ECE 299 Holography and Coherent Imaging

Lecture 11. Computer Generated Holograms

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The relationship between hologram $h_{uv}$ and image $F_{xy}$ present at the back focal plane of a lens of focal length $f$, when illuminated by coherent monochromatic light of wavelength $\lambda$.
Digital holography and (1) hologram recording (2) hologram reconstruction

\[ \text{I}(x, y) = |R + |S|^2 \]

OHT can refer to digital calculation or recording of \( t(x, y) \) or digital recording of \( I(x, y) \)
Wave transformation by diffractive elements

\[ t(x, y) = \frac{g(x, y)}{A} \]

\[ f(x, y) \]

\[ P \leftarrow \text{pro} \rightarrow \text{guloom} \]

\[ \text{operator} \]
Geometric approximation for diffractive element

\[ Q = \frac{\pi a}{\delta} = \frac{2\pi \lambda d}{\delta^2}. \]

\[ a = \frac{2\lambda d}{\delta}. \]
## Coding

<table>
<thead>
<tr>
<th>Mode of operation</th>
<th>Structure</th>
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<tbody>
<tr>
<td></td>
<td>Index modulation</td>
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<tr>
<td><strong>T</strong></td>
<td>$</td>
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<tr>
<td></td>
<td>$\arg[\psi_r]: n(x), \ d$</td>
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<tr>
<td><strong>R</strong></td>
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<td>$\arg[\psi_r]: \pi \ [\kappa = 0]$</td>
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Indirect Coding

Figure 11. A flow diagram to illustrate the indirect coding approaches. The start is at the upper left and the decisions are indicated in the lower part. This approach can be non-iterative as well as iterative.
Direct coding
Direct Coding Strategy

B. R. Brown
A. W. Lohmann

Computer-generated Binary Holograms*


Complex Spatial Filtering with Binary Masks

B. R. Brown and A. W. Lohmann

http://www.opticsinfobase.org/abstract.cfm?URI=ao-5-6-967
Figure 1 Optical system for reconstructing Fourier holograms.
Phase and amplitude coding

Fig. 3. Three ways for constructing the cell \((n,m)\). The parameters \(W\) and \(p\) that control amplitude and phase of the light emerging from this cell carry indices \((n,m)\). The slit width \(c\) is a constant. Cases b and c are particularly suitable for automatic plotting.
Figure 11 Three-dimensional image having four planes spaced in depth; separation of planes is ten times that of Fig. 10.
Phase and Amplitude Coding

Figure 7: Aperture position (squares) relative to sampling points (circles) determined by (a) phase $\varphi_n$ at sampling point and (b) phase at actual aperture position.
Phase and amplitude coding in the Fourier Plane