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model_check.m

UAV_NL Model Verification

Compares the linear/nonlinear doublet response of the current simulation model (blue/green lines) with the checkcase data (red/black).

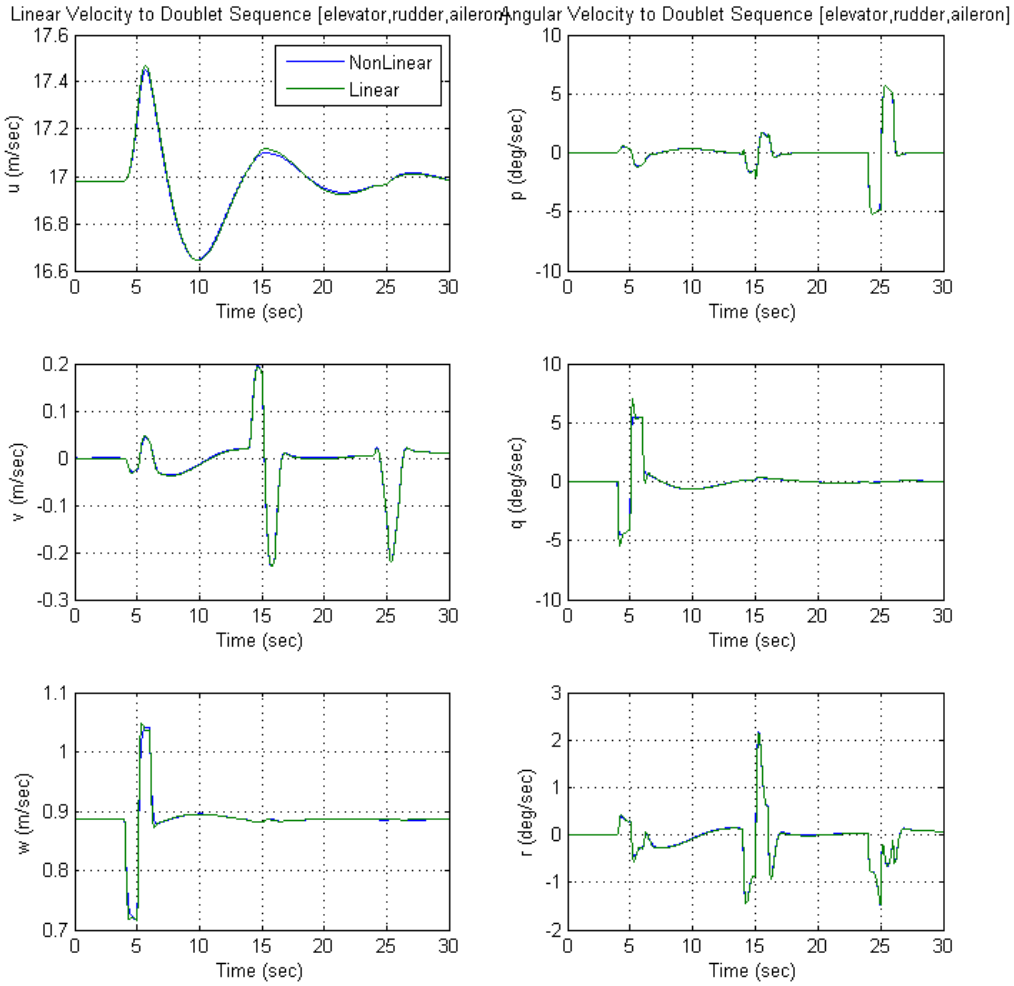
SVN Info: $Id: model_check.m 284 2011-03-03 15:07:19Z murch $

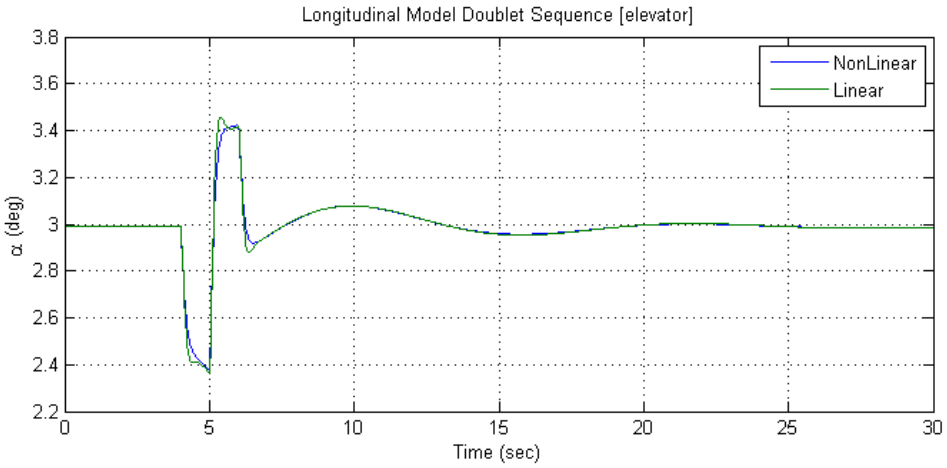
```
 Aircraft configuration saved as: UAV_modelconfig.mat

Local minimum found that satisfies the constraints.

Optimization completed because the objective function is non-decreasing in
feasible directions, to within the default value of the function tolerance,
and constraints were satisfied to within the default value of the constraint toler



No active inequalities.

 Operating Point Search Report:
---------------------------------

 Operating Report for the Model UAV_NL.
 (Time-Varying Components Evaluated at time t=0)

Operating point specifications were successfully met.

States:
----------
(1.) UAV_NL/Nonlinear UAV Model/6DoF EOM/Calculate DCM & Euler Angles/phi theta ps
      x:       0.00553      dx:    -8.68e-025 (0)
      x:        0.0522      dx:      1.6e-022 (0)
      x:             0      dx:     1.46e-022 (0)
(2.) UAV_NL/Nonlinear UAV Model/6DoF EOM/p,q,r
      x:     -8.5e-024      dx:      1.4e-012 (0)
      x:      1.6e-022      dx:     3.92e-014 (0)
      x:     1.45e-022      dx:     1.43e-013 (0)
(3.) UAV_NL/Nonlinear UAV Model/6DoF EOM/ub,vb,wb
      x:            17      dx:     2.51e-013 (0)
      x:    -1.76e-021      dx:    -5.11e-017 (0)
      x:         0.886      dx:     5.61e-014 (0)
(4.) UAV_NL/Nonlinear UAV Model/Auxiliary Equations/xe,ye,ze
      x:    -1.13e-015      dx:            17
      x:    -2.31e-015      dx:      -0.00491
```

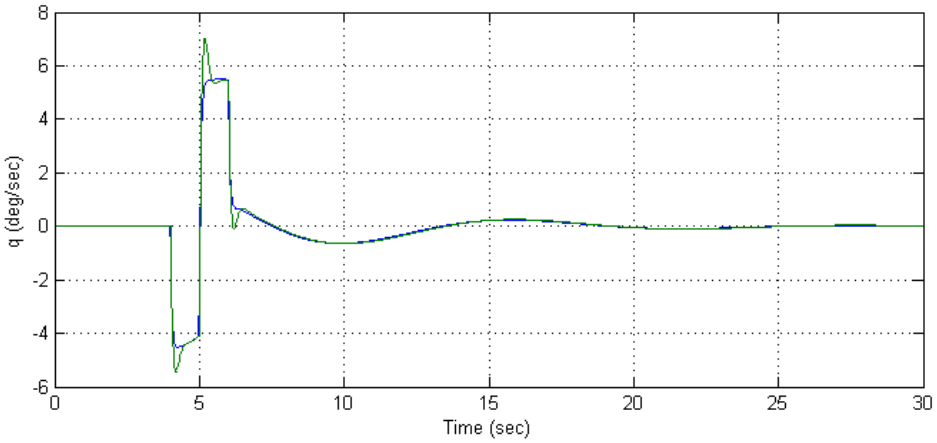
```
      x:          -100      dx:        2e-015
(5.) UAV_NL/Nonlinear UAV Model/Forces and Moments/Electric Propulsion Forces and
      x:           827      dx:      6.9e-011 (0)

Inputs:
----------
(1.) UAV_NL/elevator
      u:       -0.0772    [-0.436 0.436]
(2.) UAV_NL/aileron
      u:        0.0214    [-0.436 0.436]
(3.) UAV_NL/rudder
      u:      -0.00989    [-0.436 0.436]
(4.) UAV_NL/throttle
      u:          0.57    [0 1]
(5.) UAV_NL/flap
      u:             0

Outputs:
----------
(1.) UAV_NL/V_s
      y:            17    (17)
(2.) UAV_NL/beta
      y:    -1.04e-022    (0)
(3.) UAV_NL/alpha
      y:        0.0522    [-Inf Inf]
(4.) UAV_NL/h
      y:          79.1    [-Inf Inf]
(5.) UAV_NL/phi
      y:       0.00553    [-Inf Inf]
(6.) UAV_NL/theta
      y:        0.0522    [-Inf Inf]
(7.) UAV_NL/psi
      y:             0    [-Inf Inf]
(8.) UAV_NL/p
      y:     -8.5e-024    [-Inf Inf]
(9.) UAV_NL/q
      y:      1.6e-022    [-Inf Inf]
(10.) UAV_NL/r
      y:     1.45e-022    [-Inf Inf]
(11.) UAV_NL/gamma
      y:     1.18e-016    (0)


 Trim conditions saved as:  UAV_trimcondition.mat


 Longitudinal Dynamics
-----------------------
  State vector: x = [u w q theta Ze Omega]
  Input vector: u = [elevator throttle]
 Output vector: y = [Vs alpha q theta h]
 State matrix: A =


   -0.6161    0.8092   -9.7926   -0.8420    0.0000    0.0130
   -0.7457   -7.8119   -0.5113   15.6796   -0.0009         0
         0         0         0    1.0000         0         0
    0.2089   -4.0005         0   -9.3960    0.0000    0.0000
   -0.0521    0.9986  -17.0000         0         0         0
  135.7494    7.0878         0         0   -0.0827   -5.9162

Longitudinal Poles:
        Eigenvalue            Damping     Freq. (rad/s)
```

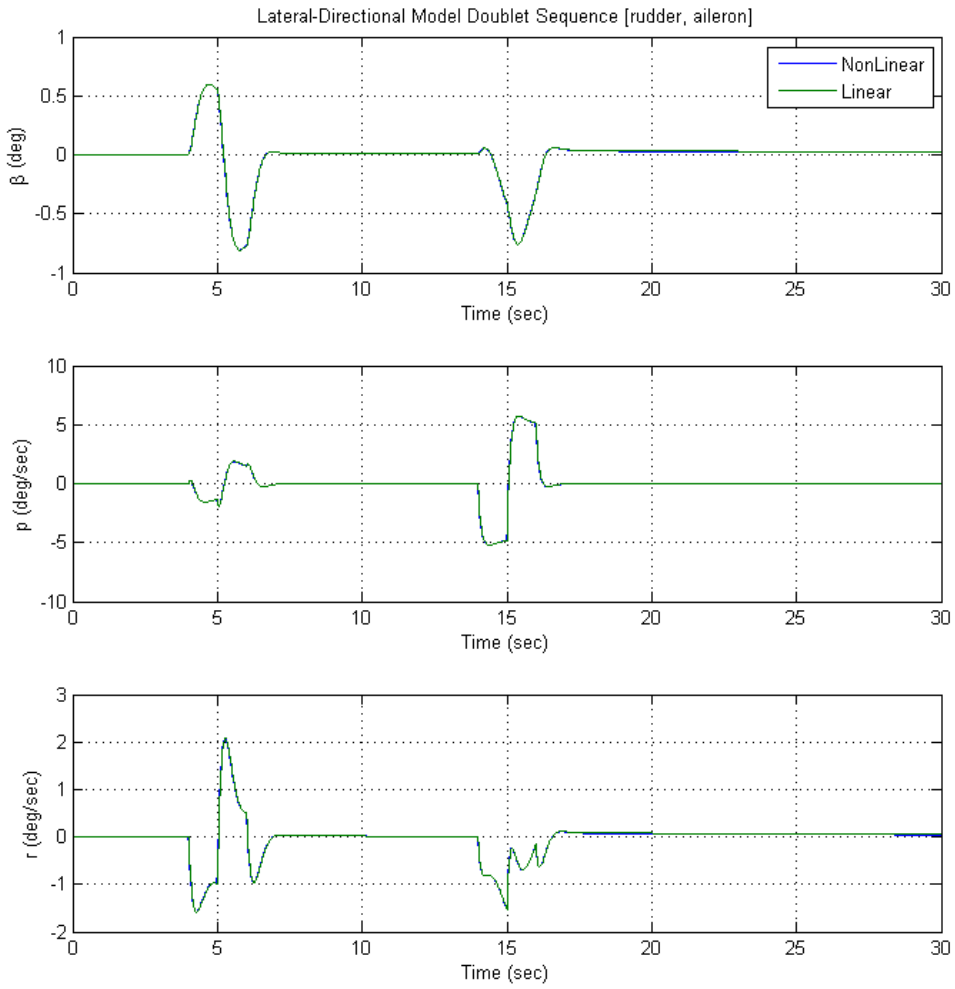
```
 -8.60e+000 + 7.90e+000i     7.36e-001      1.17e+001
 -8.60e+000 - 7.90e+000i     7.36e-001      1.17e+001
 -6.23e+000                  1.00e+000      6.23e+000
 -1.56e-001 + 5.36e-001i     2.80e-001      5.58e-001
 -1.56e-001 - 5.36e-001i     2.80e-001      5.58e-001
 -1.58e-004                  1.00e+000      1.58e-004



 Control matrix: B =
  1.0e+003 *

    0.0005         0
   -0.0028         0
         0         0
   -0.0800         0
         0         0
         0    2.5061


 Observation matrix: C =
    0.9986    0.0521         0         0         0         0
   -0.0031    0.0587         0         0         0         0
         0         0         0    1.0000         0         0
         0         0    1.0000         0         0         0
         0         0         0         0   -1.0000         0


 Eigenvalue: -8.5998 +/- 7.9048 i
 Damping = 0.7362, natural frequency = 11.6808 rad/s, period =   0.7949 s
 Eigenvalue: -6.2288
 Time constant = 0.1605 s
 Eigenvalue: -0.1559 +/- 0.5356 i
 Damping = 0.2795, natural frequency = 0.5578 rad/s, period =  11.7320 s
 Eigenvalue: -0.0002
 Time constant = 6319.9294 s

 Lateral-directional Dynamics
------------------------------
  State vector: x = [v p r phi psi]
  Input vector: u = [aileron rudder]
 Output vector: y = [beta p r phi psi]
 State matrix: A =


   -1.4762    0.8864  -16.9769    9.7924         0
   -1.7951  -12.1318   11.3027         0         0
    0.6544   -1.2726   -5.2307         0         0
         0    1.0000    0.0522    0.0000         0
         0         0    1.0013    0.0000         0

Lateral-directional Poles:
        Eigenvalue            Damping     Freq. (rad/s)

  0.00e+000                 -1.00e+000      0.00e+000
 -1.06e+001                  1.00e+000      1.06e+001
 -4.09e+000 + 3.42e+000i     7.67e-001      5.34e+000
 -4.09e+000 - 3.42e+000i     7.67e-001      5.34e+000
 -4.73e-002                  1.00e+000      4.73e-002
```

```
Control matrix: B =
         0    5.4807
  -53.5297   12.2805
  -11.2428  -13.2598
         0         0
         0         0


Observation matrix: C =
 1.0e+005 *

    0.0000         0         0         0         0
         0    0.0000         0         0         0
         0         0    0.0000         0         0
         0         0         0    0.0000         0
         0         0         0         0   -3.1416


Eigenvalue: -10.6075
Time constant = 0.0943 s
Eigenvalue: -4.0920 +/- 3.4248 i
Damping = 0.7668, natural frequency = 5.3361 rad/s, period =   1.8346 s
Eigenvalue: -0.0473
Time constant = 21.1369 s
```


Linear Velocity to Doublet Sequence [elevator,rudder,aileron]
Angular Velocity to Doublet Sequence [elevator,rudder,aileron]
NonLinear
Linear
u (m/sec)
v (m/sec)
w (m/sec)
p (deg/sec)
q (deg/sec)
r (deg/sec)
Time (sec)

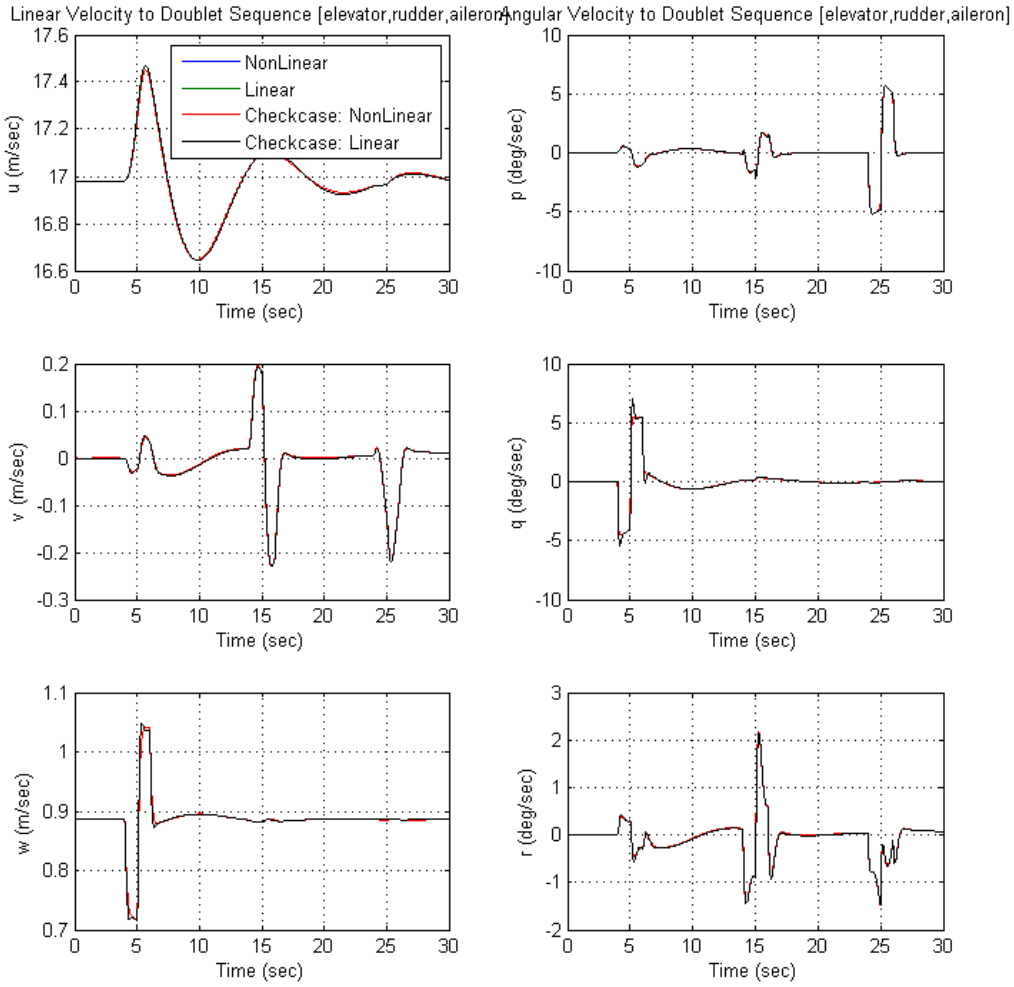

Longitudinal Model Doublet Sequence [elevator]
NonLinear
Linear
α (deg)
Time (sec)


q (deg/sec)
Time (sec)



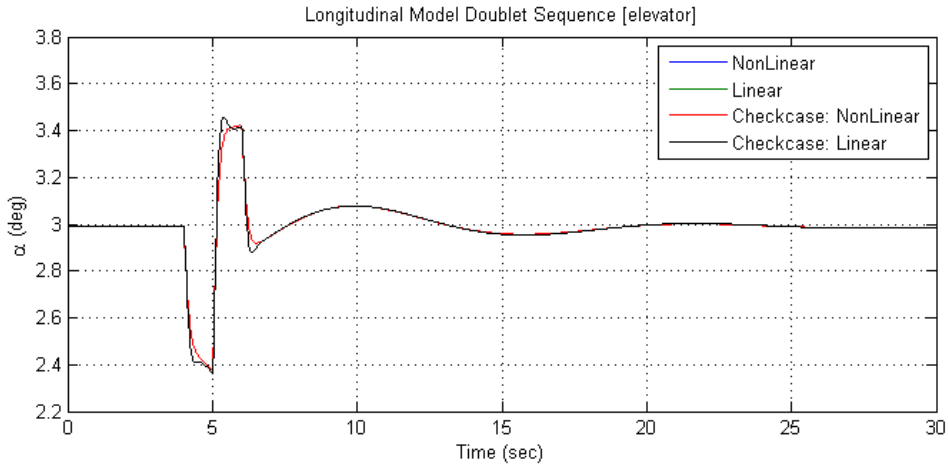
Full Linear Model

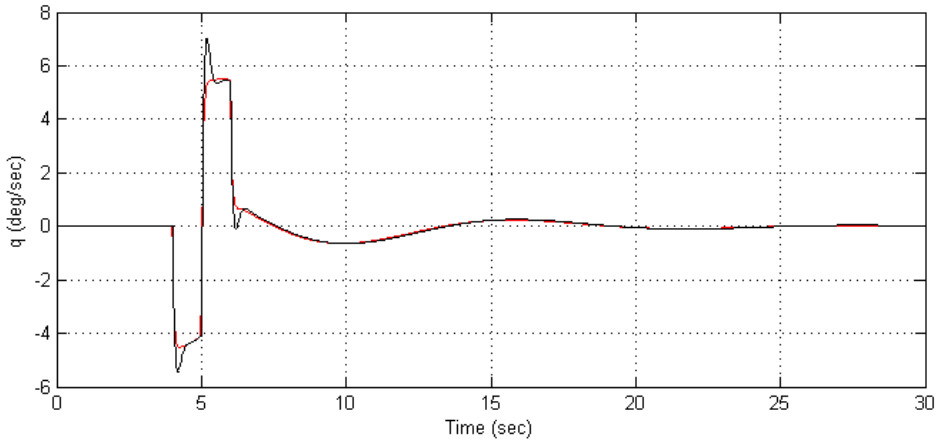
Full 13 state linear model. Doublets on elevator, aileron, and rudder.



Longitudinal Linear Model

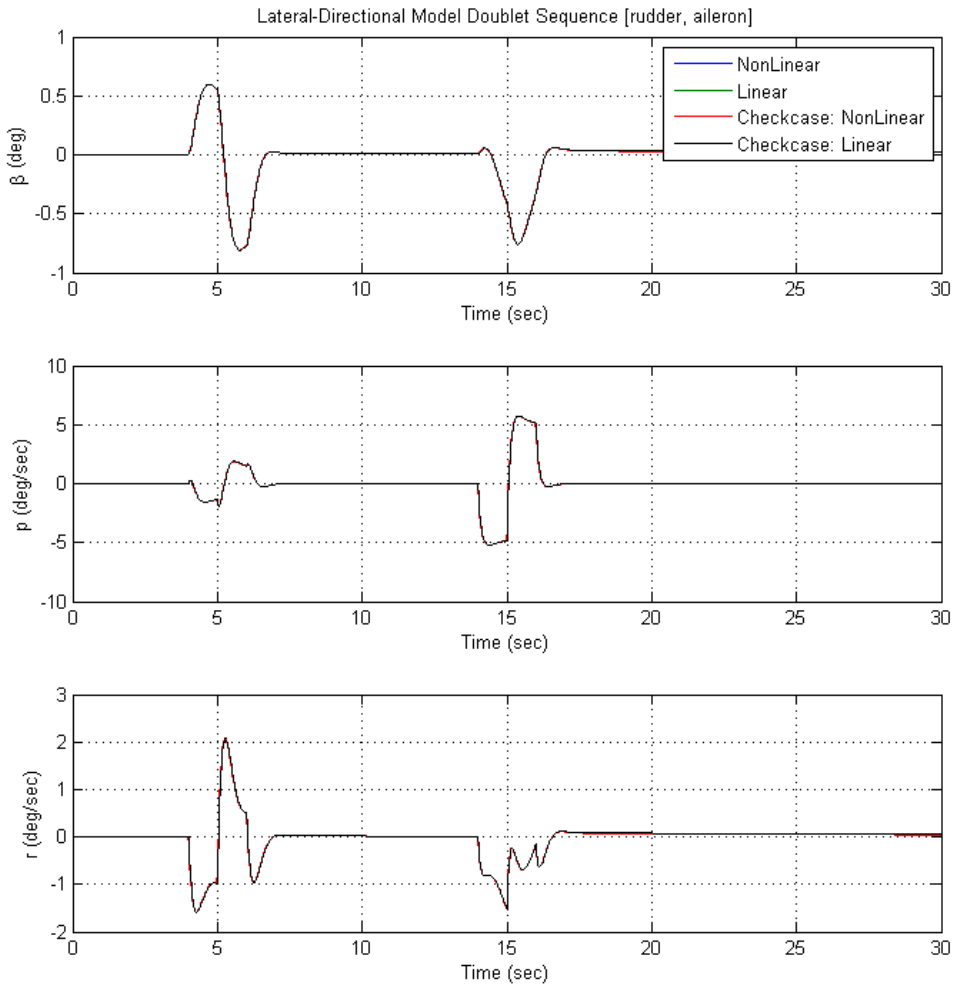
Reduced order longitudinal linear model. Doublets on elevator only.





Lateral-Directional Linear Model

Reduced order lateral directional linear model. Doublets on aileron and rudder.



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