

RA 505 Mid Sem Exam (Jan - May 2022) 28th Feb (2 PM - 4 PM)

Answer all questions. Time: 120 minutes Full Marks: 50

1

Slope of a zero crossing $\{a, -b\}$ is
(1 Point)

☒ $|a + b|$

☐ $|a - b|$

☐ Zero

☐ One

2

Match the following:
(1 Point)

a)	It is responsible for Preliminary estimating the pose and location of the robot.	i) Map
b)	It is responsible for receiving the pose information measured by Visual Odometry.	ii) Loop Detection
c)	It aims recognizing the previously visited places during the travel of the robot.	iii) Forward Odometry
d)	It is responsible for reconstructing the map according to the camera pose and frame.	iv) Backward Odometry

- ☐ a)-iv), b)-i), c)-ii), d)-iii)
- ☐ a)-iii), b)-i) , c)-ii, d)-iv)
- ☒ a)-iii), b)-iv) , c)-ii, d)- i)
- ☐ a)-iii) b)-iv), c)-i), d)-ii)

3

Which of the following statement(s) is/are CORRECT
(1 Point)

- ☒ Horn Schunck and Lucas-Kanade optical flow methods work only for small motion.
- ☒ If object moves faster, the brightness changes rapidly and smaller masks (2x2 or 3x3) fail to estimate spatio temporal derivative
- ☒ Pyramid can be used to compute large optical flow vector
- ☐ None of above

4

For Histograms of Oriented Gradients (HoG), which of the following statement(s) is/are FALSE
(1 Point)

- ☒ HoG descriptor is 128 dimensional vector
- ☐ Compute centered horizontal and vertical gradients with no smoothing
- ☐ Quantize the gradient orientation into 9 bins (0-180)
- ☐ Each block consists of 2x2 cells with size 8x8

5

Which of the following statement(s) is /are FALSE?
(1 Point)

- ☒ SLAM is a probability distribution of path (i.e. pose of the robot at discrete point of time) and map given the observation and the control.
- ☐ In Visual SLAM, camera is the only external sensor.
- ☐ Geometric SLAM is computationally costly and lacks adaptive learning capability
- ☒ RANSAC cannot be used in Pose estimation

6

For "Tomasi and Kanade" factorization method for structure of motion, which of the following statement(s) is/are CORRECT?
(1 Point)

- ☐ The camera model is prespective.
- ☒ The position of "p" points in the "F" frames which are not all coplanar.
- ☐ Camera calibration is needed.
- ☐ None of the above.

7

Which of the following statement(s) is/are TRUE
(1 Point)

- ☒ Lucas Kanade Method assume that the optical flow in a very small neighborhood in the scene is the same for all the points in that neighborhood.
- ☐ Lucas Kanade Method efficiently works on high speed motion in the scene.
- ☒ Gaussian Pyramids are smoothed copies of the image at different scales.
- ☐ Gaussian pyramids can not be used for multi resolution features extractor

8

In supervised learning setting, a neural net is being trained by
(1 Point)

- ☒ Iteratively changing the weights using error gradient and learning rate.
- ☐ Weights are fixed and initialized randomly.
- ☐ Weights are static and defined by a polynomial function.
- ☐ Learning rate is not associated with weight updation.

9

For essential matrix, which of the following statement(s) is/are FALSE
(1 Point)

- ☐ It is used in case of Calibrated Camera i.e. the intrinsic parameters are known.
- ☐ Essential matrix can be expressed in terms of the relative transformation between two image frames.
- ☒ Essential matrix has six degrees of freedom.
- ☐ None of the above.

10

Which one is the correct sequence of RANSAC Algorithm

1. Randomly Select minimal subset of points
2. Hypothesize a model
3. Select points consistent with model
4. Compute error function, i.e. shortest point to the line distance
5. Repeat hypothesize-and-verify loop

(1 Point)

- ☐ 1-2-3-4-5
- ☐ 5-4-3-2-1

☒ 1-2-4-3-5☐ 2-1-3-4-5

11

Optical flow estimation is problematic
(1 Point)

- ☒ in homogeneous image areas
- ☐ in image areas with homogeneous motion
- ☒ at image edges
- ☒ at the boundaries of moving objects

12

For structure from motion, which of the following statement(s) is/are TRUE
(1 Point)

- ☒ It is a problem of 3D reconstruction of the structure of the environment from a set of images.
- ☒ It is problem of camera pose estimation from a set of images.
- ☐ The SFM process is less computationally expensive and can be implemented in real time.
- ☐ None of the above.

13

Find out the true/false statement:

Statement 1: Higher learning rate helps to get better prediction accuracy.

Statement 2: Learning rate can control the rate of convergence of a neural network.

(1 Point)

- ☐ Statement 1 is true and statement 2 is false
- ☐ Both statements are false.
- ☒ Statement 1 is false and statement 2 is true.
- ☐ Both Statements are true.

14

For Fundamental matrix (F), which of the following statement(s) is/are TRUE.
(1 Point)

- ☒ If F is fundamental matrix of pair of cameras (P, P'), then F-Transpose is the fundamental matrix for opposite order (P', P)
- ☐ F matrix has 9 degrees of freedom.
- ☐ F is of full rank.
- ☐ All of above.

15

Which of the following statement(s) is/are CORRECT?
(1 Point)

- ☒ SLAM aims to obtain a globally consistent estimate of the camera/robot trajectory and map
- ☒ The 3-D reconstruction of the environment, or mapping, is not required in visual SLAM
- ☒ Structure from motion tackles the problem of 3D reconstruction of both the structure of the environment and camera poses from sequentially ordered image set
- ☐ None of the above.

16

Consider the following two statements and choose the correct option(s)

STATEMENT-1:

RANSAC algorithm produces a reasonable result with a certain probability, the probability decreases as the algorithm runs for a greater number of steps

STATEMENT-2:

RANSAC is a robust approach to estimate the fundamental matrix in stereo vision

(1 Point)

- ☒ Statement-1 is WRONG and Statement-2 CORRECT
- ☐ Statement-1 is CORRECT and Statement-2 WRONG
- ☐ BOTH Statement-1 and Statement-2 are WRONG
- ☐ BOTH Statement-1 and Statement-2 are CORRECT

17

What is the minimal number of point-to-point correspondences to compute affine transformation and Homography?

(1 Point)

- ☐ 1 correspondence (non colinear) for affine transformation, 2 correspondences for homography
- ☐ 2 correspondences (non colinear) for affine transformation, 3 correspondences for homography.
- ☒ 3 correspondences (non colinear) for affine transformation, 4 correspondences for homography.
- ☐ 4 correspondences for (non colinear) affine transformation, 5 correspondences for homography

18

In ORB: FAST algorithm, key points are determined by
(1 Point)

- ☐ Choosing the pixel with maximum intensity value.
- ☒ Choose the pixel if nine or more contiguous pixels (among 16 pixels surrounding the pixel of consideration) are DARKER than the pixel of consideration with intensity difference $> Th$ (a given threshold)
- ☒ Choose the pixel if nine or more contiguous pixels (among 16 pixels surrounding the pixel of consideration) are BRIGHTER than the pixel of consideration with intensity difference $> Th$ (a given threshold)
- ☐ Choosing the pixel with minimum intensity value.

19

Which of the following statement(s) is/are CORRECT?
(1 Point)

- ☒ BRIEF cannot detect the key points by itself, so we need to use it in conjunction with a keypoint detector.
- ☐ Similarity between two descriptor are evaluated using the Euclidean distance only.
- ☐ BRIEF uses Gaussian kernel for smoothing image.
- ☒ BRIEF is both translation invariance and rotation invariance

20

Consider the following description and choose the CORRECT option(s)
(1 Point)

The Basic Pinhole camera model is expressed

$$\mathbf{x} = \mathbf{KR}[\mathbf{I} \mid -\tilde{\mathbf{C}}]$$

where \mathbf{X} is now in a world coordinate

The camera projection matrix \mathbf{P}

$$\mathbf{P} = \mathbf{KR}[\mathbf{I} \mid -\tilde{\mathbf{C}}]$$

- ☐ K is called extrinsic camera parameter.
- ☒ P has the 9 degree of freedom.
- ☐ R and $\tilde{\mathbf{C}}$ are called intrinsic camera parameters.
- ☐ None of the above

21

Optical flow can be applied in which of the following cases
(1 Point)

- ☒ Video retiming
- ☒ Image stabilization
- ☒ Traffic monitoring
- ☒ Face tracking

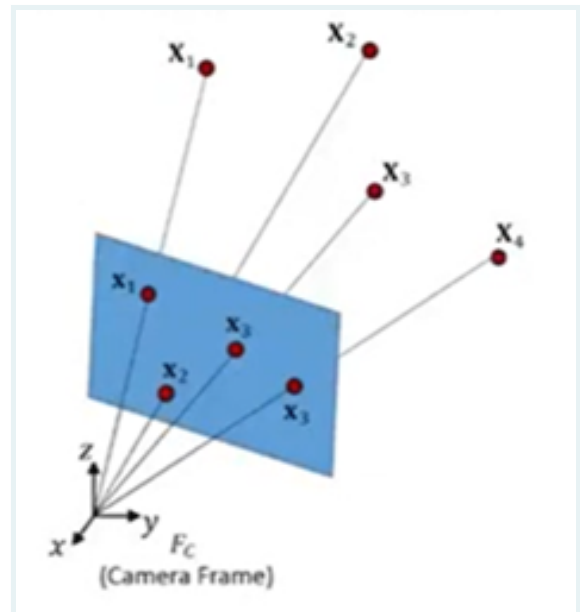
22

A 3×3 matrix is an essential matrix iff two of its singular values are equal and the third is one.

(1 Point)

- ☐ True
- ☒ False
- ☐ Can't Say

23



Considering the following scenario, which of the following statement(s) is/are FALSE?

Given, a set of 3D points $\{X_1, X_2, \dots, X_n\}$ defined in a world co-ordinate frame, and its corresponding 2D image points $\{x_1, x_2, \dots, x_n\}$ i.e. $\{X_i \leftrightarrow x_i\}$

(1 Point)

- ☐ Camera pose estimation means to find the R (rotation) matrix and t (translation) vector which correspond between world co-ordinate frame and camera co-ordinate frame.
- ☒ This problem is also called affine pose estimation problem.
- ☒ The pose estimation problem is mathematically intractable.
- ☐ None of the above.

24

SIFT Descriptor (1 Point)

- ☒ is invariant to spatial rotation, translation
- ☒ is a technique for detecting salient, stable feature points in an image
- ☐ locates the global features in an image
- ☒ is robust to illumination fluctuations

25

Which one is the Outlier detection Algorithm? (1 Point)

- ☒ SIFT
- ☒ HOG
- ☒ LOG
- ☒ RANSAC
- ☒ All the above

26

Deep learning models (a neural net with higher no. of hidden layers) were not popular before 2006 because (1 Point)

- ☒ They were computationally complex.
- ☒ Training algorithms were not efficient.
- ☒ GPU based hardware was not that much available.

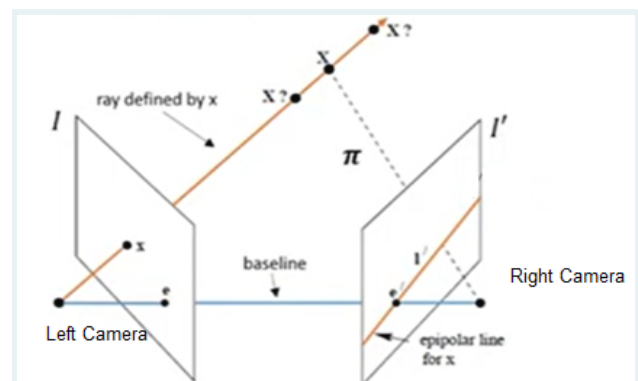
- ☐ The concept of neural net with higher hidden layers was first introduced on 2006.

27

Bundle Adjustment (1 Point)

- ☐ is a state estimation technique
- ☐ maximizes reprojection error
- ☒ is the problem of jointly refining the parameters of motion and structure to improve a visual reconstruction
- ☐ can not be used in feature-based 3D reconstruction algorithm

28



For a typical epi-polar geometry setting, which of the following statement(s) is/are TRUE (1 Point)

- ☒ The epi-polar lines are co-planer
- ☒ The point projection of X on the right camera plane can lie anywhere in the epi-polar line (I').
- ☐ The point of intersection of the left camera image plane and line between pt. X (world co-ordinate point) and left camera center c is called epi-pole.
- ☐ None of the above.

29

Which of the following statement(s) is/are TRUE
(1 Point)

- ☐ Generative methods model posterior.
- ☐ Discriminative methods model likelihood and prior.
- ☐ A Support Vector Machine (SVM) is a generative classifier.
- ☒ A logistic regression is a discriminative model.

30

When we apply LoG to a Image instead of one 2D filter, how many 1D filter can be used?
(1 Point)

- ☐ 2
- ☒ 4
- ☐ 8
- ☐ 16

31

What is/are the advantage(s) of BRIEF?
(1 Point)

- ☐ BRIEF relies on a relatively large number of intensities difference tests to represent an image patch as a binary string.
- ☒ BRIEF relies on a relatively small number of intensities difference tests to represent an image patch as a binary string.
- ☒ Construction and matching for the BRIEF descriptor much faster than for other methods.
- ☐ None of above

32

Which of the following statement(s) is/are TRUE for Lucas Kanade Method for optical flow :

(1 Point)

- ☒ Lucas Kanade Method works excellent for edges due to prominent gradient in one direction.
- ☒ Lucas Kanade Method works poorly for smooth region as the equation for all pixels in the selected window are more or less same.
- ☒ Lucas Kanade Method can reliably compute optical flow for textured region due to changes in brightness in both the direction.
- ☒ All of the above

33

Which of the following statement(s) is/are TRUE:

A) Epipolar constraint allows the estimation of the 3D coordinates of point p from its images x_1 and x_2 , given relative rotation and relative position

B) Some of the epipolar lines do not intersect at the epipole.

C) Epipolar constraint says that a point in one image generates a plane in the other on which its corresponding point must lie.

D) The fundamental matrix is the algebraic representation of epipolar geometry.

(1 Point)

- ☒ Only A) and D) TRUE
- ☐ Only A), B) and D) TRUE
- ☐ Only B), C) are TRUE
- ☐ All of the A), B), C) D) are TRUE.

34

Match the challenges of object-categorization to related row of second columns:

- | | |
|---------------------------------------|---|
| 1. Viewpoint variation. | A. Variation in the size of object |
| 2. Scale variation. | B. Orientation of object w.r.t camera |
| 3. Deformation visible | C. Only a small portion of an object is visible |
| 4. Occlusion. | D. Shape change of an object |
| 5. Illumination conditions. | E. Classes of interest can often be relatively broad |
| 6. Background clutter. level | F. Effects of lighting are drastic on the pixel level |
| 7. Intra-class variation. environment | G. Objects of interest may blend into their environment |

(1 Point)

- ☒ 1 - B, 2 - A, 3 - D, 4 - C, 5 - F, 6 - G, 7 - E
- ☐ 1 - C, 2 - B, 3 - D, 4 - E, 5 - F, 6 - G, 7 - A
- ☐ 1 - B, 2 - D, 3 - A, 4 - C, 5 - E, 6 - F, 7 - G
- ☐ 1 - C, 2 - A, 3 - E, 4 - D, 5 - F, 6 - G, 7 - A

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Which of the following network(s) is/are NOT Deep Learning model
(1 Point)

- ☐ Convolution Neural Network
- ☒ Singular Value Decomposition
- ☐ Google Net

☒ Petri Net

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Which of the statement(s) is/are FALSE:
(1 Point)

- ☐ Autoencoder tries to reproduce the input.
- ☒ Linear regression is an unsupervised approach.
- ☐ Vanishing gradient may be a problem for deeper neural network without proper measure.
- ☐ Deeper neural network likely to have more training samples to avoid overfitting.

37

Which of the following is/are INCORRECT statement(s)
(1 Point)

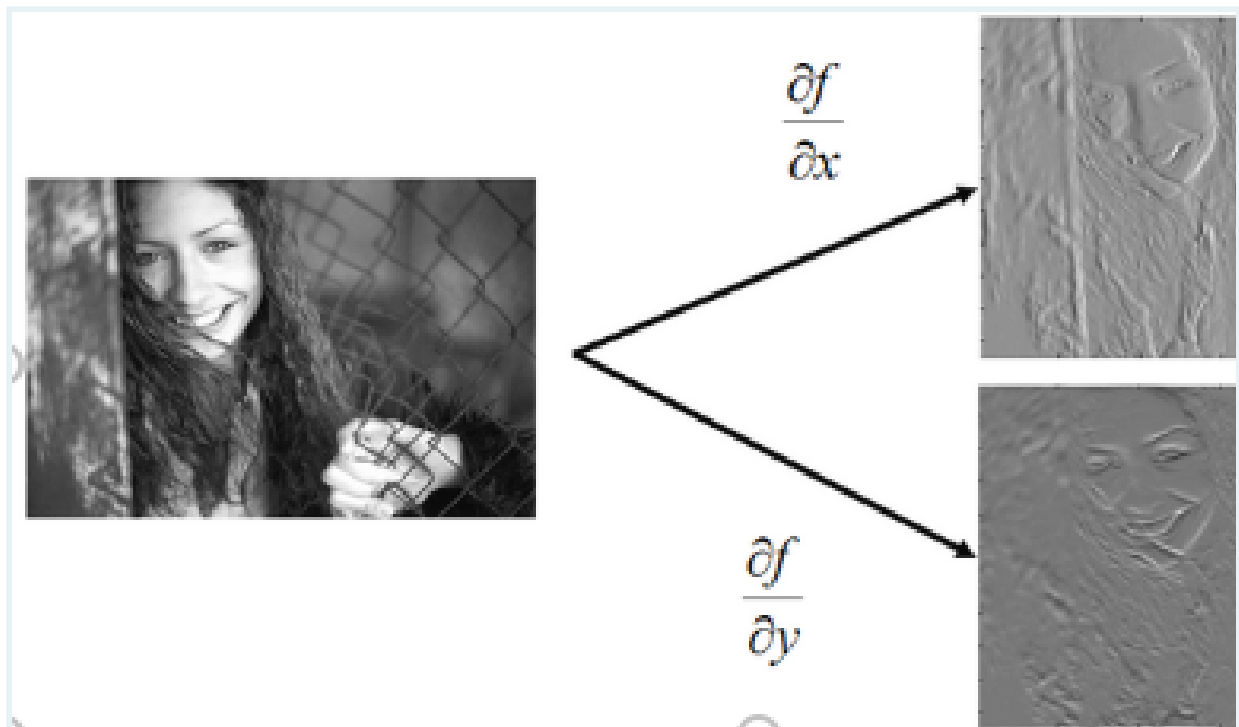
- ☐ ORB is built from FAST descriptor and Rotated BRIEF key point detector
- ☒ Limitation of FAST is that it does not include orientation.
- ☒ FAST produces a measure of cornerness, and it has large responses along edges, too.
- ☐ The BRIEF descriptor is a bit string description of an image patch constructed from a set of binary intensity tests

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a. In the df/dx image, the vertical boundary between her face and hair is more apparent, or similarly the vertical boundary between her hair and the wall.

b. The df/dy image, on the other hand, accentuates horizontal edges like the side/top of her hand, the edge of her eyes, and her eyebrows.

(1 Point)



- ☐ a is True but b is False
- ☒ a and b both are True
- ☐ a is False but b is True
- ☐ a and b both are False

39

For Gaussian filtering, with increase of sigma (σ)
(1 Point)

- ☒ Filtered image will be more blurred and more noise will be reduced.
- ☐ Filtered image will be less blurred and more noise will be reduced.
- ☐ Filtered image will be more blurred and less noise will be reduced.
- ☐ Filtered image will be less blurred and less noise will be deducted.

40

Which of following statement(s) is/are FALSE
(1 Point)

- ☐ A data point that differs considerably from other observations is referred to as an outlier.
- ☐ RANSAC algorithm terminates after a predetermined number of steps or once a predetermined number of inliers has been reached.
- ☒ Computational time remains constant with the increase of number of model parameters.
- ☒ RANSAC algorithm is robust to large number of outliers

41

Suppose you have to rotate an image. Image rotation is nothing but multiplication of image by a specific matrix to get a new transformed image.

For simplicity, we consider one point in the image to rotate with coordinates as (1, 0) to a coordinate of (0, 1), which of the following matrix (see the image) would we have to multiply with?

(1 Point)

A

1	1
1	1

B

0	
1	

C

0	-1
1	0

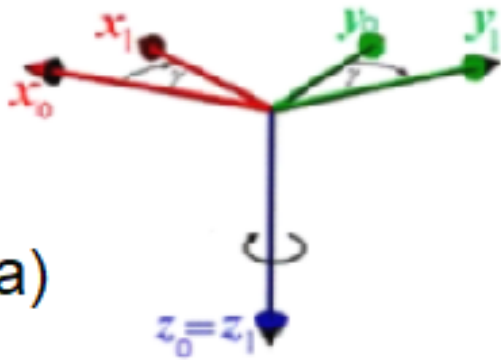
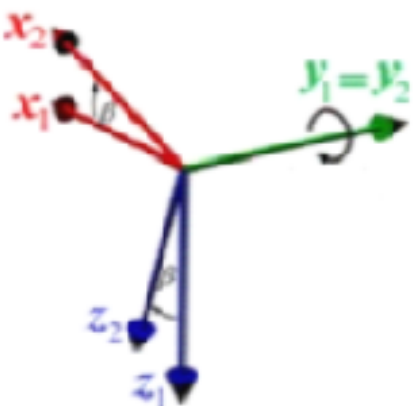
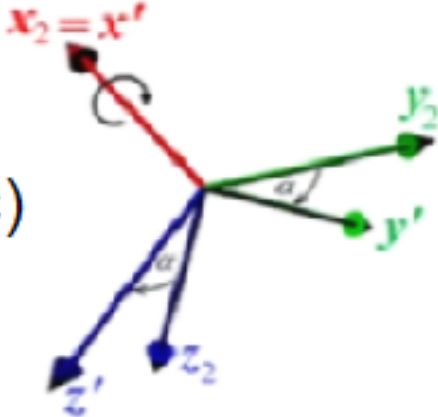
D

0	
1	

- ☐ A
- ☒ B
- ☐ C
- ☐ D

42

In case of, Euler Angles to Rotation Matrix, match the following
(1 Point)

 <p>a)</p>	<p>i) Roll</p>
 <p>b)</p>	<p>ii) Yaw</p>
 <p>c)</p>	<p>iii) Pitch</p>

- ☐ a) - (i), b) - (ii), c) - (iii)
- ☐ a) - (iii), b) - (ii), c) - (i)
- ☒ a) - (ii), b) - (iii), c) - (i)
- ☐ None of above is correct match

43

For basic pinhole camera model, which of the following statement is FALSE
(1 Point)

- ☐ The point where principal axis meets the image plane is called Principal point.
- ☐ Line from camera center perpendicular to the image plane is called principal axis.
- ☒ Image coordinate is always aligned with world coordinate.
- ☐ None of the above.

44

Match the following:
(1 Point)

a)	Technique for autonomous navigation of mobile robots	i)
b)	Technique to describe the sum of errors between the measured pixel coordinates and the re-projected pixel coordinates	ii)
c)	Technique that predicts and tracks the location of a person or object	iii)
d)	Technique for use of motion sensors to determine the robot's change in position relative to some known position	iv)

- ☐ a)-iv), b)-i), c)-ii), d)-iii)
- ☒ a)-ii), b)-iv) , c)-i), d)-iii)
- ☐ a)-ii), b)-iii) , c)-iv), d)-i)
- ☐ a)-iv) b)-i), c)-ii), d)-iii)

45

Which of the following factor does not affect the intrinsic parameters of a camera model?

(1 Point)

- ☐ Focal length
- ☐ Offset of optical center
- ☒ Exposure
- ☐ None of the above

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The image in a pinhole camera is

(1 Point)

- ☒ Inverted, i.e. upside down
- ☒ Real i.e. can be obtained on the screen
- ☒ The same colour as the object
- ☒ Smaller, equal or bigger than the object
- ☐ The nature of image depends on the shape of pinhole

47

Which of the following statement(s) is/are FALSE?

(1 Point)

- ☐ Essential matrix(E) is the product of Translation matrix(T) and Rotational matrix(R)
- ☐ Translation matrix(T) is a skew -symmetric matrix and Rotational matrix(R) is an Orthonormal matrix
- ☒ Translation matrix(T) and Rotational matrix(R) can be decomposed from Essential matrix(E) by Singular Value Decomposition

- ☐ If we take any element $a(i,j)$ from Rotational matrix(R), $a(i,j)=-a(j,i)$

48

In the context of the properties of the rotation matrix for camera calibration, which statement(s) is/are TRUE

(1 Point)

- ☐ Rotation matrix is not a square matrix.
- ☒ Rotation matrix is a orthonormal matrix.
- ☒ For rotation matrix R, Transpose (R)=Inverse (R)
- ☐ None of the above.

49

Let $f(x) = [2 \ 4 \ 2 \ 6 \ 4 \ 8 \ 4 \ 6]$, the $f'(x)$ using backward difference is

(1 Point)

- ☐ $2 \ 0 \ 2 \ 4 \ 2 \ 4 \ -2 \ 4$
- ☐ $2 \ 4 \ 2 \ 4 \ -2 \ 4 \ 2 \ 2$
- ☒ $0 \ 2 \ -2 \ 4 \ -2 \ 4 \ -4 \ 2$
- ☐ $0 \ -2 \ 2 \ -4 \ 2 \ -4 \ 4 \ -2$

50

In a noise free environment, the no. of point correspondences are required to constraint the 2D Homography (H) $\{x_i \leftrightarrow x'_i\}$ between two given images.

(1 Point)

- ☐ Two points
- ☐ Three points
- ☒ Four points

☐ Eight points

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