Practical example: diffraction

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Lecture 09

Diffraction

According to Huygens' principle, every point on the mask is a secondary source

$$E_t(\vec{r}) = \int\int_{mask} dx' dy' \frac{E(x', y')}{4\pi|\vec{r} - \vec{r}'|} e^{\vec{k}(\vec{r}-\vec{r}')}$$

Here

$$\begin{aligned} \vec{r} &= x, y, z \\ \vec{r}' &= x', y', z' \\ \vec{k} &= \frac{2\pi}{\lambda} \end{aligned}$$

Diffraction approximation

$$E_t(\vec{r}) = \sum_i \sum_k \Delta x' \Delta y' \frac{E(x'_i, y'_k)}{4\pi|\vec{r} - \vec{r}'|} e^{\vec{k}(\vec{r}-\vec{r}')}$$

Here

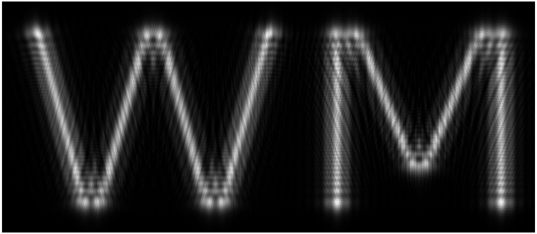
$$\begin{aligned} \vec{r} &= x, y, z \\ \vec{r}' &= x'_i, y'_k, z' \\ \vec{k} &= \frac{2\pi}{\lambda} \end{aligned}$$

It is important that integrated function does not oscillate wildly from sample point to sample point. So we need $\Delta x'$ and $\Delta y' \ll \sqrt{L\lambda}$, where L is distance between mask and target.

Sample of diffraction

Let's consider a diffraction of light on a mask shown below.

- resolution 1386×600 pixels
- physical size 2.8×1.2 cm
- distance to the target 1.1 m



- resolution 693×200 pixels,
- physical size 3.0×1.4 cm
- wavelength $\lambda = 670$ nm

Calculation time 6 and half hours at the 6 core AMD computer