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 (10.83)

$$\xi = \sum_{k=1}^{N}\sum_{i=1}^{M} \sqrt{2S_M(\omega_k, \beta_{\text{rel}} + \mu_i)\Delta\omega\Delta\mu}\,\cos(\omega_k t + \epsilon_k) \tag{10.83}$$

where $\beta_{\text{rel}} = \beta - \psi$ is the relative encounter angle (see Figure 10.14) and ...

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

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

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

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

$$\begin{aligned}
\tau_{\text{wave1}}^{\{\text{dof}\}} &= \sum_{k=1}^{N} \rho g \left| F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) \right| A_k \cos\left(\omega_e(U, \omega_k, \beta_{\text{rel}}) t + \angle F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) + \epsilon_k \right) \\
&= \sum_{k=1}^{N} \rho g \left| F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) \right| \sqrt{2 S(\omega_k) \Delta\omega} \\
&\qquad \cos\left(\omega_e(U, \omega_k, \beta_{\text{rel}}) t + \angle F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) + \epsilon_k \right) \qquad (10.93) \\
\tau_{\text{wave2}}^{\{\text{dof}\}} &= \sum_{k=1}^{N} \rho g \left| F_{\text{wave2}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) \right| A_k^2 \\
&= \sum_{k=1}^{N} \rho g \left| F_{\text{wave2}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}}) \right| 2 S(\omega_k) \Delta\omega \qquad (10.94)
\end{aligned}$$

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

$$\begin{aligned}
\tau_{\text{wave1}}^{\{\text{dof}\}} &= \sum_{k=1}^{N} \sum_{i=1}^{M} \rho g \left| F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}} + \mu_i) \right| \sqrt{2 S_M(\omega_k, \beta_{\text{rel}} + \mu_i) \Delta\omega \Delta\mu} \\
&\qquad \cos\left(\omega_e(U, \omega_k, \beta_{\text{rel}} + \mu_i) t + \angle F_{\text{wave1}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}} + \mu_i) + \epsilon_k \right) \qquad (10.96) \\
\tau_{\text{wave2}}^{\{\text{dof}\}} &= \sum_{k=1}^{N} \sum_{i=1}^{M} \rho g \left| F_{\text{wave2}}^{\{\text{dof}\}}(\omega_k, \beta_{\text{rel}} + \mu_i) \right| 2 S_M(\omega_k, \beta_{\text{rel}} + \mu_i) \Delta\omega \Delta\mu \qquad (10.97)
\end{aligned}$$

Equation (10.105)

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

Equation (10.106)

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

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

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

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

$$\psi = \text{atan2}(h_y, h_x) \tag{14.27}$$

$$\psi = \text{atan2}(m_y, m_x) \tag{14.28}$$

Equation (16.447) The correct expression is

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

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

$$\beta = \beta_1\alpha + \beta_0 \tag{16.509}$$

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

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

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

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

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)

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

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

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

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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"*.