INS_Mechanization class

member function

- construct function
- sensor update
- velocity update
  $$\mathbf{v}_k^{\mathrm{n}} = \mathbf{v}_{k-1}^{\mathrm{n}} + \Delta\mathbf{v}_{\mathrm{f},k}^{\mathrm{n}} + \Delta\mathbf{v}_{\mathrm{g/cor},k}^{n}$$
- position update
  $$\mathbf{q}_{\mathrm{n}(k)}^{\mathrm{e}(k-1)} = \mathbf{q}_{\mathrm{n}(k-1)}^{\mathrm{e}(k-1)} \star \mathbf{q}_{\mathrm{n}(k)}^{\mathrm{n}(k-1)} \qquad \mathbf{q}_{\mathrm{n}(k)}^{\mathrm{n}(k-1)} = \begin{bmatrix} \cos\|0.5\boldsymbol{\zeta}_k\| \\ \dfrac{\sin\|0.5\boldsymbol{\zeta}_k\|}{\|0.5\boldsymbol{\zeta}_k\|}0.5\boldsymbol{\zeta}_k \end{bmatrix} \qquad \mathbf{v}_{k-1/2}^{\mathrm{n}} = \tfrac{1}{2}(\mathbf{v}_{k-1}^{\mathrm{n}} + \mathbf{v}_k^{\mathrm{n}})$$
  $$\mathbf{q}_{\mathrm{n}(k)}^{\mathrm{e}(k)} = \mathbf{q}_{\mathrm{e}(k-1)}^{\mathrm{e}(k)} \star \mathbf{q}_{\mathrm{n}(k)}^{\mathrm{e}(k-1)} \qquad \mathbf{q}_{\mathrm{e}(k-1)}^{\mathrm{e}(k)} = \begin{bmatrix} \cos\|0.5\boldsymbol{\xi}_k\| \\ -\dfrac{\sin\|0.5\boldsymbol{\xi}_k\|}{\|0.5\boldsymbol{\xi}_k\|}0.5\boldsymbol{\xi}_k \end{bmatrix} \qquad \boldsymbol{\xi}_k = \boldsymbol{\omega}_{\mathrm{ie}}^{\mathrm{e}}\Delta t_k$$
  $$h_k = h_{k-1} - v_{\mathrm{D},k-1/2}\Delta t_k$$
- attitude update
  $$\boldsymbol{q}_{b(k)}^{n(k)} = \boldsymbol{q}_{n(k-1)}^{n(k)} \circ \boldsymbol{q}_{b(k-1)}^{n(k-1)} \circ \boldsymbol{q}_{b(k)}^{b(k-1)}$$
  $$\boldsymbol{q}_{b(k)}^{b(k-1)} = \begin{bmatrix} \cos\|0.5\boldsymbol{\phi}_k\| \\ \dfrac{\sin\|0.5\boldsymbol{\phi}_k\|}{\|0.5\boldsymbol{\phi}_k\|}0.5\boldsymbol{\phi}_k \end{bmatrix} \qquad \boldsymbol{\phi}_k = \int_{t_{k-1}}^{t_k}\left[\boldsymbol{\omega}_{\mathrm{ib}}^{\mathrm{b}} + \frac{1}{2}\Delta\boldsymbol{\theta}(t)\times\boldsymbol{\omega}_{\mathrm{ib}}^{\mathrm{b}}\right]dt \approx \Delta\boldsymbol{\theta}_k + \frac{1}{12}\Delta\boldsymbol{\theta}_{k-1}\times\Delta\boldsymbol{\theta}_k,$$
  $$\boldsymbol{q}_{n(k-1)}^{n(k)} = \begin{bmatrix} \cos\|0.5\boldsymbol{\zeta}_k\| \\ -\dfrac{\sin\|0.5\boldsymbol{\zeta}_k\|}{\|0.5\boldsymbol{\zeta}_k\|}0.5\boldsymbol{\zeta}_k \end{bmatrix} \qquad \boldsymbol{\zeta}_k = \int_{t_{k-1}}^{t_k}[\boldsymbol{\omega}_{ie}^{n}(t) + \boldsymbol{\omega}_{en}^{n}(t)]\,dt \approx [\boldsymbol{\omega}_{ie}^{n}(t_{k-1}) + \boldsymbol{\omega}_{en}^{n}(t_{k-1})]\,\Delta t$$
  $$\boldsymbol{\omega}_{ie}^{n} = \begin{bmatrix} \omega_e\cos\varphi & 0 & -\omega_e\sin\varphi \end{bmatrix}$$
  $$\boldsymbol{\omega}_{en}^{n} = \begin{bmatrix} v_E/(R_N+h) \\ -v_N/(R_M+h) \\ -v_E\tan\varphi/(R_N+h) \end{bmatrix}$$
  $$R_M = \frac{a(1-e^2)}{\sqrt{(1-e^2\sin^2\varphi)^3}}$$
  $$R_N = \frac{a}{\sqrt{1-e^2\sin^2\varphi}}$$
  $$a = 6378137.0$$
  $$e = 0.08181919104$$
  $$\mathbf{q}_{\delta\boldsymbol{\theta}} = \left(\mathbf{q}_{\mathrm{n}(k-1)}^{\mathrm{e}(k-1)}\right)^{-1} \star \mathbf{q}_{\mathrm{n}(k)}^{\mathrm{e}(k)} \qquad \mathbf{q}_{\mathrm{n}(k-1/2)}^{\mathrm{e}(k-1/2)} = \mathbf{q}_{\mathrm{n}(k-1)}^{\mathrm{e}(k-1)} \star \mathbf{q}_{0.5\delta\boldsymbol{\theta}}$$
- data record
- Mechanization output
- to skew symmetric matrix

member variable

- IMU output
  - Vector3d delta_theta_, last_delta_theta_
  - Vector3d delta_v_, last_delta_v_
- INS mechanization data
  - double time_, last_time_, delta_time_
  - Quaternion<double> q_b_to_n_, q_b_last_to_n_last_
  - Vector3d v_proj_n_, last_v_proj_n_, before_last_v_proj_n_
  - Quaterniond q_n_to_e, q_n_last_to_e_last_
  - double h_, h_last
  - Vector3d omega_in_proj_n_, last_omega_in_proj_n_
  - Quaterniond q_n_midway_to_e_midway_
  - double h_midway_
  - Vector3d v_midway_proj_n_
- constant
  - double a_ = 6378137.0
  - double e_ = 0.08181919104
  - double omega_e_
  - Vector3d omega_ie_proj_e_