PART 2

a) We can approximate a higher order derivative of h = [-1, 1] by convolving multiple instances of h over itself
   [-1, 1] conv [1, -1] = [1, -2, 1]
b) ?
c) g corresponds to a lowpass filter, h corresponds to a band-pass filter, and g x h corresponds to a band-pass filter. G works as a blurring filter. G x h amplifies high-frequency differences.
d) This yields a 4x4 matrix where all entries are zero.
e) Blobs / points
f) It can be separated into two instances of k = [1, -2, 1], where k * k.T = U
g) First we need to compute Gx and Gy for image patch Q. I used a kernel of [-1, 0, 1] because its equivalent and easier to work with.
   I.e. M = [[144 -96], [-96, 64]]

$$Q = \begin{bmatrix} 0 & 0 & 2 & 2 \\ 0 & 0 & 2 & 2 \\ 0 & 0 & 2 & 2 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$G_x = \begin{bmatrix} 0 & 2 & 2 & 0 \\ 0 & 2 & 2 & 0 \\ 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \qquad G_y = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & -2 & -2 \\ 0 & 0 & -2 & -2 \end{bmatrix}$$

$$\sum f_x = 12, \quad \sum f_y = -8$$

$$\sum f_x^2 = 144 \quad \sum f_y^2 = 64$$

$$\sum f_x f_y = -96$$

$$M = \begin{bmatrix} 144 & -96 \\ -96 & 64 \end{bmatrix}$$

h) If both eigenvalues are small, then the area is likely homogeneous. If both are large then the area like is a corner. If one of the eigenvalues is much larger than the other, then this indicates an edge.
i) To do this we need to compute the gradient orientations and then construct a histogram over all the orientations. Gradient orientation = arctan (Gy/Gx)

Gradient orientation $= \tan^{-1}\left(\frac{I_y}{I_x}\right)$

$$\begin{array}{c} G_y \\ G_x \end{array} \begin{bmatrix} \frac{0}{0} & \frac{0}{2} & \frac{0}{2} & \frac{0}{0} \\ \frac{0}{0} & \frac{0}{2} & \frac{0}{2} & \frac{0}{0} \\ \frac{0}{0} & \frac{0}{2} & \frac{-2}{2} & \frac{-2}{2} \\ \frac{0}{0} & \frac{0}{0} & \frac{-2}{0} & \frac{-2}{0} \end{bmatrix} \quad \theta = \begin{bmatrix} 0 & \cdots & & \\ 0 & & & \\ 0 & \cdots & & \\ 0 & 0 & -90 & -90 \end{bmatrix}$$

$\arctan\left(\frac{0}{2}\right) =$ Not Enough Time!

$\arctan\left(\frac{-2}{2}\right) =$

$\arctan\left(\frac{-}{0}\right) = -\inf \qquad \arctan\left(\frac{}{0}\right) = \inf$

~~Histogram~~ Bin = 1 2 3 4 5 6 7 8 9

Gradient magn

Unfortunately I didnt have enough time to compute the gradient orientations + magnitudes, but if i HAD, i would have constructed the histogram by taking the number of recorded angles and recording those in the histogram

j) SIFT is invariant to scaling, rotation and lightning,

k) We could attempt to compute the optical flow as the the patches are not uniform, though the resulting flow estimate would be crude.