Space frame		Transformation			Body frame	
Vector	Lie algebra	from $\{b\}$ to $\{s\}$	Adjoint matrix	from $\{s\}$ to $\{b\}$	Lie algebra	Vector
(Cartesian space)	(Tangent space)				(Tangent space)	(Cartesian space)
Spatial angular velocity $\omega_s$	$egin{array}{ll} \dot{\mathbf{R}}\mathbf{R}^{-1} &= [oldsymbol{\omega}_s  imes] \\ \dot{\mathbf{R}} &= [oldsymbol{\omega}_s  imes]  \mathbf{R} \\ \mathbf{R} &= \exp\left( [oldsymbol{\omega}_s  imes] \cdot \Delta t  ight) \end{array}$	$egin{array}{ll} \left[oldsymbol{\omega}_s imes ight] &=\mathbf{R}\left[oldsymbol{\omega}_b imes ight]\mathbf{R}^{-1} \ &=\left[\left(\mathbf{R}oldsymbol{\omega}_b ight) imes ight] \ oldsymbol{\omega}_s &=\mathbf{R}oldsymbol{\omega}_b \end{array}$	$egin{array}{ll} [\mathrm{Ad}_{\mathbf{R}}] &= \mathbf{R} \ \pmb{\omega}_s &= \mathbf{R} \pmb{\omega}_b \ [\mathrm{Ad}_{\mathbf{R}^{-1}}] &= \mathbf{R}^{-1} \ \pmb{\omega}_b &= \mathbf{R}^{-1} \pmb{\omega}_s \end{array}$	$egin{array}{ll} [oldsymbol{\omega}_b imes] &= \mathbf{R}^{-1} \left[oldsymbol{\omega}_s imes  ight] \mathbf{R} \ &= \left[\left(\mathbf{R}^{-1}oldsymbol{\omega}_s ight) imes ight] \ oldsymbol{\omega}_b &= \mathbf{R}^{-1}oldsymbol{\omega}_s \end{array}$	$\mathbf{R}^{-1}\dot{\mathbf{R}} = [\boldsymbol{\omega}_b \times]$ $\dot{\mathbf{R}} = \mathbf{R} [\boldsymbol{\omega}_b \times]$ $\mathbf{R}^{-1} = \exp([\boldsymbol{\omega}_b \times] \cdot \Delta t)$	Body angular velocity $\omega_b$
$oldsymbol{\mathcal{V}}_s = \left[egin{array}{c} oldsymbol{\omega}_s \ \mathbf{v}_s \end{array} ight]$	$egin{array}{ll} \dot{\mathbf{T}}\mathbf{T}^{-1} &= \left[oldsymbol{\mathcal{V}}_s^{\wedge} ight] \ &= \left[rac{\left[oldsymbol{\omega}_s imes ight] \mathbf{v}_s}{0^{\mathrm{T}} \mid 0} ight] \ \dot{\mathbf{T}} &= \left[oldsymbol{\mathcal{V}}_s^{\wedge} ight] \mathbf{T} \ \mathbf{T} &= \exp\left(\left[oldsymbol{\mathcal{V}}_s^{\wedge} ight] \cdot \Delta t ight) \end{array}$	$egin{array}{ll} \left[ oldsymbol{\mathcal{V}}_s^\wedge  ight] &= \mathbf{T} \left[ oldsymbol{\mathcal{V}}_b^\wedge  ight] \mathbf{T}^{-1} \ oldsymbol{\mathcal{V}}_s &= \left[ \operatorname{Ad}_{\mathbf{T}}  ight] oldsymbol{\mathcal{V}}_b \end{array}$	$\begin{bmatrix} \operatorname{Ad}_{\mathbf{T}} \end{bmatrix} &= \begin{bmatrix} \mathbf{R} & 0 \\ [\mathbf{r} \times] \mathbf{R} & \mathbf{R} \end{bmatrix} \\ \boldsymbol{\mathcal{V}}_{s} &= [\operatorname{Ad}_{\mathbf{T}}] \boldsymbol{\mathcal{V}}_{b} \\ [\operatorname{Ad}_{\mathbf{T}^{-1}}] &= \begin{bmatrix} \mathbf{R}^{-1} & 0 \\ -\mathbf{R}^{-1} [\mathbf{r} \times] & \mathbf{R}^{-1} \end{bmatrix} \\ \boldsymbol{\mathcal{V}}_{b} &= [\operatorname{Ad}_{\mathbf{T}^{-1}}] \boldsymbol{\mathcal{V}}_{s} \end{bmatrix}$	$egin{bmatrix} oldsymbol{\mathcal{V}}_b^\wedge \end{bmatrix} &= \mathbf{T}^{-1} ig[ oldsymbol{\mathcal{V}}_s^\wedge ig]  \mathbf{T} \ oldsymbol{\mathcal{V}}_b &= ig[ \mathrm{Ad}_{\mathbf{T}^{-1}} ig] oldsymbol{\mathcal{V}}_s \end{split}$	$egin{array}{lll} \mathbf{T}^{-1}\dot{\mathbf{T}} &= \left[oldsymbol{\mathcal{V}}_b^{\wedge} ight] & & & = \left[rac{\left[oldsymbol{\omega}_b imes ight]\cdot\mathbf{v}_b}{oldsymbol{0}^{\mathrm{T}} \mid 0} ight] \ \dot{\mathbf{T}} &= \mathbf{T}\left[oldsymbol{\mathcal{V}}_b^{\wedge} ight] & & & & \\ \mathbf{T}^{-1} &= \exp\left(\left[oldsymbol{\mathcal{V}}_b^{\wedge} ight]\cdot\Delta t ight) \end{array}$	$oldsymbol{\mathcal{V}}_b = \left[egin{array}{c} oldsymbol{\omega}_b \ oldsymbol{\mathbf{v}}_b \end{array} ight]$