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Centre de la Imatge i la Tecnologia Multimèdia

Lab 4

Affine transformations & Camera view

Due to January 12th 23:45h

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Bachelor's Degree in Video Game Design and Development

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Outline

1 Introduction

2 Lab Homework

3 Lab rules

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Let's work on four exercises:

1. Two exercises on affine transformations
2. Two exercises on camera view

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Before January 12th at 23:45 you must deliver:

1. The point $\mathbf{p}$ has coordinates ${}^{A}\mathbf{p} = (3, 4)^{\intercal}$ on a frame $\mathcal{A}$ and coordinates ${}^{B}\mathbf{p} = (-2.5, 0.5)^{\intercal}$; on a frame $\mathcal{B}$. It is known that the angle between x axis of frame $\mathcal{A}$ and the y axis from frame $\mathcal{B}$ is 30 degress counterclockwise.
   Do the next verifications:
   - Which are the coordinates of the origin of $\mathcal{A}$ seen from $\mathcal{B}$?
   - Which are the coordinates of the origin of $\mathcal{B}$ seen from $\mathcal{A}$?
   - Which are the coordinates of a point $\mathbf{p}$ expressed in $\mathcal{A}$ if ${}^{B}\mathbf{q} = (3, 1)^{\intercal}$

   (2.5 points)

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2 Let $\mathcal{A}$, $\mathcal{B}$ and $\mathcal{C}$, be 3 different reference frames. From them we know the origin of $\mathcal{B}$ with respect $\mathcal{A}$ is $\mathbf{o_{AB}} = (3, 1, -2)^\intercal$ and the origin of $\mathcal{C}$ with respect $\mathcal{B}$ is $\mathbf{o_{BC}} = (-3, 1, -2)^\intercal$.
The three frames has different orientations in space. $(\psi, \theta, \phi) = (25, 145, 30)^\intercal$ allows to transform from $\mathcal{A}$ to $\mathcal{B}$. The quaternion $\mathring{q} = 1/7 * (-\sqrt{3} \cdot 3.5, 3, -1, -1.5)^\intercal$ allows to express in $\mathcal{B}$ a vector defined in $\mathcal{C}$. Let in addition $\mathbf{v_1}$ and $\mathbf{v_2}$ to be points which coordinates are known in $\mathcal{C}$, ${}^{\mathbf{C}}\mathbf{v_1} = (0, 2, 0)^\intercal$ and ${}^{\mathbf{C}}\mathbf{v_2} = (0, 2, 5)^\intercal$.

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With the information provided above determine:

- The affine expression that allows to relate a vector originally given in $\mathcal{C}$ to $\mathcal{B}$.
- The affine expression that allows to relate a vector originally given in $\mathcal{C}$ to $\mathcal{A}$.
- The vectors ${}^{\mathcal{C}}\mathbf{v_1}$ and ${}^{\mathcal{C}}\mathbf{v_2}$ forms a segment. Make a 3D plot representing how the segment is seen on $\mathcal{A}$ in red, on $\mathcal{B}$ in blue and on $\mathcal{C}$ in green.

(2.5 points)

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3 The points described by the matrix **A** in *A1.csv* are contained into a circle, defined in a world frame $\mathcal{W}$.
A camera is situated at point $\mathbf{cc} = (1, 6, 1)^\intercal$ defined in the world frame. The orientation of this camera frame is achieved by rotating the world frame -90 degrees about its y axis followed by -20 degrees about the resulting z axis.
If the camera has a focal length of 1/34 m:

- Make a plot with the view of the points of the circle projected into the camera plane.
- Make also a 3D plot where all the scene is drawn in the world coordinates. The scene must contain the 2 reference frames (2 orthogonal sets of vectors) and the circle points.

(2.5 points)

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4 Four points are described by the matrix **A** in *A2.csv*. From these 4 points, two segments are defined. The segment one, goes from the point defined by the first column to the point defined by the second column. The second segment is defined by the other two points.
A camera frame is seeing the scene. The origin of the world frame seen from the camera frame is given by the vector $\mathbf{wc} = (4.665, 3.735, -0.5395)^\intercal$ and the orientation of the camera frame is obtained after rotating the world frame -170 degrees about the direction
$\mathbf{u} = (0.01, -0.2, 1)^\intercal$

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With the data provided determine:

- The minimum angle that both segments forms (hint, they intersect)
- The angle that both segments forms in the image plane
- Deliver a 3D representation of the scene with all the coordinates referred to the world frame
- Deliver the 3D scene representations but with all the coordinates referred to the camera frame

(2.5 points)

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- Always respect the delivery dates.
- Use the templates when provided and **DO NOT MODIFY THE FILE NAMES OR THE FUNCTION NAMES**
- Verify that your code works before submit.
- Always upload the files in a .zip with the name structure: Surname1_Name1_Surname2_Name2....**zip**
- Cheating will be firmly punished with a final mark of 0.