Errata

Handbook of Marine Craft Hydrodynamics and Motion Control
2nd edition

Most recently revised on August 18, 2024

These are errata for the 2nd edition of the Wiley textbook *"Handbook of Marine Craft Hydrodynamics and Motion Control"* by Thor I. Fossen.

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Section 2.4 The transformations for longitude, latitude, and height to flat Earth should be

$$\Delta l = \frac{y^n}{(R_N + h_{\text{ref}})\cos(\mu_0)} \tag{2.113}$$

$$\Delta \mu = \frac{x^n}{R_M + h_{\text{ref}}} \tag{2.114}$$

and

$$x^n = \Delta\mu\,(R_M + h_{\text{ref}}) \tag{2.118}$$

$$y^n = \Delta l\,(R_N + h_{\text{ref}})\cos(\mu_0) \tag{2.119}$$

This follows from Equation (2.39) in Farrell (2008).

Equation (5.73)–(5.75), (5.77), (5.82) The negative complex damping term $-\mathrm{j}\omega\boldsymbol{B}_{\text{total}}(\omega)$ should be positive $+\mathrm{j}\omega\boldsymbol{B}_{\text{total}}(\omega)$.

Equation (5.81) The negative term $-\mathrm{j}\omega$ should be $+\mathrm{j}\omega$.

Equation (9.123) The rudder's angle of attack should be from FLOW to BODY axes to be consistent with (2.150). Hence, the rotation matrix should use $-\delta_R$ and not δ_R such that

$$\begin{bmatrix} X_R \\ Y_R \end{bmatrix} = \begin{bmatrix} \cos(-\delta_R) & -\sin(-\delta_R) \\ \sin(-\delta_R) & \cos(-\delta_R) \end{bmatrix} \begin{bmatrix} -F_{\text{drag}} \\ -F_{\text{lift}} \end{bmatrix} \tag{9.123}$$

Equation (10.85)-(10.86) The encounter frequency should be defined in terms of the relative encounter angle to be valid for all heading angles

$$\omega_e(U, \omega_0, \beta_{\text{rel}}) = \left| \omega_0 - \frac{\omega_0^2}{g} U \cos(\beta_{\text{rel}}) \right| \tag{10.85}$$

where $\beta_{\text{rel}} = \beta - \psi$.

The relative encounter angle and spreading angle μ affect the wave elevation accordingly

$$\xi = \sum_{k=1}^{N}\sum_{i=1}^{N}\sqrt{2S_M(\omega_k, \beta_{\text{rel}} + \mu_i)\Delta\omega\Delta\mu}\ \cos\left(\omega_k t - \frac{\omega_k^2}{g}U\cos(\beta_{\text{rel}} + \mu_i)\,t + \epsilon_k\right) \tag{10.86}$$

Equation (10.93)–(10.95) For the no spreading case, the relative encounter angle $\beta_{\text{rel}} = \beta - \psi$ is used such that

$$\begin{aligned}\tau_{\text{wave1}}^{\{\text{dof}\}} &= \sum_{k=1}^{N}\rho g\left|F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}})\right| A_k\cos\left(\omega_e(U, \omega_k, \beta_{\text{rel}})t + \angle F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) + \epsilon_k\right)\\ &= \sum_{k=1}^{N}\rho g\left|F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}})\right|\sqrt{2S(\omega_k)\Delta\omega}\\ &\qquad\cos\left(\omega_e(U, \omega_k, \beta_{\text{rel}})t + \angle F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) + \epsilon_k\right)\end{aligned} \tag{10.93}$$

$$\begin{aligned}\tau_{\text{wave2}}^{\{\text{dof}\}} &= \sum_{k=1}^{N}\rho g\left|F_{\text{wave2}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}})\right| A_k^2\\ &= \sum_{k=1}^{N}\rho g\left|F_{\text{wave2}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}})\right| 2S(\omega_k)\Delta\omega\end{aligned} \tag{10.94}$$

where

$$\omega_e(U, \omega_k, \beta_{\text{rel}}) = \omega_k - \frac{\omega_k^2}{g}U\cos(\beta_{\text{rel}}) \tag{10.95}$$

Equation (10.96)–(10.97) The more general case, where the spreading function (10.80) is included, can be simulated by using varying wave directions μ_i $(i = 1, .., M)$ and

$$\begin{aligned}\tau_{\text{wave1}}^{\{\text{dof}\}} &= \sum_{k=1}^{N}\sum_{i=1}^{M}\rho g\left|F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}} + \mu_i)\right|\sqrt{2S_M(\omega_k, \beta_{\text{rel}} + \mu_i)\Delta\omega\Delta\mu}\\ &\qquad\cos\left(\omega_e(U, \omega_k, \beta_{\text{rel}} + \mu_i)t + \angle F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}} + \mu_i) + \epsilon_k\right)\end{aligned} \tag{10.96}$$

$$\tau_{\text{wave2}}^{\{\text{dof}\}} = \sum_{k=1}^{N}\sum_{i=1}^{M}\rho g\left|F_{\text{wave2}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}} + \mu_i)\right| 2S_M(\omega_k, \beta_{\text{rel}} + \mu_i)\Delta\omega\Delta\mu \tag{10.97}$$

Equation (10.105)

$$\begin{aligned}\eta_w^{\{\text{dof}\}} &= \sum_{k=1}^{N}\left|\eta_w^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}})\right| A_k\cos\left(\omega_e(U, \omega_k, \beta_{\text{rel}})t + \angle\eta_w^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) + \epsilon_k\right)\\ &= \sum_{k=1}^{N}\left|\eta_w^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}})\right|\sqrt{2S(\omega_k)\Delta\omega}\cos\left(\omega_e(U, \omega_k, \beta_{\text{rel}})t + \angle\eta_w^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) + \epsilon_k\right)\end{aligned} \tag{10.105}$$

Equation (10.106)

$$\eta_w^{\{\text{dof}\}} = \sum_{k=1}^{N}\sum_{i=1}^{M} \left|\eta_w^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}} + \mu_i)\right| \sqrt{2S_M(\omega_k, \beta_{\text{rel}} + \mu_i)\Delta\omega\Delta\mu}$$
$$\cos\left(\omega_e(U, \omega_k, \beta_{\text{rel}} + \mu_i)t + \angle\eta_w^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}} + \mu_i) + \epsilon_k\right) \quad (10.106)$$

Equation (14.18) The rotation matrix is missing. The correct expression is

$$\boldsymbol{f}^b_{\text{imu}} = -\boldsymbol{R}^\top(\boldsymbol{\Theta}_{nb})\boldsymbol{g}^n \quad (14.18)$$

Equations (14.27) and (14.28) The negative sign and the subscript m should be removed such that

$$\psi = \text{atan2}(h_y, h_x) \quad (14.27)$$
$$\psi = \text{atan2}(m_y, m_x) \quad (14.28)$$

Equation (16.447) The correct expression is

$$\begin{bmatrix} \dot{\tilde{x}} \\ \dot{\sigma}_0 \end{bmatrix} = \begin{bmatrix} -\lambda & -\lambda \\ 0 & -\lambda \end{bmatrix} \begin{bmatrix} \tilde{x} \\ \sigma_0 \end{bmatrix} \quad (16.447)$$

Section 16.4.6 (Case study) The adaptive-gain super twisting algorithm (STA) should use

$$\beta = \beta_1\alpha + \beta_0 \quad (16.509)$$

where β_0 and β_1 are constants instead of $\beta = \beta_0 =$ constant. This is also corrected in the MSS toolbox file, ExSTA.m.

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Page 45 The square root should be removed such that

$$R_M = R_N \frac{1 - e^2}{1 - e^2 \sin^2(\mu_0)} \quad (2.112)$$

Page 58 Replace the sentence below Equation (3.13) with *"Further, Equation(3.11) can be rewritten as"*

Page 228 The term T_m should be replaced by $T_m s$ in Equation (9.35) such that

$$H(s) = \frac{Q_m}{Y}(s) \approx \frac{K_m}{T_m s + 1} e^{-\tau s} \quad (9.35)$$

Example 13.1 The noise terms w_1, w_2 and w_3 in (13.45), (13.46) and (13.48), respectively should be renumbered according to w_2, w_3 and w_1 in order to match the $\boldsymbol{E}$ matrix in (13.53). More specific

$$\dot{\psi} = r \tag{14.44}$$

$$\dot{r} = -\frac{1}{T}r + \frac{K}{T}(\delta - b) + w_2 \tag{14.46}$$

$$\dot{b} = w_3 \tag{14.46}$$

$$\dot{\xi}_w = \psi_w \tag{14.47}$$

$$\dot{\psi}_w = -\omega_0^2 \xi_w - 2\lambda\omega_0\psi_w + K_w w_1 \tag{14.48}$$

Page 240 Equations (9.105)–(9.106) should be premultiplied by 1/2 and not 1/4 according to

$$Y_\delta = \frac{1}{2}(1 + a_H)\rho U_R^2 A_R C_N > 0 \tag{9.105}$$

$$N_\delta = \frac{1}{2}(x_R + a_H x_H)\rho U_R^2 A_R C_N < 0 \tag{9.106}$$

Pages 290-295 Remove the double subscript for $\epsilon_{i,k}$ in (10.86), (10.96) and (10.106) such that

$$\xi = \sum_{k=1}^{N}\sum_{i=1}^{N}\sqrt{2S_M(\omega_k, \mu_i - \beta)\Delta\omega\Delta\mu}\,\cos\left(\omega_k t - \frac{\omega_k^2}{g}U\cos(\mu_i - \beta)\,t + \epsilon_k\right) \tag{10.86}$$

$$\tau_{\text{wave1}}^{\{\text{dof}\}} = \sum_{k=1}^{N}\sum_{i=1}^{M}\rho g\left|F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \mu_i - \beta)\right|\sqrt{2S_M(\omega_k, \mu_i - \beta)\Delta\omega\Delta\mu}$$
$$\cos\left(\omega_e(U, \omega_k, \mu_i - \beta)t + \angle F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \mu_i - \beta) + \epsilon_k\right) \tag{10.96}$$

$$\eta_w^{\{\text{dof}\}} = \sum_{k=1}^{N}\sum_{i=1}^{M}\left|\eta_w^{\{\text{dof}\}}(\omega_k, \mu_i - \beta)\right|\sqrt{2S_M(\omega_k, \mu_i - \beta)\Delta\omega\Delta\mu}$$
$$\cos\left(\omega_e(U, \omega_k, \mu_i - \beta)t + \angle\eta_w^{\{\text{dof}\}}(\omega_k, \mu_i - \beta) + \epsilon_k\right) \tag{10.106}$$

Page 336 The sentence below (12.6) should be

Note that a step in the command $\boldsymbol{r}^b$ will give a step in $\ddot{\boldsymbol{\nu}}$ while ...

Page 554 The matrix $\boldsymbol{P}_{22}$ should be replaced by $\boldsymbol{P}_{21}$ in the last line of (16.19)

$$\cdots$$
$$= -\underbrace{\boldsymbol{R}^{-1}\boldsymbol{B}^\top \boldsymbol{P}_{21}}_{\boldsymbol{K}_i}\boldsymbol{z} - \underbrace{\boldsymbol{R}^{-1}\boldsymbol{B}^\top \boldsymbol{P}_{22}}_{\boldsymbol{K}_p}\boldsymbol{x} \tag{16.19}$$

Page 582 The left-hand side of (16.143) should be replaced by

$$\boldsymbol{M}(\dot{\boldsymbol{\nu}} - \boldsymbol{a}^b) = \ldots \tag{16.143}$$

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Page 29 Replace *"by Definition 2.1"* with *"by Property 2.1"*.

Page 44 Replace *"h is the vertical distance from the sea level to the coordinate origin of* $\{b\}$" with *"h is the vertical distance from the surface of the ellipsoid to the coordinate origin of* $\{b\}$".

Page 48 Replace *"From (2.36) it follows that"* with *"From (2.34) and (2.35) it follows that"*.

Page 50 Delete *"β is small and"* such that the sentence read *"Time differentiation of β under the assumption that $Ur > 0$ is constant gives"*.