

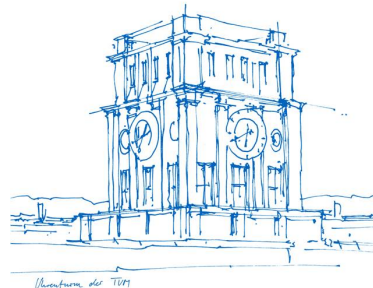


Computer Vision II: Multiple View Geometry (IN2228)

Exam Information and Knowledge Review

Dr. Haoang Li

13 July 2023 11:00-11:45





Announcements Before Class

➤ Regular Q&A

- ✓ At the end of semester, I received a relatively large number of emails/message to ask various questions.
- ✓ Some tips for you:
 - I am generally busy with some research projects. So, I may miss your email/message. I suggest that you ask questions on Moodle. I promise that I will reply to you within 3 days.
 - Try to clearly describe your questions using concise sentences. If you feel it is very difficult to describe your questions, you can send email/message to me, or visit my office this afternoon (2:00 pm—6:00 pm).
 - Some questions are self-explanatory. I strongly suggest that you first watch the course recordings if you did not attend our lectures before.



Announcements Before Class

- Documents for Knowledge Review
- ✓ I have uploaded two documents to highlight important knowledge of Chapters 01—10.
- ✓ Today, I will upload the third document for Chapters 11-13.
- ✓ For Chapter 14 (on 19 July), I will highlight important knowledge in class. You can check slides if you cannot attend that lecture.



Announcements Before Class

➤ Online Q&A Session on 20 July

- ✓ On 20 July, I will hold an online session for Q&A. If you have any questions, you can attend this session via the following link:

<https://tum-conf.zoom.us/j/3145249779> (no password)

- ✓ It will start from 11:00 AM.
- ✓ This session will be automatically recorded. I will upload the recording to Google Drive and share the link below a related post on Moodle (please check it on 20 July).



Announcements Before Class

- Online Q&A Session on 20 July
- ✓ Please note that in this session, only questions regarding knowledge and algorithms are expected. **No exam information will be provided unless there is any update.**
- ✓ All the necessary information about the exam will be provided in TODAY's class.
- ✓ Please regularly check the pinned post on Moodle to see if there is any update. For important updates, I will inform you by email.

Today's Outline

- Exam Information
- Knowledge Review



Exam Information

➤ Time

✓ Summer Semester Exam

- Our exam will take place on 04 August from 8:00 am to 10:00 am.
- Registration for our exam is possible between 22 May and 30 June.
- Deadline for grading of exams: 06 September 2023.

✓ Winter Semester Exam (Retake Exam)

- The exam dates and locations are determined centrally by the Department of Studies. It will take a while until the dates are visible to us.
- We will provide any update in time.
- **Currently, we do not receive any update.**

Exam Information

➤ Policy of Retake Exam

- ✓ If a student fails the exam in the summer semester, he/she can take the repeat exam.
- ✓ If a student cannot take the exam in the summer semester (due to time conflict, sick or any other reasons), he/she can directly take the repeat exam.
- ✓ As to the assignment bonus, as far as I know, it is only applicable to the summer semester exam. If necessary, please double-check with our teaching assistants.

Exam Information

➤ Exam Questions

✓ Structure of each exam

- You have 120 minutes to solve the exam, which contains **22 multiple-choice questions and 3 calculation questions**.
- There is not proof questions.
- You can achieve a maximum of 100 points.
- Multiple-choice questions have 44 credits.
- Three calculations questions have the remaining 56 credits.

Exam Information

➤ Exam Questions

✓ Summer semester vs. winter semester

- Summer semester exam's questions are relatively straightforward and even "boring", given that you have limited time for knowledge review.
- Winter semester exam's questions have not been finalized. Overall, questions will be more insightful and meaningful. If it involves any new knowledge that is not mentioned in the review document, I will update you in time.

Exam Information

- Cheat Sheet
- ✓ Given that the review scope is significantly narrowed down, **cheat sheet is not allowed**.
- ✓ As I mentioned before, you have three documents highlighting the important knowledge.
- ✓ I have also provided the formulas to memorize on Moodle. Please refer to the related post. I will also talk about some of them later.

Exam Information

➤ Calculator

- ✓ To save you time, **the calculator is allowed in the exam.**
- ✓ You can use the calculator for matrix multiplication, vector operations (e.g., dot product and cross product), basic algebraic operations, etc.
- ✓ You will NOT be required to perform matrix decomposition (e.g., SVD) in the exam. You can directly retrieve the decomposition results from a look-up table provided in the exam paper.



Exam Information

- Previous/Mock Exam Questions
- ✓ We officially do not provide previous/mock exam questions.
- ✓ When designing the questions of **summer semester exam**, I barely referred to the questions of previous year's exam.
- ✓ You should focus on the knowledge highlighted in the review documents.

Knowledge Review

- Multiple-choice Questions
 - ✓ All the knowledge required by multiple-choice questions have been mentioned in the knowledge review documents.
 - ✓ Knowledge review documents are applicable to both summer semester exam and winter semester exam.
 - ✓ These questions mainly focus on knowledge understanding.

Knowledge Review

➤ Multiple-choice Questions

- ✓ The most common form of questions is: “Which statement(s) about XXX is/are correct?”
 - There are four choices. At least one choice is correct.
 - Please consider each of the choices separately and select all that apply. Any number of choices can be correct, including 1, 2, 3, and 4.
 - You will get full credits if all the selections are correct, and 0 otherwise.

Knowledge Review

➤ Calculation Questions

✓ Formulas required by these questions

- FOV computation
- **Image normalization (reviewed later)**
- **Conversion between vanishing point and vanishing direction (reviewed later)**
- SVD-based rotation and translation computation based on 3D-3D correspondences
- Definitions and constraints of essential and fundamental matrices (epipolar geometry)



Knowledge Review

➤ Calculation Questions

✓ Formulas required by these questions

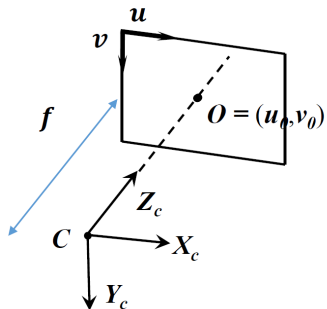
- Homography definition based on rotation, translation, and distance
- Photometric error
- Reprojection error
- SSD for evaluation (see page 04/50 of Chapter 05 Part 3)
- Relation between disparity and depth

Knowledge Review

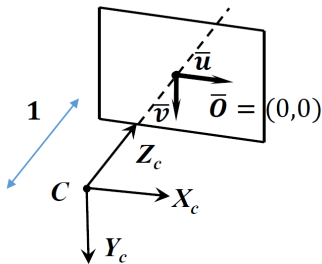
➤ Image Normalization

✓ Geometric Illustration

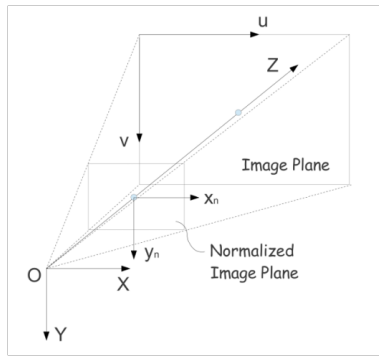
Normalized image plane is a virtual image plane. The **focal length is 1** and **origin of the pixel coordinates is at the principal point**.



Ordinary image plane



Normalized image plane

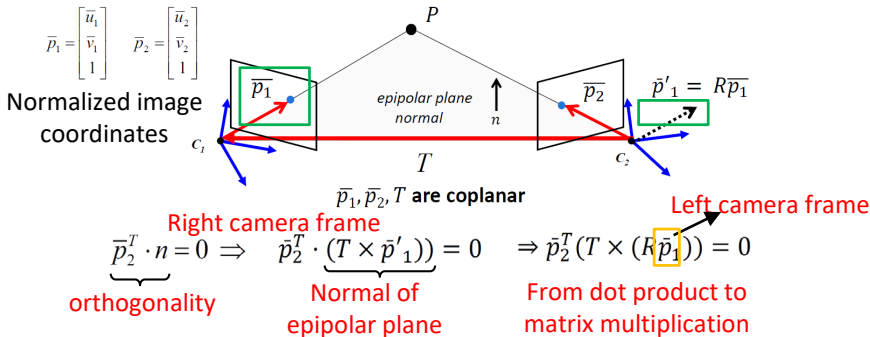


Knowledge Review

➤ Image Normalization

✓ Motivation and Application

The normalized image coordinates correspond to a 3D direction from the camera frame to the image point in the camera frame.

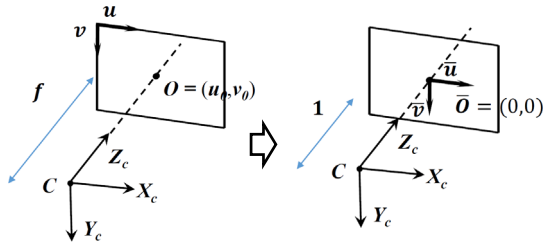


Knowledge Review

➤ Image Normalization

✓ Computation

$$\begin{bmatrix} \bar{u} \\ \bar{v} \\ 1 \end{bmatrix} = K^{-1} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & -\frac{u_0}{\alpha} \\ 0 & 1 & -\frac{v_0}{\alpha} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{u-u_0}{\alpha} \\ \frac{v-v_0}{\alpha} \\ 1 \end{bmatrix}$$



A sample code in MATLAB:

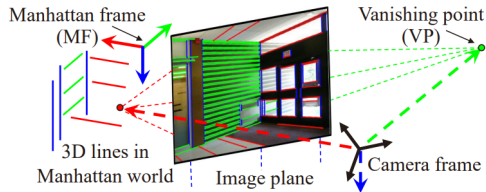
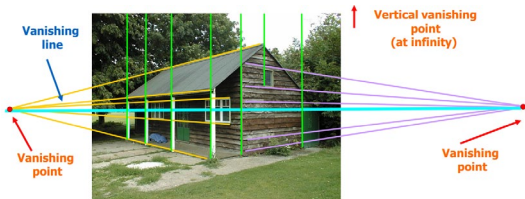
https://cvg.cit.tum.de/teaching/ss2023/mvg2023/supp_matlab_codes

Knowledge Review

➤ Vanishing Point and Vanishing Direction

✓ Definition

- A vanishing direction is defined by the connection between a vanishing point and camera center.
- Vanishing direction is parallel to a 3D dominant direction. We thus do not differentiate between them.

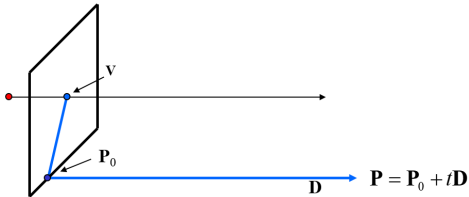


Knowledge Review

➤ Vanishing Point and Vanishing Direction

✓ Conversion

Based on intrinsic matrix \mathbf{K} , we can compute vanishing direction \mathbf{D} based on vanishing point \mathbf{v} .



Up-to-scale

$$\left\{ \begin{array}{l} \mathbf{v} = \mathbf{K} \mathbf{P}_\infty = \mathbf{K} \mathbf{D} \\ \text{Perspective projection} \\ \mathbf{K}^{-1} \mathbf{v} = \mathbf{P}_\infty = \mathbf{D} \\ \text{Image normalization} \end{array} \right.$$

Knowledge Review

➤ Additional Knowledge

✓ LoG and DoG for blob detection

Some students are still confused about the roles of LoG and DoG. Please refer to my detailed reply to this post:

<https://www.moodle.tum.de/mod/forum/discuss.php?d=431661>

✓ Depth from disparity (stereo vision) vs. Triangulation

Please refer to my detailed reply to this post:

<https://www.moodle.tum.de/mod/forum/discuss.php?d=440404>

Summary

- Exam Information
- Knowledge Review



Thank you for your listening!
If you have any questions, please come to me :-)