Midterm Questions

1 What is the objective of computer vision and how it is different from computer graphics?

2 List four examples of computer vision tasks.

3 What is the objective of visual odometry?

4 What are the underlying assumptions of visual odometry, in other words, which assumptions should be satisfied for successful visual odometry?

5 What is the potential issue of visual odometry compared against visual SLAM?

6 Given image sequence, what are the remaining procedures of visual odometry?

7 In a pin-hall camera, discuss the benefits and the drawbacks of small aperture

8 What are the two properties of converging lens?

9 The thin lens equation is given by $\frac{1}{f} = \frac{1}{Z} + \frac{1}{e}$. What do f, Z, and e represent?

10 Suppose that the focal length is fixed. How would the image plane for the focused image move, as the object moves further away?

11 What is vanishing point?

12 What is the field of view, and how does it change when the focal length is changed?

13 What is the difference between the rolling shutter and the global shutter?

14 Describe the meaning of the following equation:

$$P_c = RP_w + T$$

15 Describe the meaning of the following equation:

$$\begin{bmatrix} X_c \\ Y_c \\ Z_c \end{bmatrix} = \left[\begin{array}{c|c} & \\ R & T \\ & \end{array}\right] \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix}$$

16 Describe the meaning of the following equation:

$$\lambda \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} \alpha_u & 0 & u_0 \\ 0 & \alpha_v & v_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_c \\ Y_c \\ Z_c \end{bmatrix} = K \begin{bmatrix} X_c \\ Y_c \\ Z_c \end{bmatrix}$$

17 Describe the meaning of the following equation:

$$\lambda \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = K[\ R\ |T] \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} = M \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix}$$

18 How many degrees of freedom are in the perspective projection matrix M ?

19 How can we find the camera location from the perspective projection matrix M?

20 What are the requirements for Tsai's calibration method?

21 In Tsai's method, how the intrinsic parameter K is extracted from the projection matrix M ?

22 What are the requirements for Zhang's calibration method?

23 What is the homography?

24 How DLT is different from PnP?

25 What is the difference between image processing, image filtering, and image warping?

26 What is a neighborhood filter?

27 What is the difference between cross-correlation and convolution?

28 Why do we need padding when convoluting an image with a filter?

29 What is the difference between the averaging filter and the Gaussian filter?

30 What are the effects of the standard deviation σ and the filter size W on the Gaussian filter?

31 What is the difference between low-pass filters and high-pass filters?

32 What is the difference between the averaging filter and the median filter?

33 What is the motivation of the bilateral filter?

34 How does the bilateral filter work? More specifically, how the bilateral filter is defined?

35 What is the mathematical definition of edge?

36 What does the image gradient represent?

37 How do we compute the image gradient?

38 What is the motivation of the derivatives of Gaussian filter?

39 How do we detect edges with the derivatives of Gaussian filter?

40 What is the Laplacian of the Gaussian?

41 How do we detect edges with the Laplacian of Gaussian filter?

42 What is the procedure to perform template matching?

43 What is the difference between SSD and SAD?

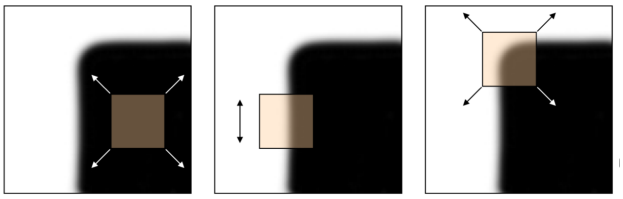
44 What is the difference between SSD and Zero-Mean SSD?

45 What is the difference between feature detection, description, and matching?

46 What are the applications of image features?

47 Which features are desirable?

48 In the following figure, how can we characterize corner?



49 Describe the meaning of the following equation:

$$E(x, y, \Delta x, \Delta y) = \begin{bmatrix} \Delta x \\ \Delta y \end{bmatrix}^T M(x, y) \begin{bmatrix} \Delta x \\ \Delta y \end{bmatrix}$$

50 How to we find corners with the following matrix?

$$M(x, y) = \sum_{u,v \in W} \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} \Bigg|_{x+u, y+v}$$

51 How do we compute Harris score and Shi-Tomasi score from the following matrix?

$$M(x, y) = \sum_{u,v \in W} \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} \Bigg|_{x+u, y+v}$$

52 What is the benefit of the Harris score compared with the Shi-Tomasi score?

53 Once the Harris corner scores are computed, how do we identify keypoints?

54 Is Harris corner detector invariant to translation and rotation?

55 Is Harris corner detector invariant to scaling?

56 Is Harris corner detector invariant to illumination change?

57 How do we select the scale of a feature using the Laplacian of Gaussian?

58 How does SIFT determine the location and the scale of a feature simultaneously?

59 How is the Laplacian of Gaussian (LoG) is related to the Difference of Gaussian (DoG)?

60 How do we make a feature descriptor rotationally invariant?

61 How do we make a feature descriptor scale invariant?

62 How is the histogram of oriented gradient (HOG) descriptor defined?

63 What are the outputs of SIFT detector and descriptor?

64 How do we match descriptors with the similarity?

65 How do we match descriptors with the distance ratio in SIFT?