$restart$
$with(Gym):$
$with(LinearAlgebra):$
$with(MTM, svd):$

Robot to table calibration

Input points as vectors in the lists.

$$p_{i,\ robot} := \left[\begin{bmatrix} -0.05907 \\ -0.31838 \\ 0.17 \end{bmatrix}, \begin{bmatrix} 0.06377 \\ -0.48364 \\ 0.17 \end{bmatrix}, \begin{bmatrix} 0.23051 \\ -0.36235 \\ 0.17 \end{bmatrix} \right]:$$

$$p_{i,\ world} := \left[\begin{bmatrix} 0.65 \\ 0.55 \\ 0.205 \end{bmatrix}, \begin{bmatrix} 0.45 \\ 0.5 \\ 0.205 \end{bmatrix}, \begin{bmatrix} 0.5 \\ 0.3 \\ 0.205 \end{bmatrix} \right]:$$

Compute centroid (Center of a figure)

$N := nops(p_{i,\ robot}):$

$$C_{p,\ robot} := \frac{1}{N} \cdot \sum_{i=1}^{N} \left(p_{i,\ robot}[i] \right):$$

$$C_{p,\ world} := \frac{1}{N} \cdot \sum_{i=1}^{N} \left(p_{i,\ world}[i] \right):$$

The two sets of points with zero centroid

for i **from** 1 **by** 1 **to** N **do** $q_{i,robot}[i] := p_{i,robot}[i] - C_{p,robot}$ **end do**:

for i **from** 1 **by** 1 **to** N **do** $q_{i,\ world}[i] := p_{i,\ world}[i] - C_{p,robot}$ **end do**:

Compute SVD (singular value decomposition)

$unassign('i')$

for i **from** 1 **by** 1 **to** N **do** $Q[i] := q_{i,robot}[i] \cdot Transpose\left(q_{i,world}[i]\right)$ **end do**:

$H := add(Q[i], i = 1..N):$

$U, \Sigma, V := svd(H):$

Compute rotation matrix and translation vector

$R^{\wedge} := V \cdot Transpose(U):$

$T^{\wedge} := C_{p,\ world} - R^{\wedge} \cdot C_{p,\ robot}:$

Define transformation matrix

$$H_{R,\,W} := \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}:$$

$H_{R,W}[1..3, 1..3] := R^{\wedge}$:

$H_{R,\,W}[1..3, 4] := T^{\wedge}$:

Computation of the coordinates

Compute the point seen from {W} in {R}

Inverse transformation matrix

$H_{R,\,W} = H_{W,\,R}{}^{-1}$

$$H_{W,\,R} := \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}:$$

$H_{W,\,R}[1..3, 1..3] := \mathit{Transpose}\left(H_{R,\,W}[1..3, 1..3]\right)$:

$P_{W,\,R_{org}} := H_{R,\,W}[1..3, 4]$:

$H_{W,\,R}[1..3, 4] := -\left(\mathit{Transpose}\left(H_{R,\,W}[1..3, 1..3]\right)\right) \cdot P_{W,\,R_{org}}$:

Computation of the point

Input point coordinates of a point in {W}.

$x := 0.3$:

$y := 0.4$:

$z := 0.205$:

$$P_{World} := \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}:$$

$P_{Robot} := H_{W,\,R} \cdot P_{World}$:

$$P_{Robot,\,xyz} := P_{Robot}[1..3] = \begin{bmatrix} 0.213241296324387 \\ -0.585006974555421 \\ 0.170000000000000 \end{bmatrix}$$