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1. Which of the following is false about epipoles? **1 / 1 point**

- ○ Epipoles are points on the image planes
- ○ The left epipole's coordinates depend on the right camera's position
- ◉ The left epipole's coordinates depend on the right camera's orientation
- ○ For each stereo pair, there is a unique epipole pair

Correct
An epipole is a projection in one camera of the optical center of the other camera. Its position does NOT depend on the other camera's orientation.

2. The left camera of an uncalibrated stereo system is located at the origin with image plane defined by $x + y = 3$, while the right camera is located at $(10, 5, 5)$ with image plane defined by $-2x + y = 8$. Where is the left epipole? **2 / 2 points**

- ○ $(5, 2.5, 2.5)$
- ◉ $(2, 1, 1)$
- ○ $(1.5, 1.5, 6)$
- ○ $(0, 3, 4)$

Correct
The left epipole lies at the intersection of the left image plane with the line passing through the camera origins. Thus, the left epipole is the point where the plane $x + y = 3$ intersects the line

$(x, y, z) = (0, 0, 0) + t(10, 5, 5)$, which is $(2, 1, 1)$.

3. Which of the following is a property of a skew-symmetric matrix R? **1 / 1 point**

- ○ $R^{-1} = R^T$
- ◉ $-R = R^T$
- ○ $R^T R = R R^T$
- ○ $R^{-1} R = R R^{-1}$

✓ **Correct**
The second answer choice is a property of a skewed symmetric matrix.

4. Suppose we have a stereo system where both cameras are facing the same direction, the left camera is at the origin and the right camera is at (x, y, z). What is the essential matrix? **2 / 2 points**

- ○ $\begin{bmatrix} x & 0 & 0 \\ 0 & y & 0 \\ 0 & 0 & z \end{bmatrix}$
- ○ $\begin{bmatrix} 1 & 0 & x \\ 0 & 1 & y \\ 0 & 0 & z \end{bmatrix}$
- ◉ $\begin{bmatrix} -0 & -z & --y \\ -z & -0 & -x \\ -y & -x & --0 \end{bmatrix}$
- ○ \begin{align*}\begin{bmatrix} {1} \hspace{3em} {0} \qquad {x/z} \\ {0} \hspace{3em} {1} \qquad {y/z} \\{0} \hspace{3em} {0} \hspace{3em} {1} \end{bmatrix}\end{align*}

Correct

The essential matrix is $E = T_x R$. Since the cameras are facing the same direction, the rotation matrix R is the identity. The translation vector is just (x, y, z).

5. We learned that both the essential matrix E and the fundamental matrix F encapsulate the epipolar constraint between the two cameras. What is the difference between the two? **1 / 1 point**

- (●) E depends on extrinsic parameters; F depends on both extrinsic and intrinsic parameters
- ( ) E depends on intrinsic parameters; F depends on extrinsic parameters
- ( ) E depends on extrinsic parameters; F depends on intrinsic parameters
- ( ) E depends on both extrinsic and intrinsic parameters; F depends on extrinsic parameters

Correct

The essential matrix $E = T_x R$ depends on the position and orientation of the camera, thus only extrinsic parameters. On the other hand, the fundamental matrix F converts the homogeneous coordinates of a point from one image to the other image, thus depending on both the extrinsic and intrinsic paramters.

6. Why is there significant overlap in the fields of view for the vision system of predatorial animals? **1 / 1 point**

- ( ) Each eye can be sensitive to different lighting conditions
- ( ) Damage to one of the eyes can more easily be compensated by the other
- ( ) The images from each eye can be combined to form a crisper single image
- (●) The eyes form a stereo system that can perform depth perception

Correct

Please refer to the lecture video for explanation

7. When performing stereo calibration, from correspondences we can set up a system of equations $A\mathbf{f} = 0$ to solve for the flattened fundamental matrix $\mathbf{f}$. We then minimize $A\mathbf{f}$ subject to $||\mathbf{f}||^2 = 1$. Here, we have such constraint because: **1 / 1 point**

- ○ The constraint makes the optimization easier
- ◉ $A\mathbf{f} = 0$ is not sufficient to produce a unique $\mathbf{f}$
- ○ The projection matrix $\mathbf{p}$ is only valid when $||\mathbf{f}||^2 = 1$
- ○ The correspondences to form A is noisy

✓ **Correct**
Fundamental matrix acts on homogenous coordinates. Therefore, any $k\mathbf{f}$ (k is an arbitary constant) is a solution. To isolate to a single solution, we need to add such constraint.

8. Consider an uncalibrated stereo system with two identical cameras. If we move the scene point (x, y, z) to (x', y', z') such that $z' = 2z$, how does the fundamental matrix change? **1 / 1 point**

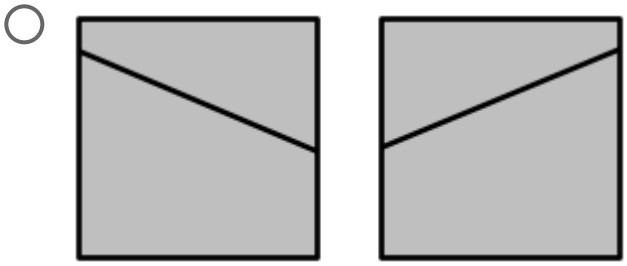
- ◉ It is is unchanged
- ○ It is scaled by a factor of 2
- ○ It is scaled by a factor of 1/2
- ○ It is scaled by a factor of 4

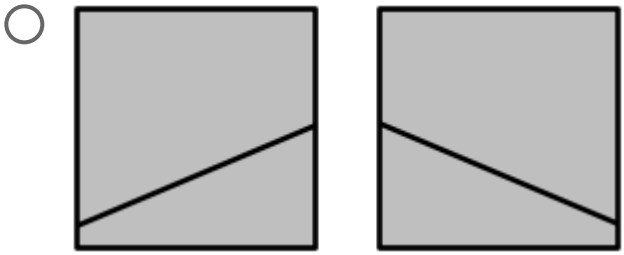
✓ **Correct**
The fundamental matrix is independent of scene structure.

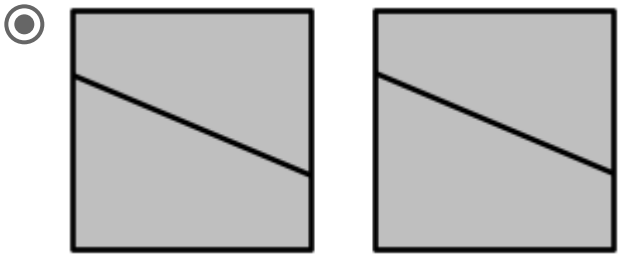
9. Consider an uncalibrated stereo system with two identical cameras. This system has the following properties: **0 / 1 point**

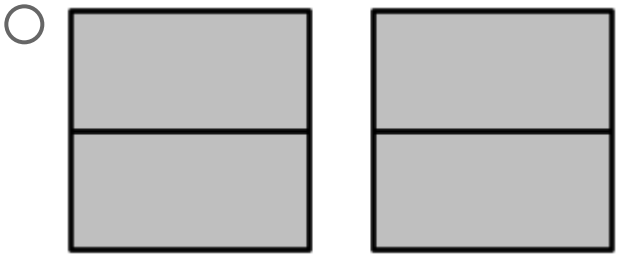
- The field of view of each camera is 90 degrees.
- The optical axes of the two cameras form a 90-degree angle.
- The centers of projection are at equal distances from the intersection of optical axes.
- The baseline of the two cameras is parallel to their scan lines.

Which of the following can be a pair of epipolar lines?









⊗ **Incorrect**

10. When determining the depth of a point we arrive at the equation $Ax = b$, where A is a 4×3 matrix, x is a 3×1 vector and b is a 4 by 1 vector. Which of the following is a correct solution for x? **1 / 1 point**

- ○ $x = A^T b$
- ○ $x = A^{-1} b$
- ◉ $x = (A^T A)^{-1} A^T b$
- ○ There is no closed form solution for x

✓ **Correct**
This is the solution to the least squares problem using the pseudo-inverse.