17p-D5-6

# Digital Holographic Imaging of Vector Wave from a Polarization Hologram with Spatial Phase Shifting

**Grad. Sch. Eng., Utsunomiya Univ.[1], CORE, Utsunomiya Univ.[2] Daisuke Barada[1,2], Takuya Tanimoto[2], Kenta Yamashita[1], Shigeo Kawata[1,2], Toyohiko Yatagai[2]**

**E-mail: barada@cc.utsunomiya-u.ac.jp**

Holographic memory is expected as a next-generation optical memory because it potentially has terabyte data capacity per disk and gigabit data transfer rate. Furthermore, when a polarization-sensitive medium is used as a recording medium, a vector wave can be recorded so that few times data capacity and data transfer rate are expected. However, the optical system for the vector wave recording technique such as dual-channel polarization holography[1,2] is complicated. Therefore, simple recording and reconstruction methods have been investigated. In this paper, a digital holographic reconstruction method with spatial phase-shifting is proposed.

In polarization holography, a vector wave with arbitrary image plane position can be generated by using an adequate recording condition. In this study, phase data pages included in $p$- and $s$-polarization components were used. The phase values $\Phi_p$ and $\Phi_s$ were respectively shifted by $\phi_{p,m}$ and $\phi_{s,m}$ as shown in Fig.1, where

$$\phi_{p,m} = \begin{cases} (m-1)\pi/2 & m = 1,2,3,4 \\ (m-4)\pi/2 & m = 5,6,7,8 \\ (m-7)\pi/2 & m = 9,10,11,12 \\ (m-10\pi/2 & m = 13,14,15,16 \end{cases} \quad (1)$$

$$\phi_{s,m} = \begin{cases} (m-1)\pi/2 & m = 1,2,3,4 \\ (m-6)\pi/2 & m = 5,6,7,8 \\ (m-11)\pi/2 & m = 9,10,11,12 \\ (m-16)\pi/2 & m = 13,14,15,16 \end{cases} . \quad (2)$$

When the vector wave is generated from a polarization hologram and the phase pattern is imaged on an image sensor, the interference pattern with illumination beams is expressed by

$$I_m = \left| A_R + A_p \exp[\mathrm{i}(\Phi_p + \phi_{p,m})] + A_s \exp[\mathrm{i}(\Phi_s + \phi_{p,s})] \right|^2 , \quad (3)$$

where $A_R$, $A_p$, and $A_s$ are the amplitudes of illuminating beam, $p$- and $s$-polarization components, respectively. The phase values of two data pages can be extracted by

$$\Phi_p = \arg\left( \sum_{m=1}^{16} I_m \exp(-\mathrm{i}\phi_{p,m}) \right) \quad (4)$$

$$\Phi_s = \arg\left( \sum_{m=1}^{16} I_m \exp(-\mathrm{i}\phi_{s,m}) \right) . \quad (5)$$

By using the proposed method, it is expected that the optical system of dual-channel polarization holography is simplified.

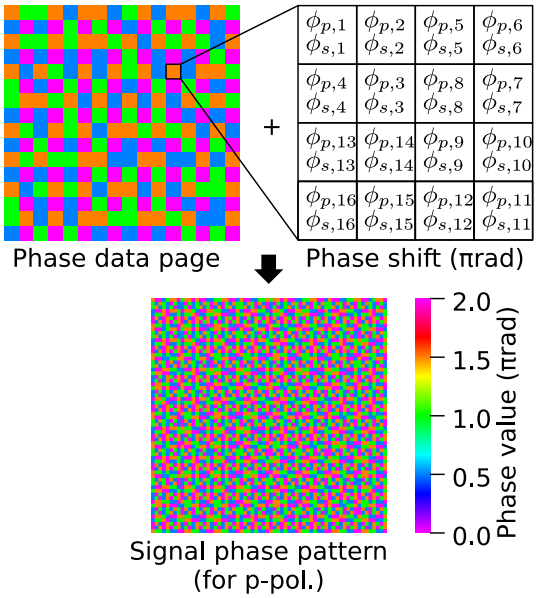


Fig. 1: Phase data page and phase pattern shifted by $\phi_{p,m}$ or $\phi_{s,m}$

[1] D. Barada *et al.*, Opt. Lett. **37** (2012) 4528

[2] T. Ochiai *et al.*, Opt. Lett. **38** (2013) 748