1.)

a.)

$$K_a = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 0.\overline{11} & 0.\overline{11} & 0.\overline{11} \\ 0.\overline{11} & 0.\overline{11} & 0.\overline{11} \\ 0.\overline{11} & 0.\overline{11} & 0.\overline{11} \end{bmatrix}$$

b.)

$$K_b = \frac{1}{5}\begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0.2 & 0 \\ 0.2 & 0.2 & 0.2 \\ 0 & 0.2 & 0 \end{bmatrix}$$

c.)

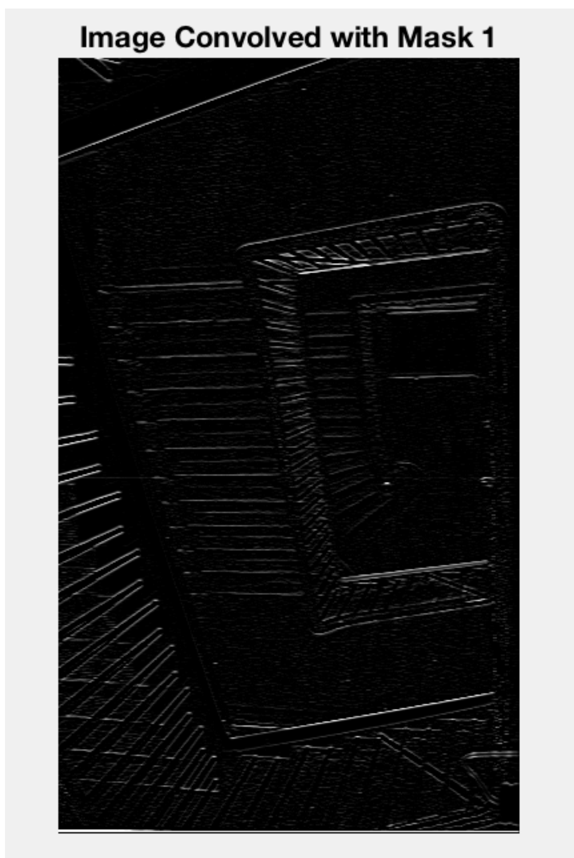
When passing an image through either of these filters, each input image corresponds to a unique output; so, as long as the applied filter is known, it should be possible to implement deconvolution to recover the original image.

d.)

$$K_d = \frac{1}{15}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 3 & 2 \\ 1 & 2 & 1 \end{bmatrix} = \begin{bmatrix} 0.0\overline{6} & 0.1\overline{3} & 0.0\overline{6} \\ 0.1\overline{3} & 0.2 & 0.1\overline{3} \\ 0.0\overline{6} & 0.1\overline{3} & 0.0\overline{6} \end{bmatrix}$$

2.)

Mask 1:



Highlighted horizontal edges.

Mask 2:

Highlighted vertical edges and widened their presence on the output image (made the vertical edges bold).

Mask 3:

Performed a blurring operation; namely, a mean filter.

3.)

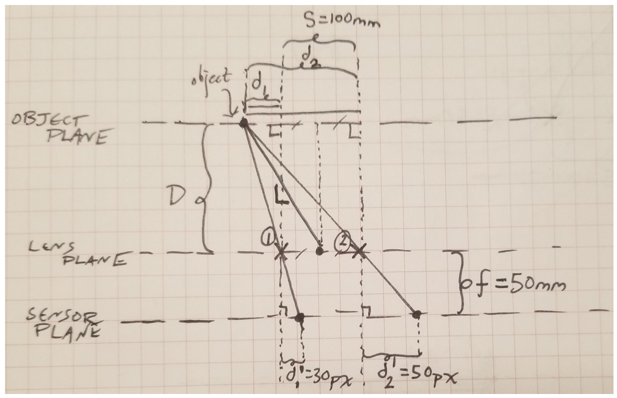
$$w = 1in, \quad d = 1ft = 12in, \quad w' = \frac{47px}{100\frac{px}{in}} = 0.47in$$

$$\because \frac{w'}{w} = \frac{f}{d}$$

$$f = \frac{dw'}{w} = \left(12in * \frac{0.47in}{1in}\right)$$

$$\rightarrow \boldsymbol{f = 5.64in}$$

4.)



Find L.

$$r = 20\frac{px}{cm} = 2\frac{px}{mm}, \quad s = 10cm = 100mm, \quad f = 50mm$$

$$d_1' = \frac{30px}{2\frac{px}{mm}} = 15mm, \quad d_2' = \frac{50px}{2\frac{px}{mm}} = 25mm$$

$$L = \sqrt{D^2 + \left(d_1 + \frac{s}{2}\right)^2} = \sqrt{D^2 + d_1^2 + d_1 s + \frac{s^2}{4}}$$

$$\frac{D}{f} = \frac{d_1}{d_1'} = \frac{d_2}{d_2'}$$

$$s = d_2 - d_1$$

$$\because d_1 = \left(\frac{D}{f}\right)d_1', \quad d_2 = \left(\frac{D}{f}\right)d_2'$$

$$s = \left(\frac{D}{f}\right)d_2' - \left(\frac{D}{f}\right)d_1' = \left(\frac{D}{f}\right)(d_2' - d_1')$$

$$\rightarrow D = \frac{sf}{d_2' - d_1'} = \frac{100mm * 50mm}{25mm - 15mm} = 500mm$$

$$\therefore d_1 = \left(\frac{500mm}{50mm}\right) * 15mm = 150mm$$

$$\therefore L = \sqrt{(500mm)^2 + (150mm)^2 + (150mm * 100mm) + \frac{(100mm)^2}{4}}$$

$$\rightarrow \boldsymbol{L = 538.5mm}$$