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Selected Problems

1. What is the main advantage of performing feature descriptor matching in feature space rather than image space?

2. Given the following 5 by 5 image region:

```
    0 0 1 3 4
    0 0 2 5 5
    1 2 4 8 16
    1 3 6 3 4
    1 4 8 6 10
```

compute the Hessian matrix and find its eigenvectors and eigenvalues. Use 5-tap central differences to obtain the necessary derivatives.

3. Show that the eigenvectors obtained in the previous question are orthogonal.

4. Given the following 3 by 3 image region containing pixel values (comprised between 0 and 7) in the left image of a stereo pair:

```
r_1 = [3  7  6]
      [2  1  5]
      [4  5  2]
```

and two other 3 by 3 image regions in the right image, such as:

```
r_2 = [6  5  1]
      [2  2  1]
      [7  3  5]
```

```
r_3 = [1  5  2]
      [4  4  3]
      [7  4  6]
```

Compute the histogram for each image region. Use these histograms to construct three descriptors $D(r_1)$, $D(r_2)$, and $D(r_3)$, and determine which descriptor among $\{D(r_2), D(r_3)\}$ is the most similar to $D(r_1)$ using Euclidian distance.

5. Explain why scale, rotation, and illumination invariance are important properties of image descriptors.