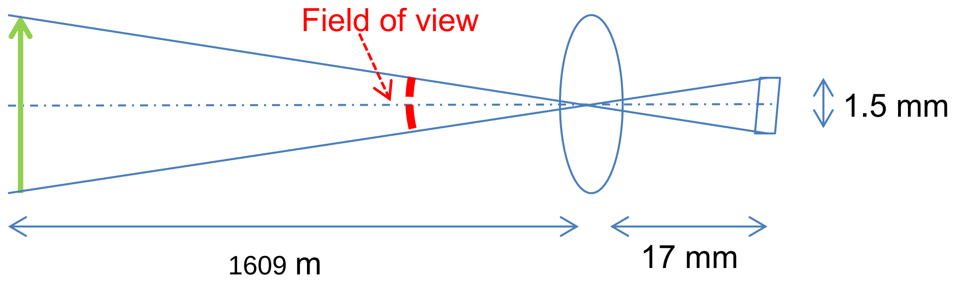
**Assignment #1**

1)

The episode is 50x60 + 40 = 3040 seconds long. At 23 frames per second, there are 69920 images. Each image is 512x384x3 = 589824 bytes in size. So the total size is 69920x589824 = 4.123x10^10 bytes. This is 4.123x10^10/(1024x1024) = 39320 MB (megabytes). With compression we can reduce this file by a factor of more than 100. These data show why video data compression is so important.

2)

(a) If the fovea covers an area of 1.5mm x 1.5mm, and contains 337,000 cones, then we can think of the fovea as a square sensor array, which translates into an NxN array of size 580x580 cones. Assuming equal spacing between cones, this gives 580 cones and 580 spaces on a line 1.5
mm long. Each cone is s = 1.5 mm / 1160 = 0.0013 mm in diameter.
Assuming the focal length of the eye is 17 mm, then the field of view of the fovea of the human eye is 2* arc tan ((1.5/2)/17) = 5 degrees. For comparison, the diameter of the full moon as seen from earth is about 0.5 degree.



(b) The bird is at a distance of 1 mile, or d = 1609 m. If we assume that the eye has a focal length of f=17 mm, then h/f = s/d or
Considering that the bird is 76cm, h = s*f/d = (0.76 m)*(17x10^-3m)/ (1609 m) = 8^-6 m = 0.008 mm. In part (a) we found that a cone is about 0.0013 mm in diameter. So the image of the bird covers about 6 cone diameters. Considering that the bird is 29cm, h = s*f/d = (0.29 m)*(17x10^-3m)/ (1609 m) = 3^-6 m = 0.003 mm.So the image of the bird covers more than 2 cone diameters.
So with this size bird, it would be possible.

3)

```
clear all
close all
N = 400;
I = 64*ones(N,N);
R1 = 100;
R2 = 50;
for r=1:N
   for c=1:N
      if (r-N/2)^2 + (c-N/2)^2 < R2^2
              I(r,c) = 192;
     elseif (r-N/2)^2 + (c-N/2)^2 < R1^2
              I(r,c) = 128;
     end
   end
end
I = I + 32*(rand (N)-0.5);
imshow(I,[0 255]), impixelinfo
imwrite(uint8(I), 'test.tif');
```

4) a) forward mapping

$$T_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 5 & 2 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 \\ -\sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} & 0 \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$T = T_1 \times T_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 5 & 2 & 1 \end{bmatrix} \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} & 0 \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} & 0 \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} & 0 \\ \frac{5\sqrt{3}}{2}-1 & \frac{5}{2}+\sqrt{3} & 1 \end{bmatrix}$$

$$[u \;\; v \;\; 1] = [x \;\; y \;\; 1]\, T = [x \;\; y \;\; 1] \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} & 0 \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} & 0 \\ \frac{5\sqrt{3}}{2}-1 & \frac{5}{2}+\sqrt{3} & 1 \end{bmatrix} \qquad \begin{cases} u = \frac{\sqrt{3}}{2}x - \frac{1}{2}y + \frac{5\sqrt{3}}{2} - 1 \\ v = \frac{1}{2}x - \frac{\sqrt{3}}{2}y + \frac{5}{2} + \sqrt{3} \end{cases}$$

b) Inverse mapping

$$[x, \; y, \; 1] = [u, \; v, \; 1]\, T^{-1} = [u \;, v, \; 1] \begin{bmatrix} \frac{\sqrt{3}}{2} & -\frac{1}{2} & 0 \\ \frac{1}{2} & \frac{\sqrt{3}}{2} & 0 \\ -5 & -2 & 1 \end{bmatrix} \qquad \begin{cases} x = \frac{\sqrt{3}}{2}u + \frac{1}{2}v - 5 \\ y = \frac{-1}{2}u + \frac{\sqrt{3}}{2}v - 2 \end{cases}$$

C) Using the forward transformation, the coordinates of a pixel goes to new coordinates, but somehow we should find the pixel value when several coordinates will be transformed to the same coordinate in the transformed image or when No pixel gets transformed to some coordinates of the transformed image.

We usually use inverse mapping. In this case, u,v are mapped to an x,y location . However, x,y might not be an integer number. We need then to interpolate among the nearest pixels in the original image to find the value of the pixel in the transformed image.