ICP optimization on Manifold (in 3D)

given a set of points in the world frame, roughly known correspondences

W.R.t ⇒ with respect to !

→ state domain $X \rightarrow SE(3)$

- euclidean parametrization for perturbation ⇒ $\mathbb{R}^6$
- box ⊞ operator

& measurement space $Z \rightarrow$

- box ⊟ used in the expression of the error

$X \in SE(3)$

$$\Delta x = \underbrace{\begin{pmatrix} \Delta x & \Delta y & \Delta z \end{pmatrix}}_{\Delta t} \quad \underbrace{\begin{pmatrix} \Delta\alpha_x & \Delta\alpha_y & \Delta\alpha_z \end{pmatrix}}_{\Delta\alpha}$$

$v2t$ ⇒ 6 dimension vector ⇒ $\left[R \mid t\right]$

$SE(3)$

$$X \boxplus \Delta x = v2t(\Delta x)\, X$$

$$= \begin{bmatrix} R(\Delta\alpha) & \Delta t \\ 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} R & t \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} R(\Delta\alpha)\cdot R & R(\Delta\alpha)\cdot t + \Delta t \\ 0 & 1 \end{bmatrix} = \left[R(\Delta\alpha)\cdot R \;\middle|\; R(\Delta\alpha)\cdot t + \Delta t \right]$$

Given the measurements (set of points) candidate,

$$\exists \equiv -$$

Script

- good initial guess > in both cases manifold ws not
- bad " "

↳ manifold → particularly important in this case!

icp_3D_nls ⇒ case w/ outliers

(wrong correspondences!)

↓

w/ and w/o robustness estimator

↓

the larger dri, smaller weight given to measurement