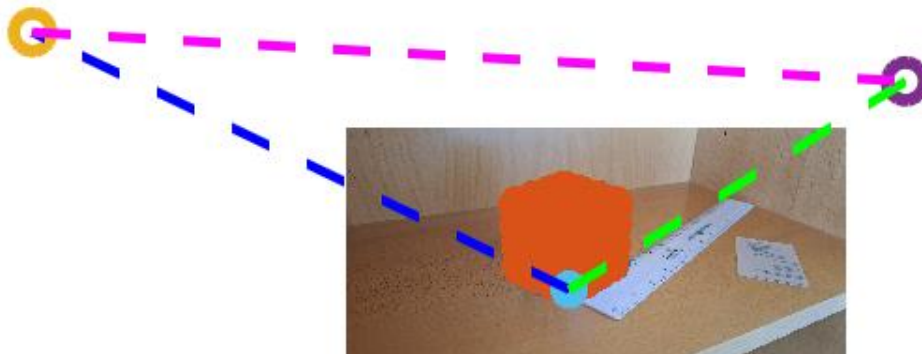
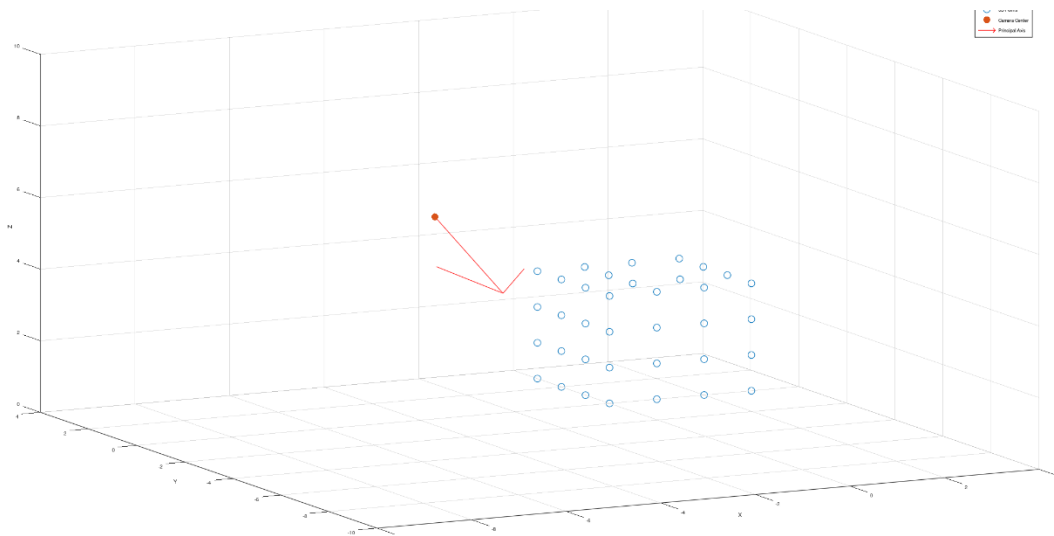


# Lab Report: Camera Calibration

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## Part 1: P Matrix Estimation Using Provided Code



P [3x4 double]				
	1	2	3	4
1	0.037285	-0.094513	0.022115	-0.80166
2	0.011217	0.0076618	0.088607	-0.5818
3	-1.4583e-05	-2.0691e-05	1.2521e-05	-0.00043987
4				

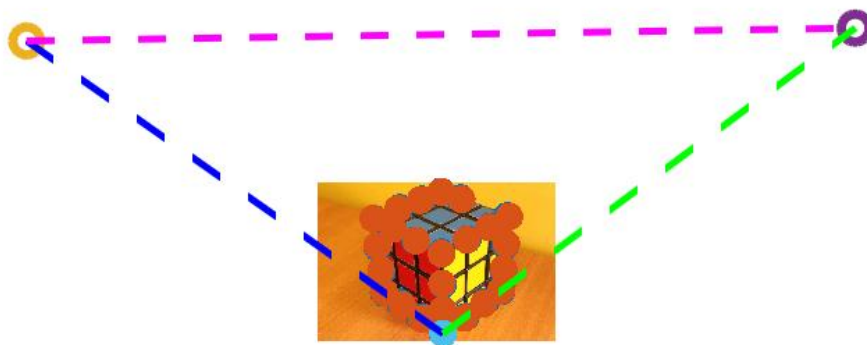
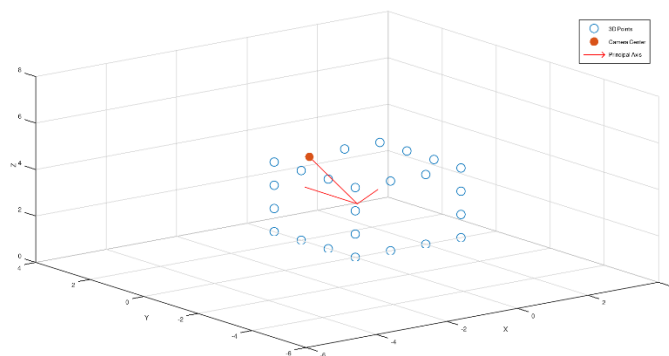
R [3x3 double]			
	1	2	3
1	-0.80185	0.59543	0.050018
2	-0.30064	-0.32968	-0.89495
3	-0.51639	-0.73265	0.44336

**Computed Matrices:** The projection matrix ( $PP$ ), intrinsic matrix ( $KK$ ), and rotation matrix ( $RR$ ) were successfully computed. These results represent the camera's projection model and alignment with the world points.

**3D Visualization:** The camera centre and principal axis are correctly visualized, showing proper alignment with the 3D world points.

**Projected Points:** The overlay of projected points onto the image demonstrates accurate back-projection, with vanishing lines verifying geometric consistency.

## Part 2: P Matrix Estimation Using a Self-Taken Image



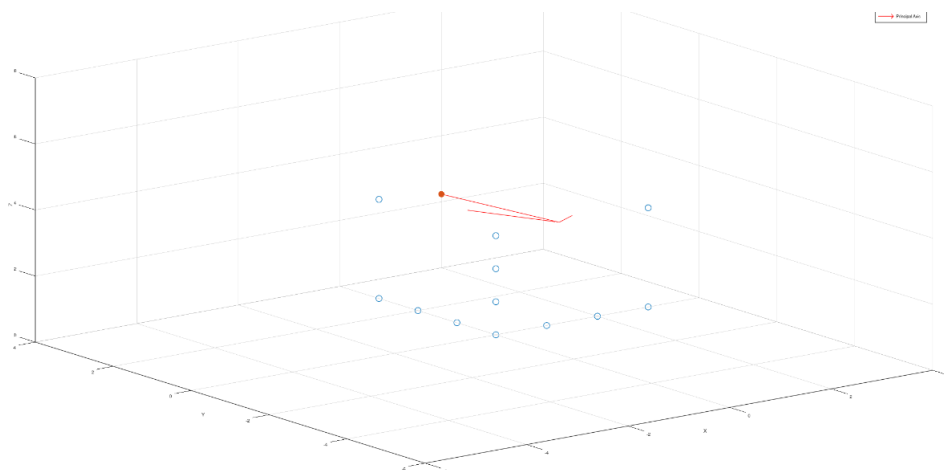
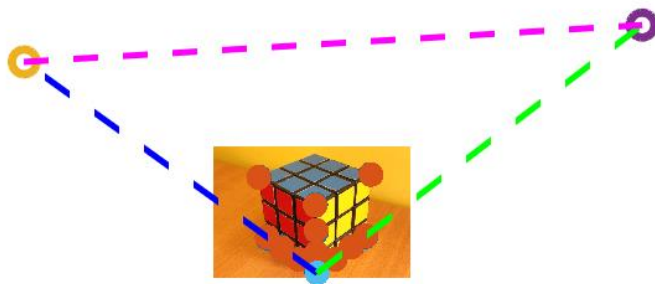
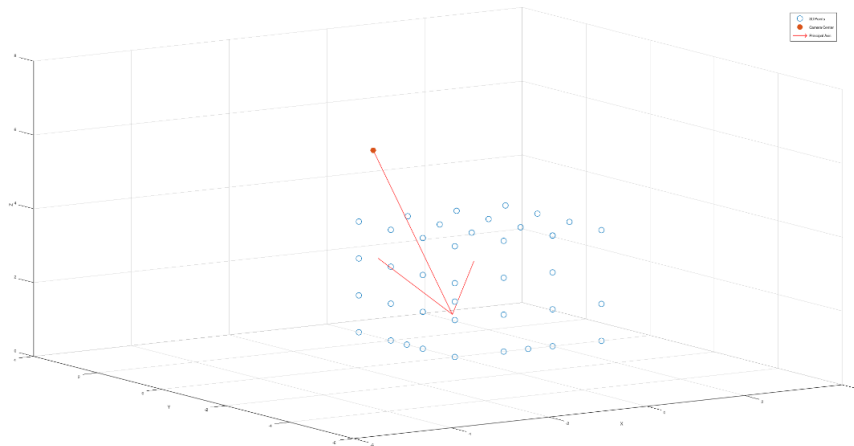
P [3x4 double]				
	1	2	3	4
1	0.078687	-0.14495	0.036068	-0.61935
2	0.038003	0.041335	0.15102	-0.74963
3	-6.284e-05	-6.2631e-05	6.2555e-05	-0.0011463

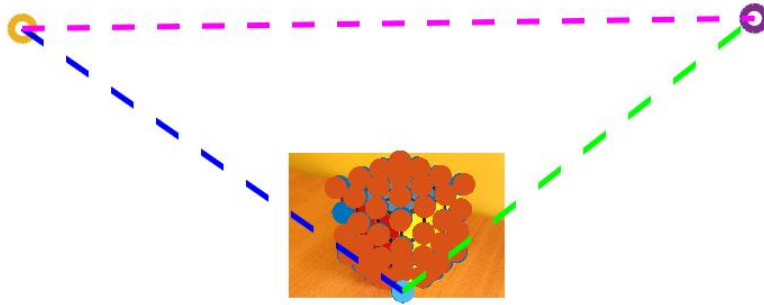
K [3x3 double]			
	1	2	3
1	-1457.6	-1.2886	542.24
2	0	-1435	379.34
3	0	0	1

R [3x3 double]			
	1	2	3
1	-0.71226	0.7018	-0.012853
2	-0.39699	-0.41787	-0.81718
3	-0.57887	-0.57694	0.57624

- **Selected Points:** A custom image was processed, and 24 corresponding points were selected and labeled for 3D-2D mapping.
- **Computed Matrices:** The computed matrices ( $P, K, RP, K, R$ ) are consistent with the custom camera setup and show accurate calibration.
- **3D Visualization:** The camera position, orientation, and world points are well-represented, confirming the validity of the computed parameters.
- **Projected Points:** The overlay of projected points aligns with the image features, indicating successful projection and calibration.

### Part 3: Experiment and Reflection





## Reflection Questions

### 1. How does increasing the number of points affect the accuracy and stability of the P matrix estimation?

Increasing the number of points improved the accuracy and stability of the P matrix. With fewer points (e.g., 12), the P matrix estimation was less reliable, as minor inaccuracies in point selection had a significant impact. However, with more points (e.g., 24 and 40), the estimation stabilized due to the over-determined nature of the system, which reduced the impact of errors in individual points.

### 2. Is there a noticeable difference in the accuracy of the back-projection when using fewer points versus more points?

Yes, the back-projection accuracy improved as the number of points increased. When using only 12 points, the alignment between the projected and actual points was less precise. With 24 and 40 points, the projections aligned more accurately with the input image, resulting in a more realistic visualization.

### 3. What challenges did you encounter when manually selecting points and entering 3D world coordinates?

Manually selecting points was time-consuming and prone to human error, especially in ensuring precise alignment with the 3D world coordinates. Errors in point selection or coordinate input often led to noticeable inaccuracies in the computed matrices. Additionally, identifying correspondences in a structured manner was challenging in complex scenes.