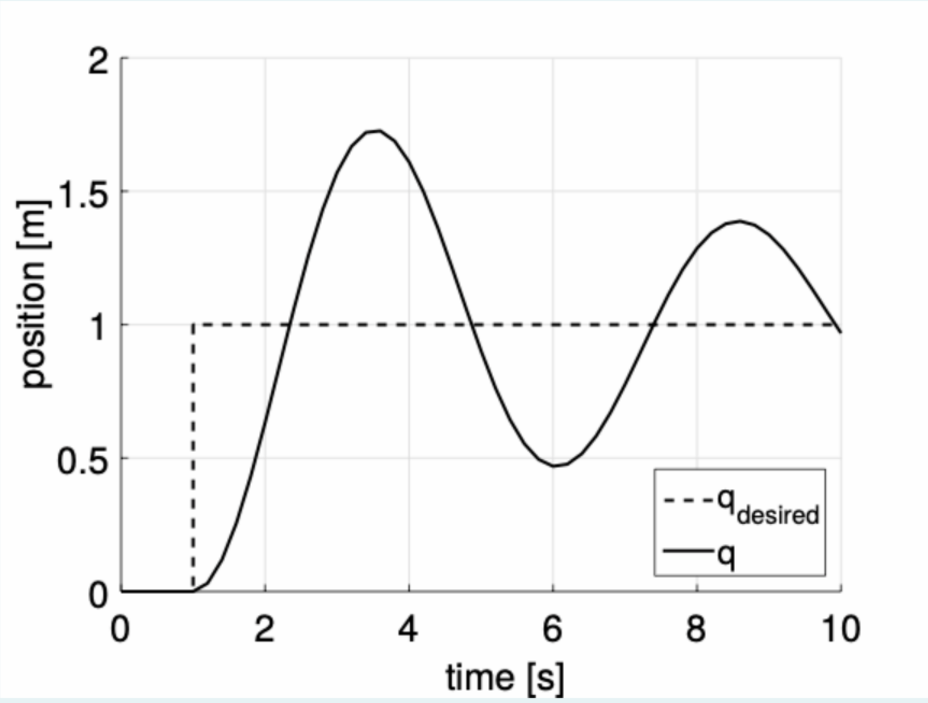
Robotics Online Exam WS 2020/21

Frage **1**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

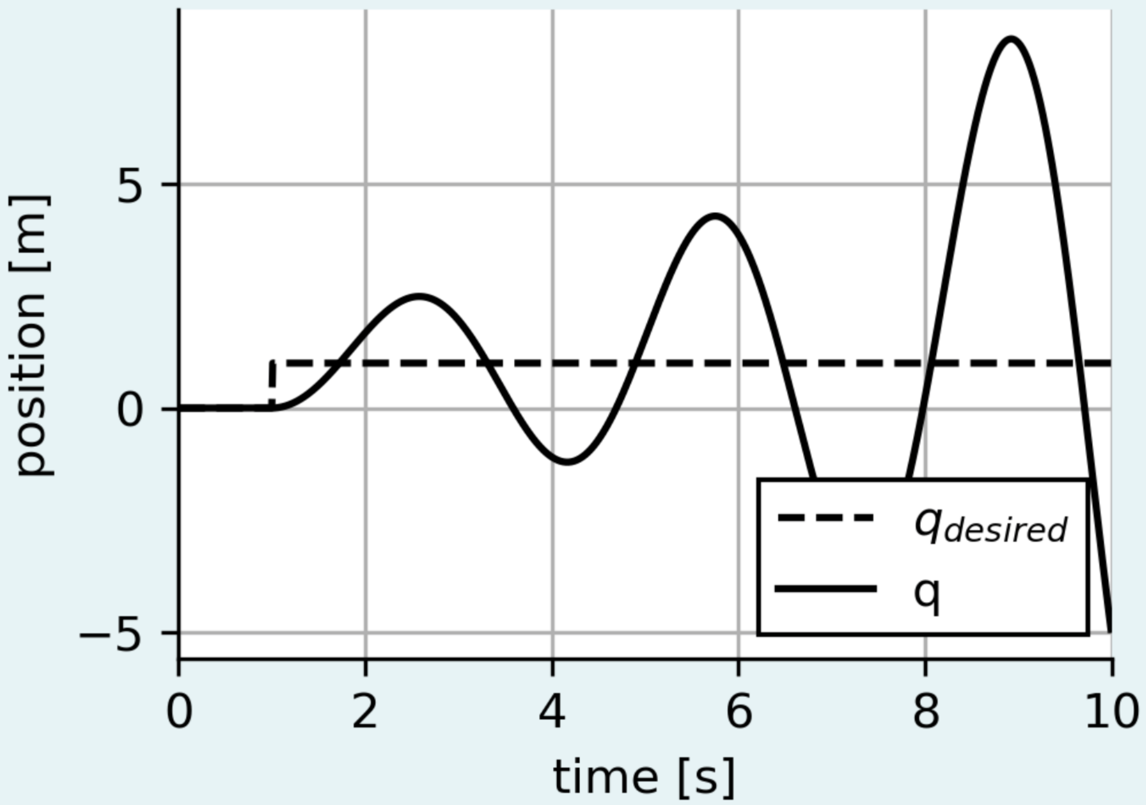


- a. Critically Damped
- b. Unstable
- c. None of these
- d. Under-damped
- e. Over-damped

Your answer is correct.

Die richtige Antwort ist:
Under-damped

Frage **2**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

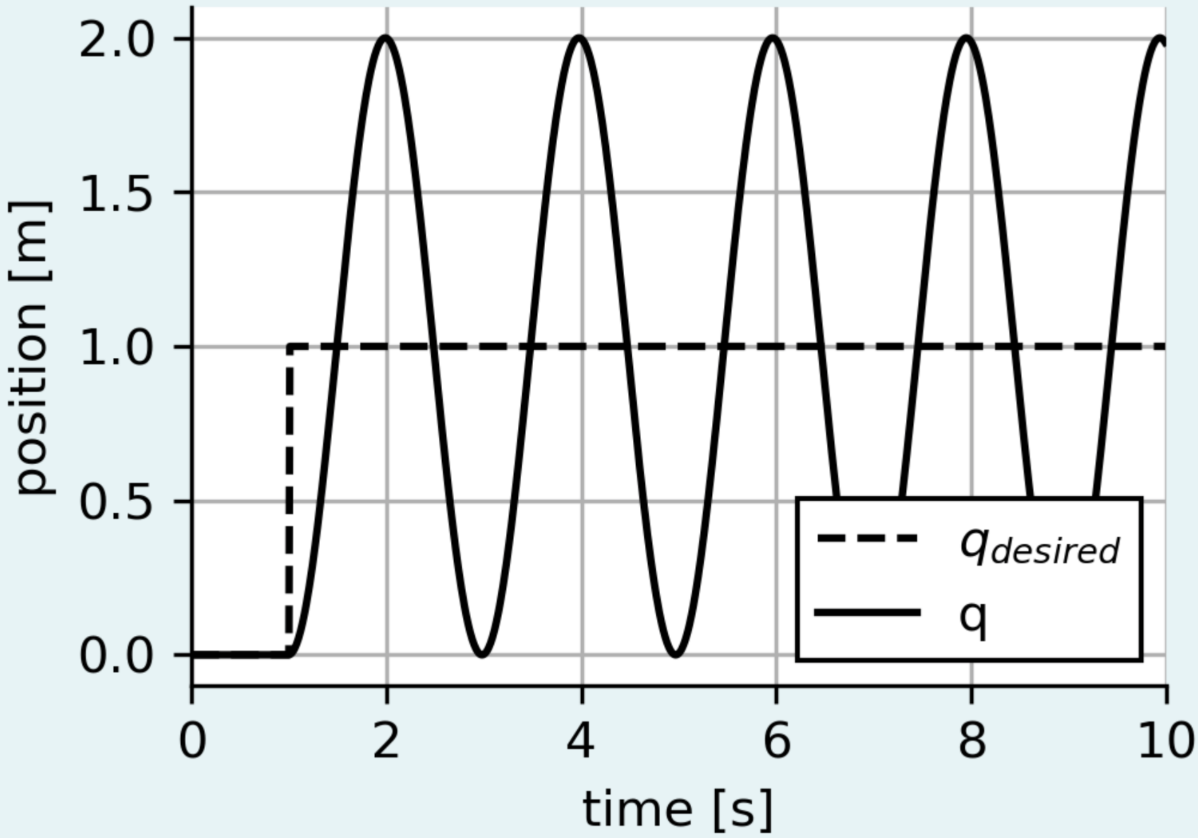


- a. None of these
- b. Over-damped
- c. Unstable (selected)
- d. Under-damped
- e. Critically Damped

Your answer is correct.

Die richtige Antwort ist:
Unstable

Frage **3**
Falsch
Erreichte Punkte 0,00 von 1,00
Frage markieren



- a. None of these
- b. Critically Damped
- c. Under-damped
- d. Unstable (selected)
- e. Over-damped

Your answer is incorrect.

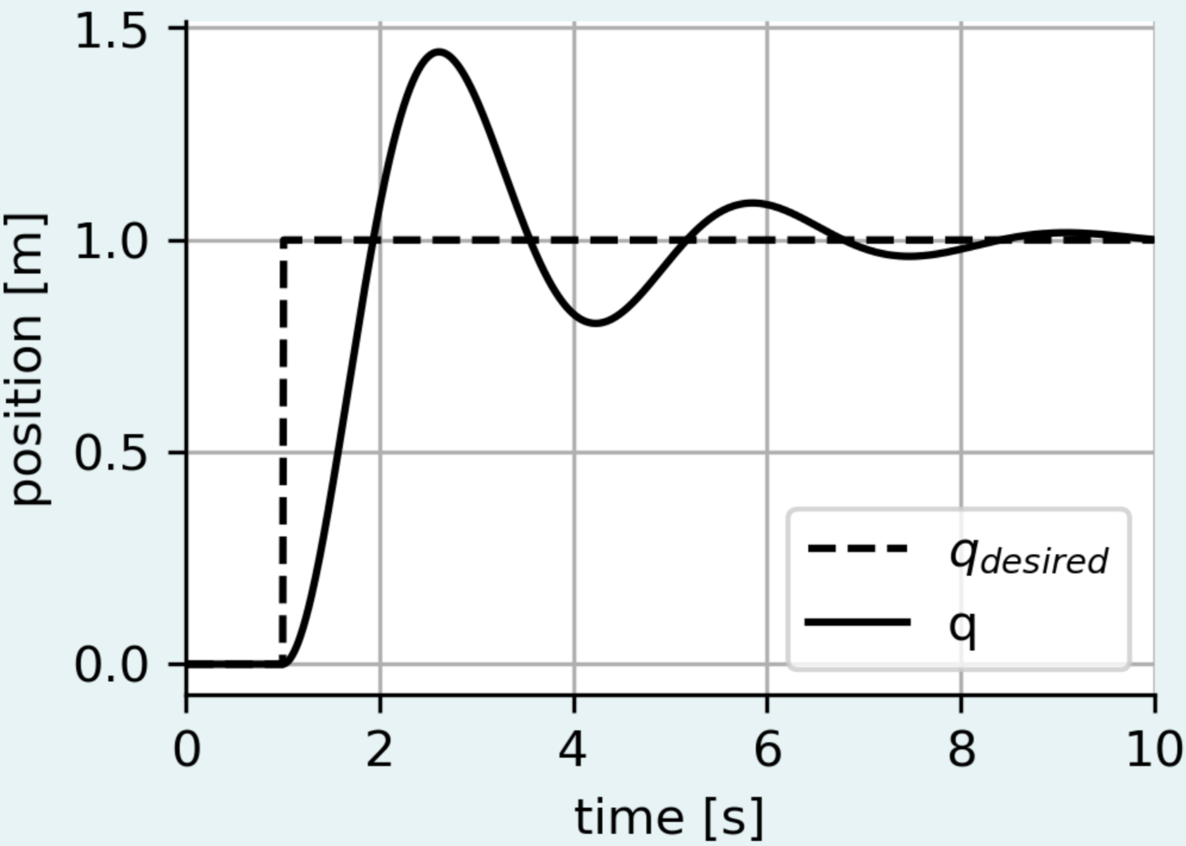
Die richtige Antwort ist:
None of these

Frage **4**

Richtig

Erreichte Punkte 1,00 von 1,00

Frage markieren



- a. $\zeta = 1.1, \omega_n = 0.7$
- b. $\zeta = 0.25, \omega_n = 2$
- c. $\zeta = -0.5, \omega_n = 0.5$
- d. $\zeta = 0.0, \omega_n = 0.6$

Your answer is correct.

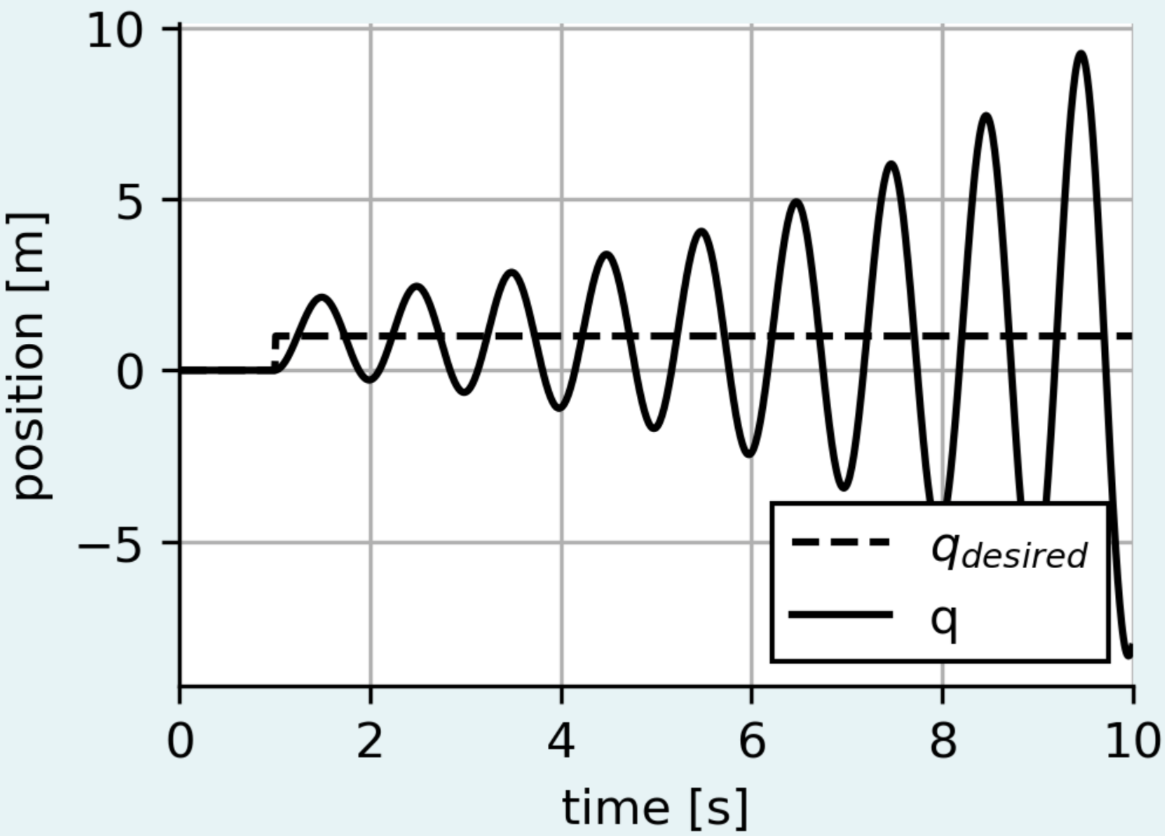
Die richtige Antwort ist:
$\zeta = 0.25, \omega_n = 2$

Frage **5**

Richtig

Erreichte Punkte 1,00 von 1,00

Frage markieren



- a. $\zeta = 0.0, \omega_n = 0.3$
- b. $\zeta = 2.0, \omega_n = 0.2$
- c. $\zeta = -0.04, \omega_n = 6.3$
- d. $\zeta = 0.05, \omega_n = 0.5$

Your answer is correct.

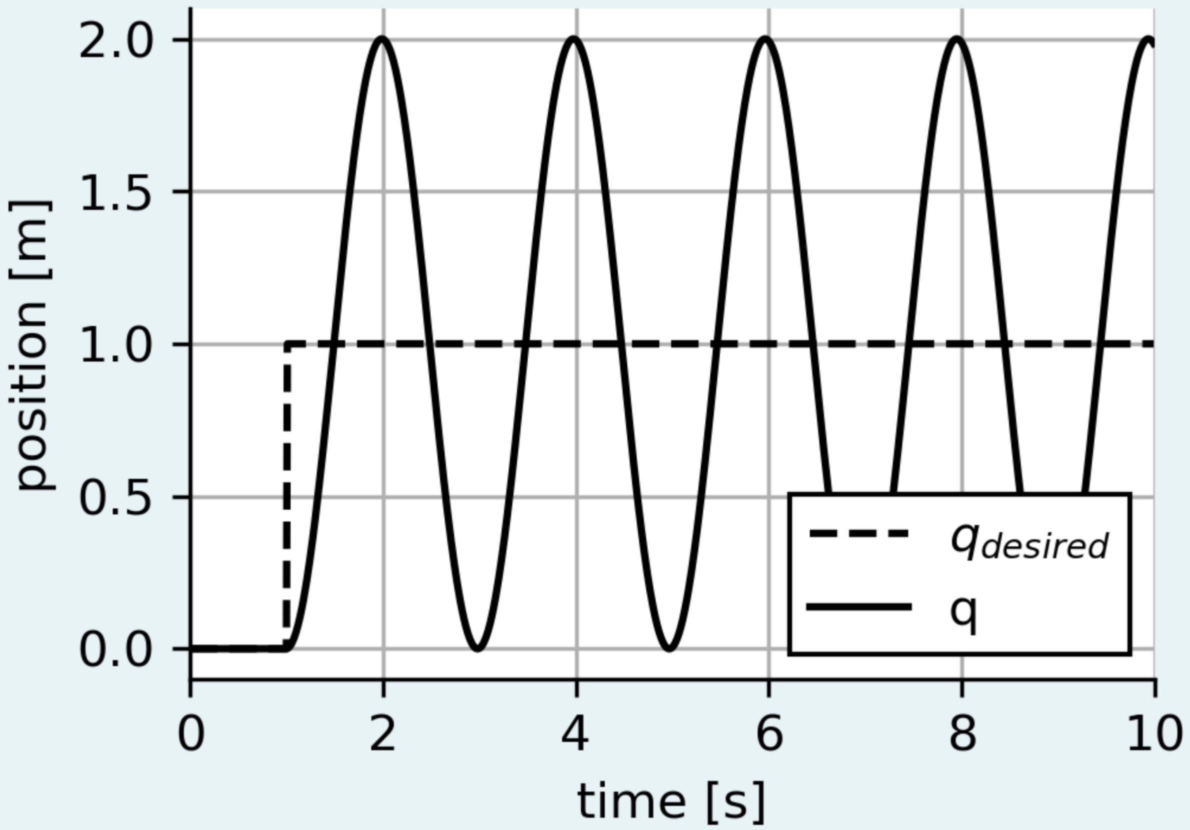
Die richtige Antwort ist:
$\zeta = -0.04, \omega_n = 6.3$

Frage **6**

Richtig

Erreichte Punkte 1,00 von 1,00

Frage markieren



a. $\zeta = 2.0, \omega_n = 0.2$

b. $\zeta = -0.05, \omega_n = 0.4$

c. $\zeta = 0.0, \omega_n = 3.2$

d. $\zeta = 0.05, \omega_n = 0.5$

Your answer is correct.

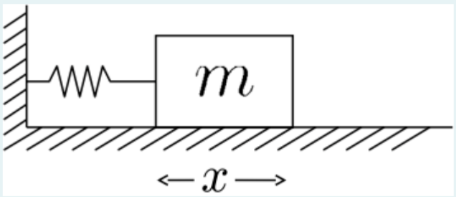
Die richtige Antwort ist:
$\zeta = 0.0, \omega_n = 3.2$

Frage **7**

Richtig

Erreichte Punkte 4,00 von 4,00

Frage markieren



The motion of a robot with a single prismatic joint can be modeled as: $m\ddot{q} + b\dot{q} + kq = f$,
which depends on mass $m = 2$, stiffness $k = 4$, and friction $b = 4$.

We want to set the control force $f = -k_p x - k_v \dot{x}$ so that the controlled system is critically damped and has a closed-loop stiffness of $k' = 8$.
(Hint: a natural system is critically damped when $b = 2\sqrt{mk}$.)

How do you choose the values of k_p and k_v?

- a. $k_p = 8$ and $k_v = 2$
- b. $k_p = 2$ and $k_v = 4$
- c. $k_p = 8$ and $k_v = 6$
- d. $k_p = 2$ and $k_v = 4$
- e. $k_p = 4$ and $k_v = 2$
- f. $k_p = 4$ and $k_v = 4$ (selected)

Your answer is correct.

Die richtige Antwort ist:
$k_p = 4$ and $k_v = 4$

Information

Frage markieren

You are given a different robot with a single revolute joint. However, this robot's dynamics are very complicated and can be modeled as:

$m(q)\ddot{q} + b(q)\dot{q} + kq + c(q, \ddot{q}) + g(q) = \tau$

Here, b indicates friction, k is the stiffness, c encodes centrifugal and coriolis forces, and g represents gravity.
An additional control torque τ is applied.
We want to use control-law partitioning for controlling this robot, i.e. $\tau = \alpha\tau' + \beta$, so that $\tau' = \ddot{q} = -k_p x - k_v \dot{x}$ is a unit-mass system.

Frage **8**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

What is α?

- (x) a. $\alpha = m(q)$
- ( ) b. $\alpha = (b - k_p)q(k - k_v)\dot{q}$
- ( ) c. $\alpha = \ddot{q}$
- ( ) d. $\alpha = m(q)q + b(q)\dot{q} + kq$

Your answer is correct.

Die richtige Antwort ist:
$\alpha = m(q)$

Frage **9**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

What is β?

- ( ) a. $\beta = m(q)q + b(q)\dot{q} + kq + c(q, \ddot{q} + g(q)$
- (x) b. $\beta = b(q)\dot{q} + kq + c(q, \ddot{q} + g(q)$
- ( ) c. $\beta = m(q)q$
- ( ) d. $\beta = k_v(b(q)\dot{q}) + k_p(kq + c(q, \ddot{q}) + g(q))$

Your answer is correct.

Die richtige Antwort ist:
$\beta = b(q)\dot{q} + kq + c(q, \ddot{q} + g(q)$

Frage **10**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

When applying control-law partitioning to control the robot, how can you achieve critical damping?

- ( ) a. $k_p = \alpha$ and $k_v = \beta$
- ( ) b. $\ddot{q} = k_v(b(q)\ddot{q}) + k_p(kq + c(q, \ddot{q}) + g(q))$
- ( ) c. $k_p = \alpha\ddot{q} + \beta$
- ( ) d. impossible to do analytically
- (x) e. $k_v = 2\sqrt{k_p}$

Your answer is correct.

Die richtige Antwort ist:
$k_v = 2\sqrt{k_p}$

Frage **11**
Richtig
Erreichte Punkte 3,00 von 3,00
Frage markieren

Imagine you are on the International Space Station and you want to find out your own body mass.
Luckily, there is a spring with a known resting position and a known spring constant. One end of this spring is attached to the space station while you are at the other end.

First, you compress and lock the spring. Finally, you release the spring.

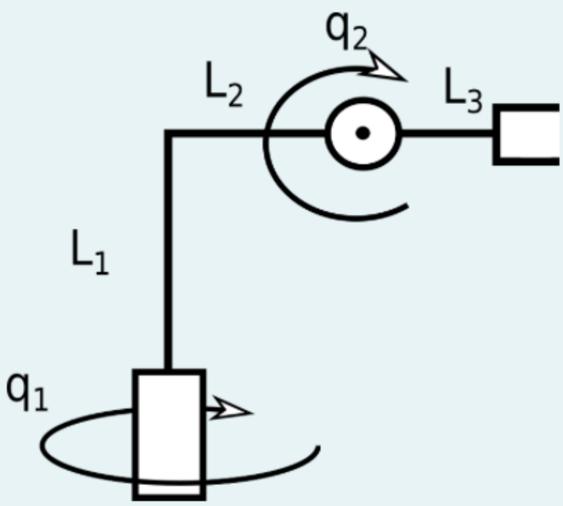
Select true if a method lets you measure your mass and false if it does not.
(Ignore air resistance.)

True	False		
◉ ✓	○ ✗	The spring pushes you away and you float out of the station into space (some other space ship picks you up later, hopefully). Ground control measures the acceleration of the space station which has a known mass and your smartphone, which has a built-in inertial measurement unit (IMU), measures your acceleration.	✔
◉ ✓	○ ✗	You hold on tightly to your end of the spring. During oscillation, you rub your body against a surface which creates friction of known intensity. You measure how long it takes until the amplitude of oscillation falls below a specific threshold.	✔
◉ ✓	○ ✗	The spring pushes you away and you float to the opposite wall at a known distance while your colleague measures the time it takes you to float there.	✔
◉ ✓	○ ✗	The spring pushes you away. At the exact same time, at the opposite wall at a known distance, your colleague, for whom the mass is known, releases her own spring which is an exact copy of yours. Another colleague measures the time before you two hit each other on your trajectories.	✔
◉ ✓	○ ✗	You hold on tightly to your end of the spring and count the number of oscillations per second.	✔

Information

Frage markieren

Consider a 2-DOF robot arm with two rotational joints, q_1 and q_2 (see figure below). The joints have ranges $[0, 2\pi]$. The links have lengths L_1, L_2, and L_3. You can ignore self-collisions.



Frage **12**

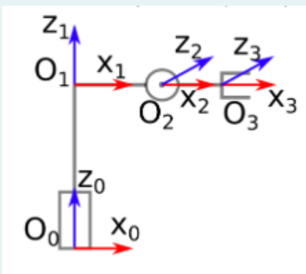
Falsch

Erreichte Punkte 0,00 von 2,00

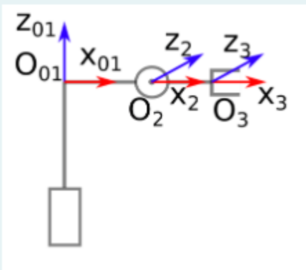
Frage markieren

Select the frame assignment that follows the Denavit-Hartenberg convention:

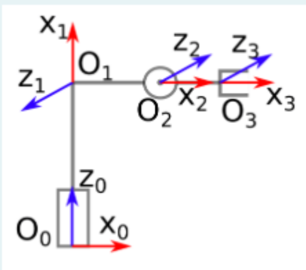
a.



b.

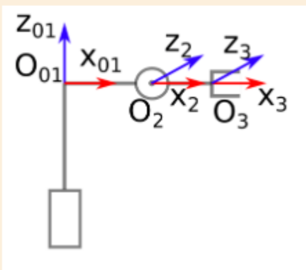


c.



Your answer is incorrect.

Die richtige Antwort ist:



Frage **13**

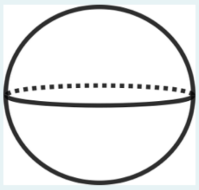
Falsch

Erreichte Punkte 0,00 von 2,00

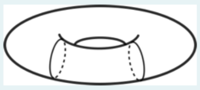
Frage markieren

The lengths of the links are given by $L_1 = 10$ cm, $L_2 = 5$ cm, and $L_3 = 8$ cm. The joints have no rotational limits. Which geometric shape best represents the robot's work space?

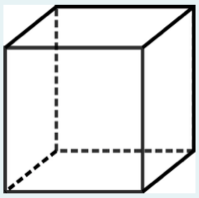
a.



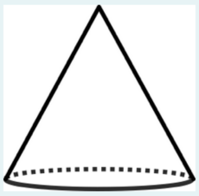
b.



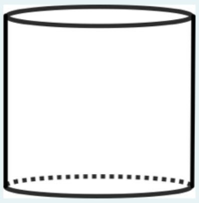
c.



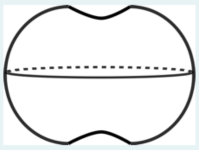
d.



e.



f.



Your answer is incorrect.

Die richtige Antwort ist:

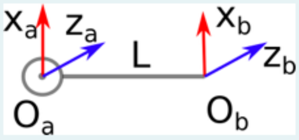
Frage **14**

Richtig

Erreichte Punkte 2,00 von 2,00

Frage markieren

q_a is a rotational jointat at O_a. Select the correct homogeneous transformation ${}^a_bT$ from frame b to frame a:



a. $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & L - q_a \\ 0 & 0 & 0 & 1 \end{bmatrix}$

b. $\begin{bmatrix} cos(q_a) & -sin(q_a) & 0 & 0 \\ sin(q_a) & cos(q_a) & 0 & L \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

c. $\begin{bmatrix} cos(q_a) & -sin(q_a) & 0 & 0 \\ 0 & 0 & -1 & L_3 \\ -sin(q_a) & cos(q_a) & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

d. $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & L \\ 0 & 0 & 0 & 1 \end{bmatrix}$

Your answer is correct.

Die richtige Antwort ist:

$\begin{bmatrix} cos(q_a) & -sin(q_a) & 0 & 0 \\ sin(q_a) & cos(q_a) & 0 & L \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

Frage **15**
Teilweise richtig
Erreichte Punkte 2,00 von 4,00
Frage markieren

Which of the following statements are true/false?

True	False		
○	◉	$R^T = R^{-1}$ if R is a rotation matrix	✗
○	◉	Unit quaternions represent 3D translations.	✓
○	◉	Given three frames A, B, and C, the homogeneous transformation from frame C to frame B can be written as ${}^C_BT = {}^A_CT^{-1} \cdot {}^A_BT$	✗
◉	○	All homogeneous transformationa are affine transformations.	✓

$R^T = R^{-1}$ if R is a rotation matrix

: True

Unit quaternions represent 3D translations.: False

Given three frames A, B, and C, the homogeneous transformation from frame C to frame B can be written as ${}^C_BT = {}^A_CT^{-1} \cdot {}^A_BT$

: True

All homogeneous transformationa are affine transformations.: True

Frage **16**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

Which of the following statement is true about homogenous transformations. There is only one correct answere.

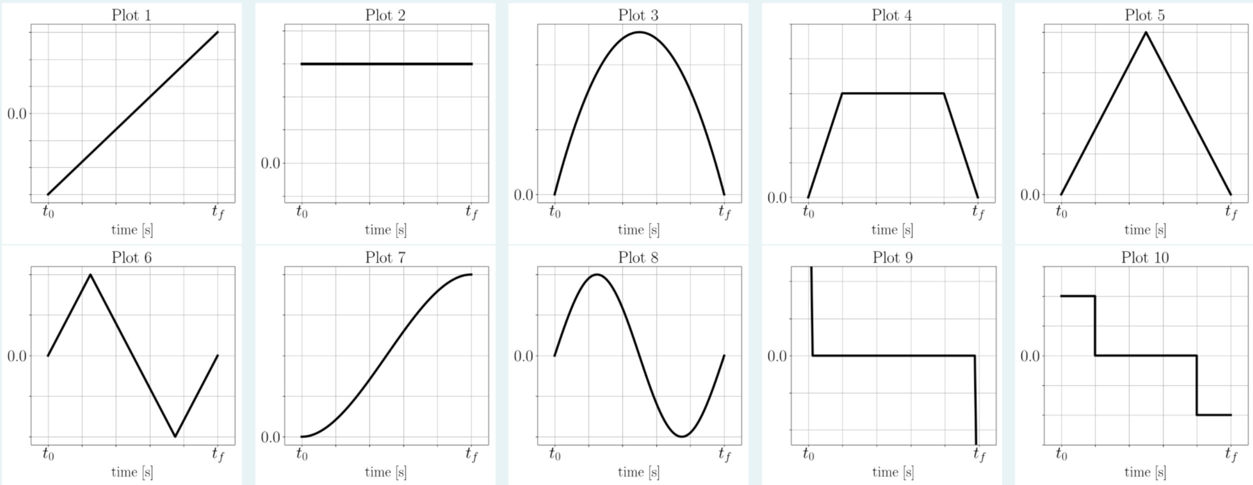
- ◉ a. Rotation can be represented as a homogeneous transformation.
- ○ b. Sheering can be represented as a homogeneous transformation.
- ○ c. Scaling can be represented as a homogeneous transformation.

Your answer is correct.

Die richtige Antwort ist:
Rotation can be represented as a homogeneous transformation.

Information
Frage markieren

When we interpolate two joint positions, different interpolation methods result in different profiles for joint position, joint velocity, and joint acceleration.
The figure below shows ten different plots. Each plot could show either the desired position q, velocity $\dot{q}$, or acceleration $\ddot{q}$ for a single robot joint.



In the questions below, please *select the matching plot* for each of the specified trajectory interpolation methods and joint parameters below.

Notes:

- Focus on the *qualitative* shape of the plot.
- Assume $q(t_0) \neq q(t_f)$.
- You can select the same plot more than once.

Frage **17**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

joint **acceleration** $\ddot{q}$ for a **linear** interpolation between two points: Plot 9 ✔

Frage **18**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

joint **position** q for a **cubic spline** interpolation between two points: Plot 7 ✔

Frage **19**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

joint **acceleration** $\ddot{q}$ for a **cubic spline** interpolation between two points: Plot 1 ✔

Frage **20**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

joint **position** q for a **linear** interpolation between two points: Plot 1 ✔

Frage **21**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

joint **velocity** $\dot{q}$ for a **linear** interpolation between two points: Plot 2 ✔

Frage **22**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

joint **velocity** $\dot{q}$ for a **parabolic blend** interpolation between two points: Plot 4 ✔

Frage **23**

Richtig

Erreichte Punkte 3,00 von 3,00

Frage markieren

The following function computes the forward kinematics of a manipulator with two degrees of freedom, $q1$ and $q2$:

$$F(q) = \begin{pmatrix} x \\ y \\ \theta \end{pmatrix} = \begin{pmatrix} L_2 \cdot \sin(q_2) \\ q_1 + 2 + L_2 \cdot \cos(q_2) \\ q_2 \end{pmatrix}$$

Please derive the Jacobian matrix for the above robot arm.

Hint: $\sin'(x) = \cos(x) \qquad \cos'(x) = -\sin(x)$

Wählen Sie eine Antwort:

- ○ $\begin{pmatrix} L_2 \cdot \cos(q_2) & 0 \\ -L_2 \cdot \sin(q_2) & 1 \\ 1 & 0 \end{pmatrix}$
- ○ $\begin{pmatrix} L_2 \cdot \cos(q_2) & -L_2 \cdot \sin(q_2) & 1 \\ 0 & q_1 & 0 \end{pmatrix}$
- ◉ $\begin{pmatrix} 0 & L_2 \cdot \cos(q_2) \\ 1 & -L_2 \cdot \sin(q_2) \\ 0 & 1 \end{pmatrix}$
- ○ $\begin{pmatrix} -L_2 \cdot \sin(q_2) & L_2 \cdot \cos(q_2) & 1 \\ 0 & 1 & 0 \end{pmatrix}$

Your answer is correct.

Die richtige Antwort ist:

$$\begin{pmatrix} 0 & L_2 \cdot \cos(q_2) \\ 1 & -L_2 \cdot \sin(q_2) \\ 0 & 1 \end{pmatrix}$$

Information

Frage markieren

Select the one correct choice for each of the the following questions about the Jacobian J of a robot arm. Assume that J^{-1} is computable.

Frage **24**

Richtig

Erreichte Punkte 1,00 von 1,00

Frage markieren

J^{-1} maps from :

Wählen Sie eine Antwort:

- ○ None of the above.
- ○ Forces in operational space $\mapsto$ torques in configuration space
- ○ Torques in configuration space $\mapsto$ forces in operational space
- ◉ End-effector velocity $\mapsto$ joint velocity
- ○ End-effector pose $\mapsto$ Joint configuration
- ○ Joint velocity $\mapsto$ end-effector velocity

Your answer is correct.

Die richtige Antwort ist:
End-effector velocity $\mapsto$ joint velocity

Frage **25**

Falsch

Erreichte Punkte 0,00 von 1,00

Frage markieren

J^{-T} maps to:

Wählen Sie eine Antwort:

- ○ Joint velocity **from** end-effector velocity
- ○ Forces in operational space **from** torques in configuration space
- ○ End-effector pose **from** joint configuration
- ○ End-effector velocity **from** joint velocity
- ○ None of these.
- ◉ Torques in configuration space **from** forces in operational space

Your answer is incorrect.

Die richtige Antwort ist:
Forces in operational space **from** torques in configuration space

Frage **26**

Richtig

Erreichte Punkte 1,00 von 1,00

Frage markieren

Consider a (planar) serial kinematic chain that uses only prismatic joints. Assuming a task space described by (x, y, θ), which of the following statements are true?

Wählen Sie eine Antwort:

- ◉ Its Jacobian is singular.
- ○ Its Jacobian has only positive or zero-valued entries.
- ○ Its Jacobian is full-rank.
- ○ Its Jacobian has only negative or zero-valued entries.
- ○ None of these.

Your answer is correct.

Die richtige Antwort ist: Its Jacobian is singular.

Frage **27**

Richtig

Erreichte Punkte 1,00 von 1,00

Frage markieren

Assume a 6×6 Jacobian J for a 6-joint robot arm. The task space is described by the end-effector's 3D position and orientation.

The 2nd row of J contains (assume joints and rows/columns are indexed from 1):

Wählen Sie eine Antwort:

- ○ None of these.
- ◉ The y-component of the end-effector velocity as a function of all joint velocities
- ○ The rotational parts of the end-effector velocity when the 2nd joint moves
- ○ The translational parts of the end-effector velocity when the 2nd joint moves
- ○ The complete end-effector velocity vector when the 2nd joint moves

Your answer is correct.

Die richtige Antwort ist: The y-component of the end-effector velocity as a function of all joint velocities

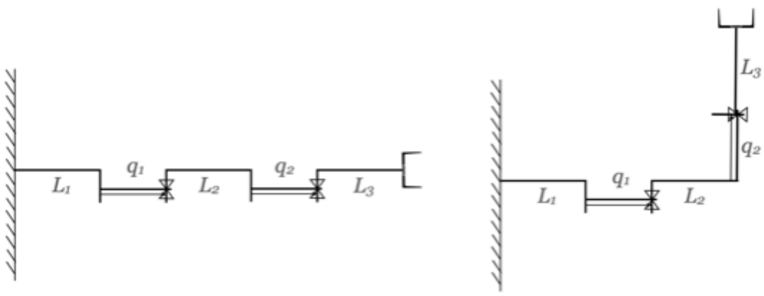
Frage **28**

Richtig

Erreichte Punkte 2,00 von 2,00

Frage markieren

Below are two different kinematic chains. The task space is (x, y, θ) for each robot.



(a) a 2-DoF manipulator

(b) a 2-DoF manipulator

For the general case, match each kinematic chain configuration with the *rank* of its Jacobian.

(a) 1 ✔

(b) 2 ✔

Your answer is correct.

Die richtige Antwort ist: (a)
→ 1,
(b)

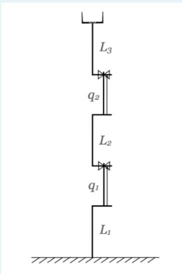
→ 2

Frage **29**

Richtig

Erreichte Punkte 2,00 von 2,00

Frage markieren



Drag entries onto the matrix to assemble the Jacobian for this kinematic chain.

$$\begin{pmatrix} 0 & 0 \\ 1 & 1 \\ 0 & 0 \end{pmatrix}$$

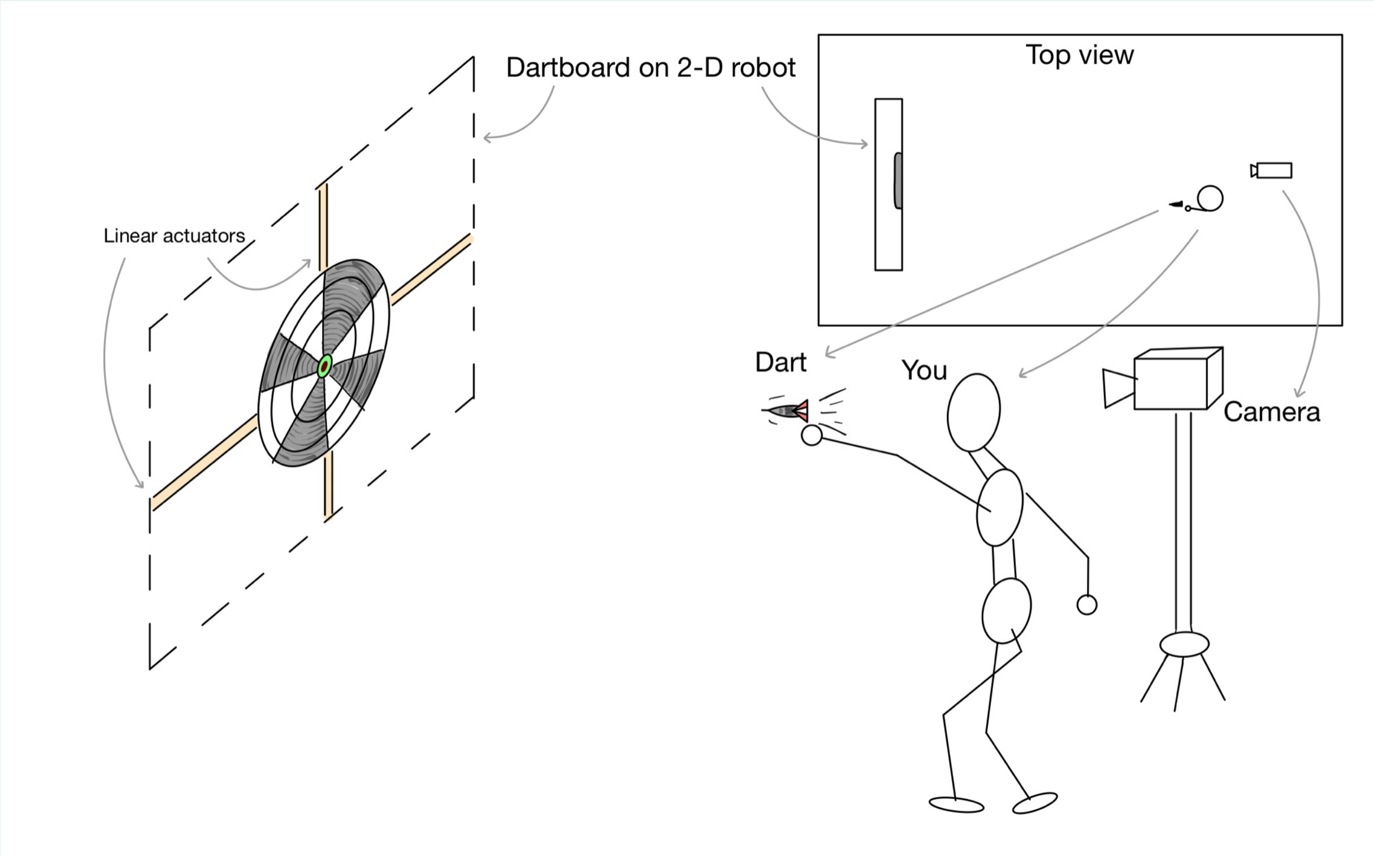
1	0	L_1	L_2	$\cos(q_1)$	$\cos(q_2)$	$L_1 \cdot \cos(q_1)$	$L_2 \cdot \cos(q_2)$	$\sin(q_1)$	$\sin(q_1)$
				$L_1 \cdot \sin(q_1)$	$L_2 \cdot \sin(q_2)$				

Your answer is correct.

Information

Frage markieren

Following is a schematic of a "dart-catching" robot purposed for you. Your first task is to program the robot to catch your dart in the bullseye **every time**.



Following are the details of your setup:

1. The robot operates only in the X-Y axes
2. Consider all components (i.e., camera, robot, controller etc.) are fast enough to catch darts thrown at any humanly possible speed
3. The camera parameters including its distance is perfectly known
4. There are "dart-detector" and "bullseye-detector" feature detectors available, that can find the 2-D locations of dart arrow and dart board's bullseye (center of the dart board) respectively

Following are the pre-conditions and assumptions for your task:

1. You must **only** use visual servoing for this task. You can ignore ballistics, and thus moving the board continuously to meet the arrow is sufficient
2. You will throw the dart into robot's working area. That is, your throws won't be so off that the robot can't catch it

Frage **30**

Teilweise richtig

Erreichte Punkte 3,00 von 4,00

Frage markieren

Arrange the steps in order to compose a visual servoing loop

Step 1 Grab/acquire image from camera ✔

Step 2 Using the given feature detector, find dart and bullseye in the image space ✔

Step 3 Calculate feature error ✔

Step 4 Calculate Jacobian mapping from end-effector velocity to feature velocity ✖

Step 5 Calculate desired end-effector velocity ✖

Step 6 Calculate desired end-effector velocity ✔

Step 7 Calculate desired end-effector pose ✔

Step 8 Instruct robot to move to intended pose ✔

Your answer is partially correct.

Sie haben 6 richtig ausgewählt.
Die richtige Antwort ist:
Step 1 → Grab/acquire image from camera,

Step 2 → Using the given feature detector, find dart and bullseye in the image space,

Step 3 → Calculate feature error,

Step 4 → Calculate desired feature velocity,

Step 5 → Calculate Jacobian mapping from end-effector velocity to feature velocity,

Step 6 → Calculate desired end-effector velocity,

Step 7 → Calculate desired end-effector pose,

Step 8 → Instruct robot to move to intended pose

Frage **31**

Richtig

Erreichte Punkte 2,00 von 2,00

Frage markieren

If the image Jacobian J describes the following relationship:

$\dot{i} = J\dot{e}$

where $\dot{i}$ is the first derivative of image coordinates w.r.t time, and $\dot{o}$ is the first derivative of end-effector coordinates w.r.t time in task space.

For the dart-catching robot, the size of the image Jacobian J is a $k \times n$ matrix, where k is 2 ✔ and n is 2 ✔ .

Your answer is correct.

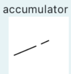
Die richtige Antwort lautet:
If the image Jacobian J describes the following relationship:

$\dot{i} = J\dot{e}$
where $\dot{i}$ is the first derivative of image coordinates w.r.t time, and $\dot{o}$ is the first derivative of end-effector coordinates w.r.t time in task space.

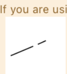
For the dart-catching robot, the size of the image Jacobian J is a $k \times n$ matrix, where k is [2] and n is [2].

Frage **32**
Teilweise richtig
Erreichte Punkte 2,00 von 3,00
Frage markieren

You find out that the "bullseye detector" you've been given in the setup doesn't perform well. For that, you want to use Hough transform to improve the image processing pipeline. But first, you have to prove your understanding of the Hough transform. Please select True/False for each option below

True	False		
◉ ✓	○ ✗	A. Hough transform involves detection of basic features/shapes by a voting procedure in a parameter space	✓
○ ✗	◉ ✓	B. If you are using Hough transform for lines, the following (broken) line results in two peaks in the accumulator 	✓
○ ✓	◉ ✗	C. Hough transform could be used to not only detect simple shapes such as lines and circles, but also any closed shape in the 2-D plane	✗

Hough transform involves detection of basic features/shapes by a voting procedure in a parameter space: True
If you are using Hough transform for lines, the following (broken) line results in two peaks in the accumulator


: False
Hough transform could be used to not only detect simple shapes such as lines and circles, but also any closed shape in the 2-D plane: True

Frage **33**
Richtig
Erreichte Punkte 1,00 von 1,00
Frage markieren

Alright, now with your improvements to the "bullseye detector", your dart-catching robot catches your dart every time you throw at it, exactly on the bullseye! Now you show off your amazing dart-throwing skills to a friend and challenge them to hit the bullseye.

To annoy them, **you should make the robot NEVER catch your friend's dart on the bullseye**, BUT in the space between second and third ring on the dart board.

If you could change one and only one step from your visual servoing control loop you answered initially which of the following steps would you choose? [Calculate feature error] ✓

Remember, you should make sure that your friend will miss the bullseye every single time they throw. They shouldn't even hit the bullseye by chance.

Your answer is correct.

Die richtige Antwort lautet:
Alright, now with your improvements to the "bullseye detector", your dart-catching robot catches your dart every time you throw at it, exactly on the bullseye! Now you show off your amazing dart-throwing skills to a friend and challenge them to hit the bullseye.
To annoy them, **you should make the robot NEVER catch your friend's dart on the bullseye**, BUT in the space between second and third ring on the dart board.

If you could change one and only one step from your visual servoing control loop you answered initially which of the following steps would you choose? [Calculate feature error]

Remember, you should make sure that your friend will miss the bullseye every single time they throw. They shouldn't even hit the bullseye by chance.

Frage **34**

Vollständig

Erreichte Punkte 2,00 von 2,00

Frage markieren

Please elaborate how your chosen step above would allow you to achieve the feat. Please answer in no more than 2-3 sentences.

the detected circle should not be in the center of the image but such that the center covers the second/third ring. This results in a different feature error than before.

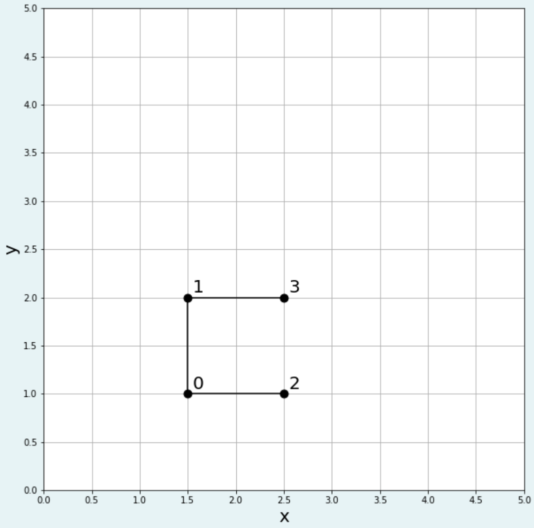
Kommentar:
yes

Frage **35**

Richtig

Erreichte Punkte 2,00 von 2,00

Frage markieren



The figure shows a tree generated by the RRT algorithm in a two-dimensional configuration space (C = [0, 5] × [0, 5]) after three iterations. Node 0 indicates the root node.

Order the nodes by the size of their Voronoi regions (in ascending order)?

1. (smallest): 0 ✔

2.: 2 ✔

3.: 1 ✔

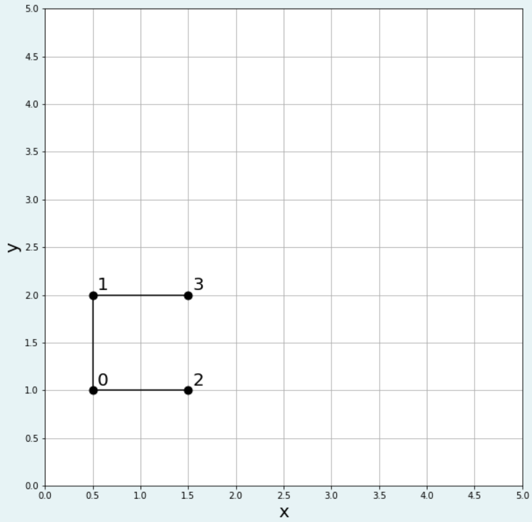
4. (largest): 3 ✔

Frage **36**

Richtig

Erreichte Punkte 2,00 von 2,00

Frage markieren



The figure shows a tree generated by the RRT algorithm in a two-dimensional configuration space ($C = [0, 5] \times [0, 5]$) after three iterations. Node 0 indicates the root node. What is the probability that node 3 is extended in the next iteration (state your answer in percent, e.g. 60%)?

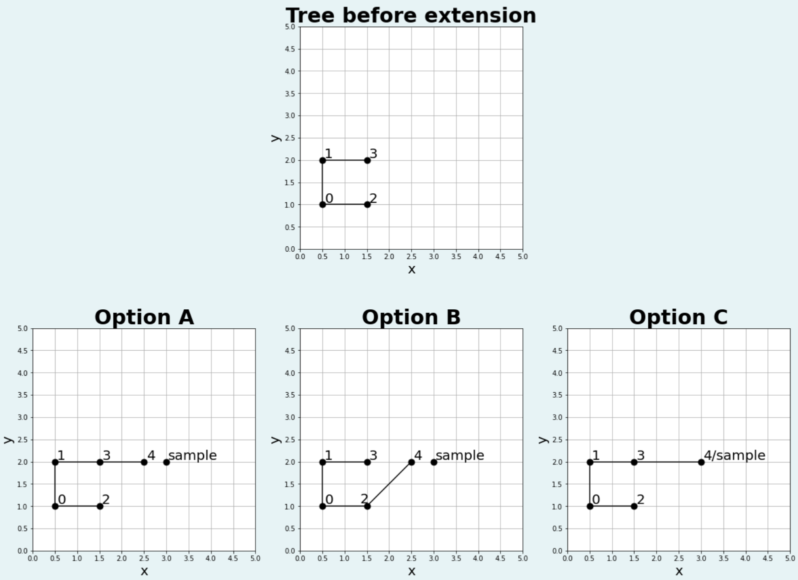
Antwort: 56

Frage **37**

Teilweise richtig

Erreichte Punkte 2,00 von 3,00

Frage markieren



The figure in the first row shows a tree generated by the RRT algorithm in a two-dimensional configuration space (C = [0, 5] × [0, 5]) after three iterations. Node 0 indicates the root node. Extend steps of length d=1 are performed.

In the next iteration, the sample (3, 2) is drawn to guide the extend step. In the three other figures above, you can see three different variants of the tree after the sampled node has been processed (Options A, B, C).

Indicate the correct execution and select the reason why the other ones are incorrect:

Option A: Correct extension ✔

Option B: Wrong neighbor selection ✖

Option C: Wrong extend step ✔

Frage **38**
Falsch

Erreichte Punkte 0,00 von 1,00

Frage markieren

The nearest-neighbor selection in the basic RRT algorithm is changed. Now - if the tree has more than one node - the second nearest neighbor is selected for an extend step. The modified RRT algorithm returns SUCCESS if a node in a small ϵ-region around the goal is added to the tree.

Yes	No		
○ ☑	◉ ✗	The modified RRT algorithm is probabilistically complete.	✗
◉ ✗	○ ☑	The modified RRT algorithm still implements the Voronoi Bias.	✗

The modified RRT algorithm is probabilistically complete.: Yes
The modified RRT algorithm still implements the Voronoi Bias.: No

Frage **39**
Richtig

Erreichte Punkte 3,00 von 3,00

Frage markieren

Below is a two-link robot with three obstacles in workspace and configuration space.

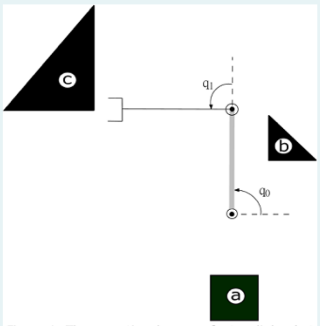


Figure 1: The operational space of a two link robot with three obstacles

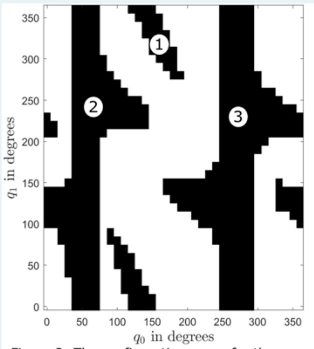


Figure 2: The configuration space for the scene from Figure 1 (we ignore self-collisions)

Please match the three obstacles a, b and c In Figure 1 to the obstacles 1, 2 and 3 in Figure 2.

(a) 3 ✔
(b) 2 ✔
(c) 1 ✔

Frage **40**
Falsch
Erreichte Punkte 0,00 von 0,50
Frage markieren

If a solution to a motion planning problem exists, the exact cell decomposition planner finds the shortest path from start to goal in a finite amount of time.

Bitte wählen Sie eine Antwort:

- (•) Wahr ✖
- ( ) Falsch

Die richtige Antwort ist 'Falsch'.

Frage **41**
Richtig
Erreichte Punkte 0,50 von 0,50
Frage markieren

Counteracting the Voronoi bias can help RRT to solve the bug-trap problem.

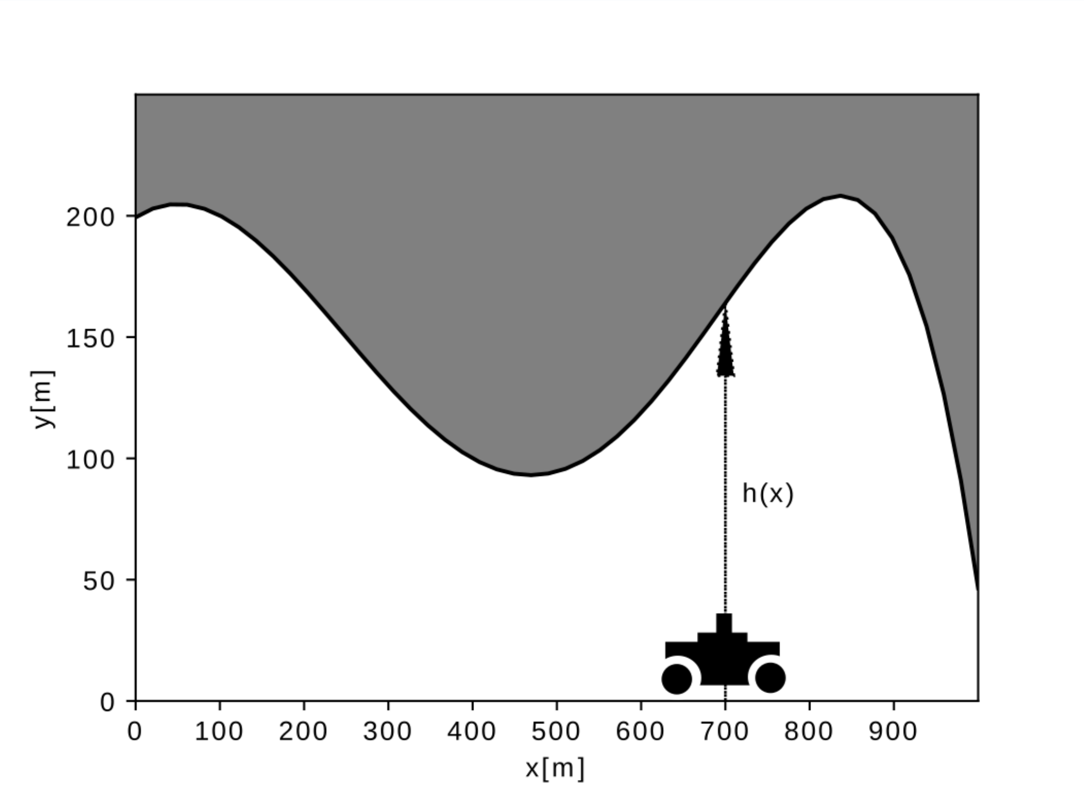
Bitte wählen Sie eine Antwort:

- (•) Wahr ✔
- ( ) Falsch

Information

Frage markieren

A robot is driving around in a cave and localizes itself by measures the height h of the cave ceiling using a laser range finder.
Using this information, it employs a particle filter with five particles to estimate its position x.



Frage **42**

Richtig

Erreichte Punkte 2,00 von 2,00

Frage markieren

The particle filter is initialized with five particles *p1* , *p2*, *p3* , *p4* , and *p5* (with uniform weights) at the following positions:

x_{p1} = 150m, x_{p2} = 190m, x_{p3} = 210m, x_{p4} = 320m, and x_{p5} = 720m.

Now, the robots moves forward (positive x-direction) until its odometry reports a movement of δ = 100m. But the odometry is not very accurate. So the motion model of its particle filter includes additive zero-mean Gaussian noise with standard deviation of 50m.
Using a random number generator, you sample five times from this probability distribution, once for each particle.You get:

40,−70, 10, −35, and −30.

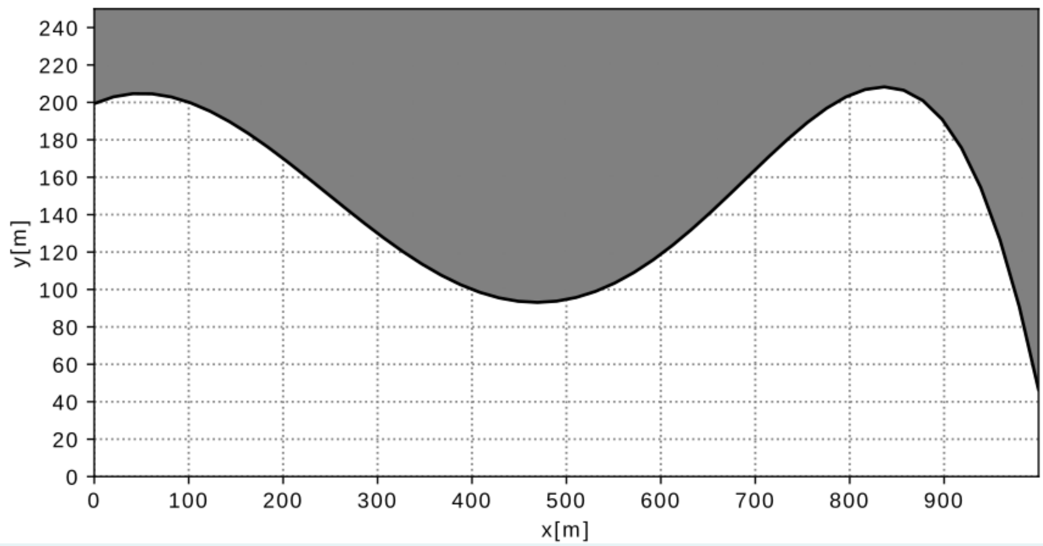
What are the new locations for the particles? Please perform a prediction step to compute the new particle positions. Use the sampled motion model noise in this order for the corresponding particles *p1* to *p5* .

- ○ a. x_{p1} = 250m, x_{p2} = 290m, x_{p3} = 310m, x_{p4} = 420m, and x_{p5} = 820m
- ◉ b. x_{p1} = 290m, x_{p2} = 220m, x_{p3} = 320m, x_{p4} = 385m, and x_{p5} = 790m
- ○ c. x_{p1} = 190m, x_{p2} = 120m, x_{p3} = 220m, x_{p4} = 285m, and x_{p5} = 690m

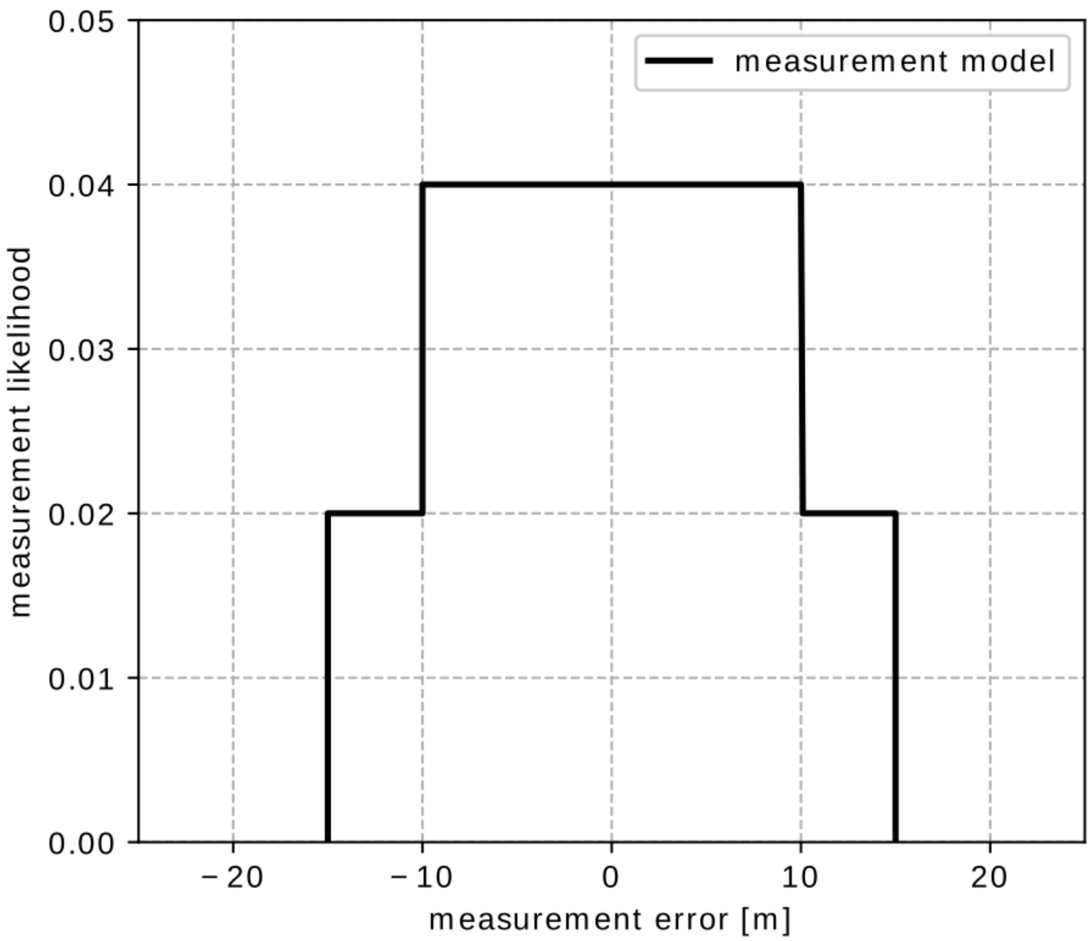
Frage **43**
Richtig
Erreichte Punkte 4,00 von 4,00
Frage markieren

The robot uses a height map of the area and a model of the measurement noise of its ceiling-height sensor to calculate the particle weights.

The following Figure shows the height-map for the cave's ceiling:



And this Figure shows the likelihood model for measurements:



After a few iterations of the particle filter the position of the five particles are:

x_{p1} = 400m, x_{p2} = 950m, x_{p3} = 300m, x_{p4} = 200m, and x_{p5} = 650m.

The ceiling-height sensor returns a measurement of

h = 135m.

Use the height map and the measurement model to compute the normalized importance factors w_{p1}, w_{p2}, w_{p3}, w_{p4}, and w_{p5} of the corresponding particles. (Note: The height is measured from floor to ceiling. Ignore any height of the robot itself.)

- (●) a. $w_{p1} = 0, w_{p2} = \frac{1}{3}, w_{p3} = \frac{1}{3}, w_{p4} = 0, w_{p5} = \frac{1}{3}$
- ( ) b. $w_{p1} = \frac{1}{3} w_{p2} = 0, w_{p3} = \frac{1}{3}, w_{p4} = \frac{1}{3}, w_{p5} = 0$
- ( ) c. $w_{p1} = \frac{1}{3} w_{p2} = 0, w_{p3} = \frac{1}{3}, w_{p4} = 0, w_{p5} = \frac{1}{3}$

Die Antwort ist richtig.

Die richtige Antwort ist:
$w_{p1} = 0, w_{p2} = \frac{1}{3}, w_{p3} = \frac{1}{3}, w_{p4} = 0, w_{p5} = \frac{1}{3}$

Frage **44**

Richtig

Erreichte Punkte 1,00 von 1,00

Frage markieren

Assume that the robot received a different measurement such that the resulting importance factors are

w_{p1} = 0.1, w_{p2} = 0.5, w_{p3} = 0.4, w_{p4} = 0, and w_{p5} = 0.

The current particle positions before resampling are

x_{p1} = 1, x_{p2} = 2, x_{p3} = 3, x_{p4} = 4, and x_{p5} = 5.

Now assume that the robot performed a resampling step and maintains the following particle set:

x_{p1} = 2, x_{p2} = 2, x_{p3} = 2, x_{p4} = 3, and x_{p5} = 3.

Wahr	Falsch		
(●)	( )	This new particle set may have been obtained by stochastic universal sampling	✔
(●)	( )	This new particle set may have been obtained by sampling for a categorical distribution ("roulette wheel sampling")	✔