Problem 1

(1) Translate the given image by $(t_x = 3.75, t_y = 4.3)$ pixels. Use target-to-source mapping.

1. for every target pixel (x_t, y_t)
2. find the source pixel $(x_s, y_s) = (x_t, y_t) - (t_x, t_y)$
3. use round-off or bilinear interpolation to locate an integer value for the calculated source pixel

(2) Rotate the given image by 2.5 and -2.5 degrees. Use target-to-source mapping.

1. for every target pixel (x_t, y_t)
2. find the source pixel $(x_s, y_s) = (x_t \cos\theta - y_t \sin\theta, x_t \sin\theta + y_t \cos\theta,)$
3. use round-off or bilinear interpolation to locate an integer value for the calculated source pixel

Problem 2

(1) Scale the given image by 0.8 and 1.3 factors. Use target-to-source mapping.

1. for every target pixel (x_t, y_t)
2. find the source pixel $(x_s, y_s) = (x_t/a, y_t/a)$
3. use round-off or bilinear interpolation to locate an integer value for the calculated source pixel

(2) Convolve the given image with Gaussian kernel of these σ values : 0.8, 1.2 and 1.6.

1. find the support (kernel size) for the given σ.

$$\text{support} = \text{ceil}(6\sigma + 1)$$

   support must be odd.

2. create a Gaussian kernel

$$\frac{1}{2\pi\sigma^2} \exp\left(- \frac{m^2 + n^2}{2\sigma^2} \right)$$

3. convolve: move kernel over each pixel, perform weighted average and assign it to target image

Problem 3

Apply a space variant blur to the given image.

1. create a blur surface

$$\sigma(m, n) = \frac{1}{2\pi\sigma_t^2} \exp\left(- \frac{(m - \frac{N}{2})^2 + (n - \frac{N}{2})^2}{2\sigma_t^2} \right)$$

2. find the support (kernel size) for each pixel (corresponding σ)

$$\text{support} = \text{ceil}(6\sigma + 1)$$

support must be odd.

3. create a Gaussian kernel

$$\frac{1}{2\pi\sigma^2} \exp\left(- \frac{m^2 + n^2}{2\sigma^2} \right)$$

4. multiply kernel with the pixel intensity value, keep it as a layer image

5. repeat for all pixels, add all layers

Problem 4

Deduce the shape of the object from the given set of frames

1. for every pixel

2. form an array of values calculated from focus operator

$$SML(g(x,y)) = \sum_{i=x-q}^{x+q} \sum_{j=x-q}^{x+q} ML(g(i,j))$$

$$ML(g(x,y)) = |g_{xx}| + |g_{yy}|$$

3. calculate the distance of that pixel ($\overline{d}$) from the focus plane using the peak value, its previous and next values (see notes for formula)

4. form the shape by using the $\overline{d}$ of all pixels

Problem 5

(1) Compute 2D DFT from 1D DFT

1. compute 1D DFT of each row of the image

2. compute 1D DFT of each column of the DFT image

3. transpose

(2) Interchange phase components of DFT of two images, and observe their IDFTs

1. Phase component contains the high frequency information (edges) and hence is responsible for the visual appearance.

Problem 6

Singular value decomposition

1. Compute SVD.

2. Drop eigen values one-by-one from the decomposition and observe the output image (compression).

3. Calculate the error.

Problem 7 Bilateral filter the image