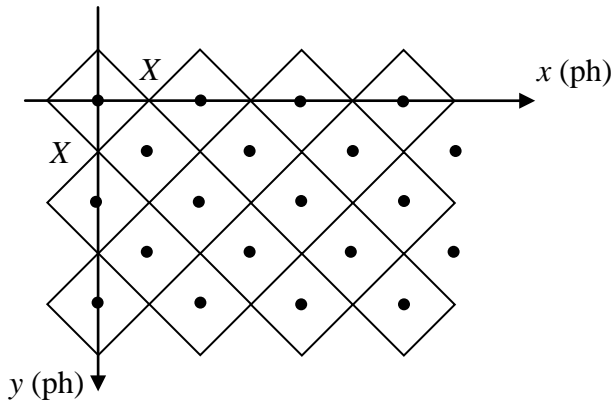1. Compute the frequency response of a moving average filter on a square lattice with a rectangular region of support.

2. A simplified schematic of the pixel interleaved array CCD (PIACCD aka SuperCCD) is shown in Fig. 1.

Fig. 1 Upper-left portion of a SuperCCD sensor array

We assume that the acquisition process involves integration of light over the diamond-shaped cells, with amplification, to give sample values associated with the center of each diamond. This is modeled by the equivalent system shown in Fig. 2, where Λ is the lattice composed of the centers of the diamond cells as indicated in Fig. 1.
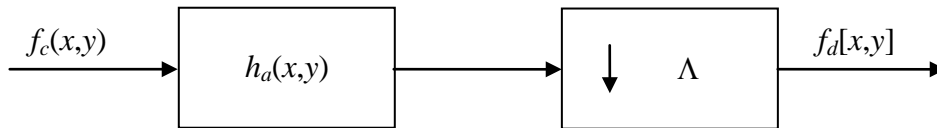
Fig. 2 Equivalent system for the Super CCD acquisition system

In Fig. 2,

$$h_a(x, y) = \begin{cases} k & |x| + |y| \le X \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

(a) Explain clearly why $h_a(x, y)$ has the form shown in equation (1) above and sketch this impulse response.

(b) Write an expression for $h_a(x, y)$ in terms of the standard rect function. Explain how you got it and make sure your expression is correct by checking its value at the vertices of the diamond cell.

(c) Determine the frequency response $H_a(u,v)$.

(d) Determine the value of k, in terms of X, so that the DC gain of $H_a(u,v)$ is 1.0.