decomposed by a diffraction grating. After passing through a cylindrical lens, the rainbow is focused to the focal plane of a volume holographic lens. All the in-focus points along the x dimension are Bragg-matched; in the y dimension they are also Bragg-matched because of degeneracy. Therefore, the entire rainbow plane is Bragg-matched, resulting in a broad field of view (FOV). When shifted out of focus, each point source in the rainbow becomes Bragg-mismatched due to defocus, much as a narrow-band source at the same wavelength would be[1].

A four-dimensional (3D + spectral) imaging system was devised recently. One unique advantage of this system is that it can be used under natural broadband light illumination on this principle [2]. The imaging process of the 4D imaging system can be understood as a combination of non-invasive optical slicing and spectral analysis. A narrow slit portion (along the y axis) of the object on the focal plane is sampled and its spectrum is laterally imaged on the CCD camera. To cover the entire four-dimensional object space (three spatial dimensions plus one spectral dimension), auxiliary mechanical scanning (rotational mirror as shown in Figure 2) or multiplexing holograms corresponding to different slits are necessary. Also both the 1st order and 0th order diffraction from the volume hologram are measured simultaneously to normalize the brightness of objects.

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**REFERENCES**
