Homework 1 of CSE 473/573

Due Time: 3:00PM Oct. 08, 2018 at Norton 112

1 Camera Parameters [50%]

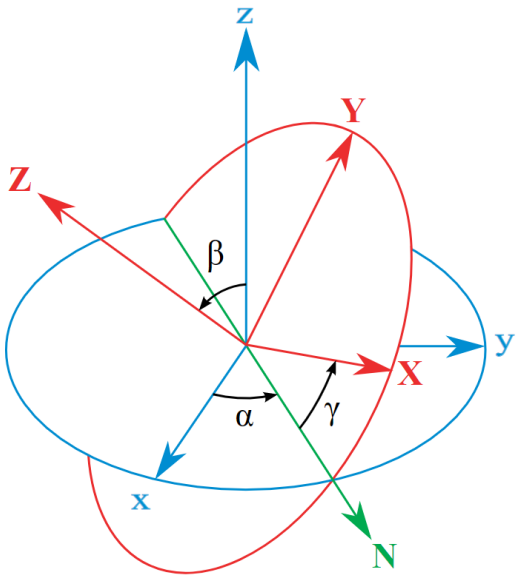

Figure 1: Illustration of Euler angles.

1. Rotation matrix [10%]
As shown in Fig. 1, the Euler angle α, β and γ is $30°, 50°$ and $70°$, respectively. Calculate the camera rotation matrix R, which is part of the camera's extrinsic parameter matrix.

2. Translation vector [10%]
The position of the origin of the camera-centered coordinate is $[600, 300, 200]$ in the world coordinate system. Calculate the camera translation vector t, which is also part of the camera's extrinsic parameter matrix.

3. Using the extrinsic parameters you have obtained project a point whose coordinate is $[50, 70, 90]$ in the world coordinate system into the camera-centered coordinate system. [10%]

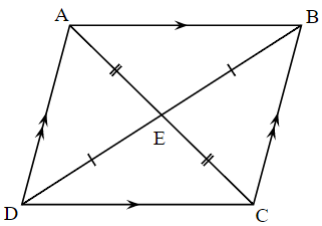

Figure 2: Illustration the parallelogram.

4. Intrinsic parameters [10%]
The focal length f, coordinate of the principal point on the image plane $[u_0, v_0]$ are 300 and $[200, 150]$, respectively. As shown in Fig. 2., the camera, which projects a square in the real world to a parallelogram on the image plane. Angle between AD and DC is $80°$. Calculate the camera's intrinsic parameter matrix.

5. Using the intrinsic parameters you have obtained project a point whose coordinate is $[60, 80, 100]$ in the camera-centered coordinate system onto the image plane. [10%]

2 Template matching [20%]

26	3	184	75	80	128	72	0	84
89	65	0	200	224	18	170	26	54
47	75	127	52	94	26	68	43	199
81	87	86	0	97	3	9	208	218
23	12	188	176	180	1	2	6	3
0	80	54	39	31	22	40	9	2
5	21	9	12	98	176	211	105	9

3	10	20
18	1	5
2	30	3

Figure 3: Left: gray scale values of a 7×9 image; right: gray scale values of a 3×3 template.

As shown in Fig. 3, we have an image and a template. We would like to determine which one of the three positions in the image indicated by the three shaded pixels best matches the template.

1. Sum of squared difference [10%]
Compute the sum of squared difference (SSD) at the three positions indicated by the shaded pixels. Explain which position is the best.

2. Normalized cross correlation [10%]
Compute the normalized cross correlation (NCC) at the three positions indicated by the shaded pixels. Explain which position is the best.

3 Fourier Series [30%]

Consider the following three continuous-time signals:

$$\begin{aligned} f(t) &= 2sin(3\pi t) \\ g(t) &= cos(2\pi t) \\ h(t) &= f(t)g(t) \end{aligned}$$

1. What are the Fourier series coefficients of $f(t)$ and $g(t)$? [10%]

2. Using results of the question 1 (the previous question) and the relationship between convolution in temporal domain and multiplication in frequency domain, compute the Fourier series coefficients of $h(t)$. [10%]

3. Compute the Fourier series coefficients of $h(t)$ through direct expansion of $h(t)$ in trigonometric form, and compare the results with that of question 2 (the previous question). [10%]

Late Submission Policy

- Completed homework and project deliverables are to be submitted by their deadline.
- Late submissions are allowed for one day and will result in a 20% penalty. A day is defined as 24 hours after the day/time the assignment is due (excluding weekends or school holidays). No help will be available from the TAs or from the instructor for an assignment after its scheduled due date.
- After one day, no submissions will be accepted.