**Prof. Dr.-Ing.
Michael Schmiechen**
Bartningallee 16
D-10557 Berlin (Tiergarten)
Germany

Phone: +49-(0)30-392 71 64
E-mail: m.schm@t-online.de
Website: http://www.m-schmiechen.de

MS 201308112100
201308312230
201404172000
201404182000
201404241600
201408091700
201408271700

To whom it may concern

Routines of a quasi-steady ship 'model' powering trial

Filter raw data

$$\text{Filter}(t, x, ord_{max}) :=$$

$n \leftarrow \text{last}(t)$

for $i \in 0..n$

  for $j \in 0..3$

    $A_{i,j} \leftarrow (t_i)^j$

$X \leftarrow \text{geninv}(A) \cdot x$

$x_{0.trend} \leftarrow A \cdot X$

$x_{0.red} \leftarrow x - x_{0.trend}$

$\Delta t \leftarrow t_n - t_0$

$\Delta x_{0.red} \leftarrow x_{0.red_n} - x_{0.red_0}$

for $i \in 0..n$

  $x_{0.red_i} \leftarrow x_{0.red_i} - i \cdot \frac{\Delta x_{0.red}}{n}$

$x_{0.red.F} \leftarrow \text{cfft}(x_{0.red})$

for $k \in ord_{max} + 1 .. n - ord_{max}$

  $x_{0.red.F_k} \leftarrow 0$

$\omega \leftarrow \frac{2 \cdot \pi}{\Delta t}$

for $k \in 1 .. ord_{max}$

$$x_{1.red.F_k} \leftarrow x_{0.red.F_k} \cdot (-k \cdot \omega \cdot i)$$

$$x_{1.red.F_{n+1-k}} \leftarrow x_{0.red.F_{n+1-k}} \cdot (k \cdot \omega \cdot i)$$

$$x_{2.red.F_k} \leftarrow x_{0.red.F_k} \cdot (-k \cdot \omega \cdot i)^2$$

$$x_{2.red.F_{n+1-k}} \leftarrow x_{0.red.F_{n+1-k}} \cdot (k \cdot \omega \cdot i)^2$$

$$x_{0.red} \leftarrow \mathrm{Re}\left(\mathrm{icfft}\left(x_{0.red.F}\right)\right)$$

$$x_{1.red} \leftarrow \mathrm{Re}\left(\mathrm{icfft}\left(x_{1.red.F}\right)\right)$$

$$x_{2.red} \leftarrow \mathrm{Re}\left(\mathrm{icfft}\left(x_{2.red.F}\right)\right)$$

for $i \in 0..n$

$$x_{0_i} \leftarrow x_{0.red_i} + i \cdot \frac{\Delta x_{0.red}}{n} + x_{0.trend_i}$$

$$x_{1.trend} \leftarrow \sum_{k=1}^{3} k \cdot X_k \cdot A^{\langle k-1 \rangle}$$

$$x_1 \leftarrow x_{1.red} + \frac{\Delta x_{0.red}}{\Delta t} + x_{1.trend}$$

$$x_{2.trend} \leftarrow \sum_{k=2}^{3} k! \cdot X_k \cdot A^{\langle k-2 \rangle}$$

$$x_2 \leftarrow x_{2.red} + x_{2.trend}$$

$$\left[x_0 \;\; x_1 \;\; x_2 \right]$$

Various functions

$$J(D,V,N) := \frac{V}{D \cdot N} \qquad KP(\rho,D,P,N) := \frac{P}{\rho \cdot D^5 \cdot N^3}$$

$$Fn(V,L) := \frac{V}{\sqrt{g \cdot L}} \qquad CP(\rho,D,P,V) := \frac{P}{\rho \cdot D^2 \cdot V^3}$$

$$VT(\omega_T, v, t) := v_0 + v_1 \cdot \cos(\omega_T \cdot t) + v_2 \cdot \sin(\omega_T \cdot t)$$

$$dir(\psi_{HG}) := if\left(\psi_{HG} > \frac{\pi}{2}, 1, -1\right)$$

Check distributions

```
norm_distr(sampl) := | r ← rows(sampl)
                     | c ← cols(sampl)
                     | for i ∈ 0 .. r − 1
                     |    | fract ← 2·(i + 1)/(r + 1) − 1
                     |    | dst ← fract
                     |    | distr_i ← √2·root(erf(dst) − fract, dst)
                     |    | for j ∈ 0 .. 1
                     |    |    A_distr[i,j] ← (distr_i)^j
                     | for j ∈ 0 .. c − 1
                     |    sampl_sort^<j> ← sort(sampl^<j>)
                     | distr_par ← geninv(A_distr)·sampl_sort
                     | sampl_fair ← A_distr·distr_par
                     | for j ∈ 0 .. c − 1
                     |    distr_par[2,j] ← distr_par[1,j] / √r
                     | [distr  sampl_sort  sampl_fair  distr_par]
```

Analyse power supplied at (quasi-)stationary conditions

$$
\begin{array}{l}
\mathrm{Supplied}\left(\omega,\rho,D,\Delta t,V_{HG},\psi_{HG},N_S,P_S\right) := \\
\quad \text{for } i \in 0..\mathrm{last}(\Delta t) \\
\qquad A_{sup_{i,0}} \leftarrow \left(N_{S_i}\right)^3 \\
\qquad A_{sup_{i,1}} \leftarrow \left(N_{S_i}\right)^2 \cdot V_{HG_i} \\
\qquad A_{sup_{i,2}} \leftarrow -\left(N_{S_i}\right)^2 \cdot \mathrm{dir}\left(\psi_{HG_i}\right) \\
\qquad A_{sup_{i,3}} \leftarrow A_{sup_{i,2}} \cdot \cos\left(\omega \cdot \Delta t_i\right) \\
\qquad A_{sup_{i,4}} \leftarrow A_{sup_{i,2}} \cdot \sin\left(\omega \cdot \Delta t_i\right) \\
\quad X_{sup} \leftarrow \mathrm{geninv}\left(A_{sup}\right) \cdot P_S \\
\quad P_{S.sup} \leftarrow A_{sup} \cdot X_{sup} \\
\quad \Delta P_{S.sup} \leftarrow P_S - P_{S.sup} \\
\quad \text{for } k \in 0..1 \\
\qquad p_k \leftarrow X_{sup_k} \\
\qquad p_{n_k} \leftarrow \dfrac{10^6 \cdot p_k}{\rho \cdot D^{(5-k)}} \\
\quad p_2 \leftarrow \mathrm{Stdev}\left(\Delta P_{S.sup}\right) \\
\quad c \leftarrow \mathrm{svds}\left(A_{sup}\right) \\
\quad p_3 \leftarrow \dfrac{c_4}{c_0} \\
\quad \text{for } k \in 0..2 \\
\qquad v_k \leftarrow \dfrac{X_{sup_{2+k}}}{X_{sup_1}} \\
\quad \text{for } i \in 0..\mathrm{last}(\Delta t) \\
\qquad V_{WG_i} \leftarrow \mathrm{VT}\left(\omega, v, \Delta t_i\right) \\
\qquad V_{HW_i} \leftarrow V_{HG_i} - V_{WG_i} \cdot \mathrm{dir}\left(\psi_{HG_i}\right)
\end{array}
$$

$$J_{HW_i} \leftarrow J(D, V_{HW_i}, N_{S_i})$$
$$K_{P.sup_i} \leftarrow KP(\rho, D, P_{S.sup_i}, N_{S_i})$$
$$\begin{bmatrix} \Delta P_{S.sup} & v & V_{WG} \\ V_{HW} & p & P_{S.sup} \\ J_{HW} & p_n & K_{P.sup} \end{bmatrix}$$

Determine mean current

$$C0(\omega, \rho, D, \Delta t, V_{HG}, \psi_{HG}, N_S, P_S) :=$$

```
for j ∈ 0.. last(Δt)
    A sup[j,0] ← (N S[j])^3
    A sup[j,1] ← (N S[j])^2·V HG[j]
    A sup[j,2] ← -(N S[j])^2·dir(ψ HG[j])
    A sup[j,3] ← A sup[j,2]·cos(ω·Δt[j])
    A sup[j,4] ← A sup[j,2]·sin(ω·Δt[j])
X sup ← geninv(A sup)·P S
P S.sup ← A sup·X sup
ΔP S.sup ← P S − P S.sup
for k ∈ 0.. 2
    v[k] ← X sup[2+k] / X sup[1]
V WG.mean ← v[0]
V WG.mean
```

END
Routines of a quasi-steady ship 'model' powering trial