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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).

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SVN Info: \$Id: model\_check.m 252 2011-01-20 21:36:15Z murch \$

```
Aircraft configuration saved as: UAV_modelconfig.mat
Warning: UAV_NL.mdl, line 18749: "UAV_NL/Nonlinear
UAV Model" is a parameterized link. To view,
discard, or propagate the changes for this link, use
the "Link Options" menu item
```

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 tolerance.

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 psi
      x:      0.00481      dx:    -1.72e-026 (0)
      x:      0.0217      dx:    -1.87e-023 (0)
      x:      0          dx:    -2.75e-023 (0)
(2.) UAV_NL/Nonlinear UAV Model/6DoF EOM/p,q,r
      x:      5.8e-025      dx:      9e-012 (0)
      x:    -1.88e-023      dx:      7.75e-022 (0)
      x:    -2.74e-023      dx:      7.77e-013 (0)
(3.) UAV_NL/Nonlinear UAV Model/6DoF EOM/ub,vb,wb
      x:      17          dx:      2.96e-011 (0)
      x:    -2.92e-021      dx:    -2.92e-017 (0)
```

---

```

      x:          0.37      dx:      -3.2e-022 (0)
(4.) UAV_NL/Nonlinear UAV Model/Auxiliary Equations/xe,ye,ze
      x:      4.05e-016      dx:          17
      x:      -3.82e-015      dx:      -0.00178
      x:          -100      dx:          0
(5.) UAV_NL/Nonlinear UAV Model/Forces and Moments/Electric Propulsion Forces and
      x:          827      dx:      -3.01e-010 (0)

```

Inputs:

```

-----
(1.) UAV_NL/elevator
      u:          0.091      [-0.436 0.436]
(2.) UAV_NL/aileron
      u:          0.0218      [-0.436 0.436]
(3.) UAV_NL/rudder
      u:      -0.0086      [-0.436 0.436]
(4.) UAV_NL/throttle
      u:          0.571      [0 1]
(5.) UAV_NL/flap
      u:          0

```

Outputs:

```

-----
(1.) UAV_NL/V_s
      y:          17      (17)
(2.) UAV_NL/beta
      y:      -1.72e-022      (0)
(3.) UAV_NL/alpha
      y:          0.0217      [-Inf Inf]
(4.) UAV_NL/h
      y:          79.1      [-Inf Inf]
(5.) UAV_NL/phi
      y:          0.00481      [-Inf Inf]
(6.) UAV_NL/theta
      y:          0.0217      [-Inf Inf]
(7.) UAV_NL/psi
      y:          0      [-Inf Inf]
(8.) UAV_NL/p
      y:      5.8e-025      [-Inf Inf]
(9.) UAV_NL/q
      y:      -1.88e-023      [-Inf Inf]
(10.) UAV_NL/r
      y:      -2.74e-023      [-Inf Inf]
(11.) UAV_NL/gamma
      y:          0      (0)

```

Trim conditions saved as: UAV\_trimcondition.mat  
Warning: UAV\_NL.mdl, line 18749: "UAV\_NL/Nonlinear UAV Model" is a parameterized link. To view, discard, or propagate the changes for this link, use the "Link Options" menu item

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 =

```

Columns 1 through 5

---

```

-0.6218    0.5910   -0.3637   -9.8036    0.0000
-0.9839   -7.8049   15.3209   -0.2132   -0.0009
 0.1807   -8.3092  -35.2017    0.0000
      0         0    1.0000    0.0000
-0.0217    0.9998    0 -17.0000    0
135.9053    2.9560    0      0   -0.0829

```

Column 6

```

0.0130
0
-0.0000
0
0
-5.9194

```

Longitudinal Poles:

Eigenvalue	Damping	Freq. (rad/s)
-2.93e+001	1.00e+000	2.93e+001
-1.37e+001	1.00e+000	1.37e+001
-6.24e+000	1.00e+000	6.24e+000
-1.69e-001 + 4.39e-001i	3.59e-001	4.71e-001
-1.69e-001 - 4.39e-001i	3.59e-001	4.71e-001
-1.57e-004	1.00e+000	1.57e-004

Control matrix: B =  
1.0e+003 \*

```

-0.0004    0
-0.0037    0
-0.1060    0
      0     0
      0     0
      0    2.5075

```

Observation matrix: C =  
Columns 1 through 5

```

0.9998    0.0217    0      0      0
-0.0013    0.0588    0      0      0
      0      0    1.0000    0      0
      0      0      0    1.0000    0
      0      0      0      0   -1.0000

```

Column 6

```

0
0
0
0
0

```

```

Eigenvalue: -29.2718
Time constant = 0.0342 s
Eigenvalue: -13.7022
Time constant = 0.0730 s
Eigenvalue: -6.2354
Time constant = 0.1604 s

```

---

Eigenvalue:  $-0.1691 \pm 0.4391 i$   
 Damping = 0.3594, natural frequency = 0.4705 rad/s, period = 14.3089 s  
 Eigenvalue: -0.0002  
 Time constant = 6357.6174 s

#### Lateral-directional Dynamics

---

State vector:  $x = [v \ p \ r \ \phi \ \psi]$   
 Input vector:  $u = [\text{aileron} \ \text{rudder}]$   
 Output vector:  $y = [\text{beta} \ p \ r \ \phi \ \psi]$   
 State matrix:  $A =$

-1.4765	0.3697	-16.9960	9.8035	0
-1.7440	-12.1069	10.9184	0	0
0.6903	-1.0701	-5.4645	0	0
0	1.0000	0.0218	-0.0000	0
0	0	1.0002	-0.0000	0

#### Lateral-directional Poles:

Eigenvalue	Damping	Freq. (rad/s)
0.00e+000	-1.00e+000	0.00e+000
-1.10e+001	1.00e+000	1.10e+001
-3.99e+000 + 3.36e+000i	7.65e-001	5.22e+000
-3.99e+000 - 3.36e+000i	7.65e-001	5.22e+000
-5.79e-002	1.00e+000	5.79e-002

#### Control matrix: $B =$

0	5.4807
-53.7367	11.4365
-10.3888	-13.5671
0	0
0	0

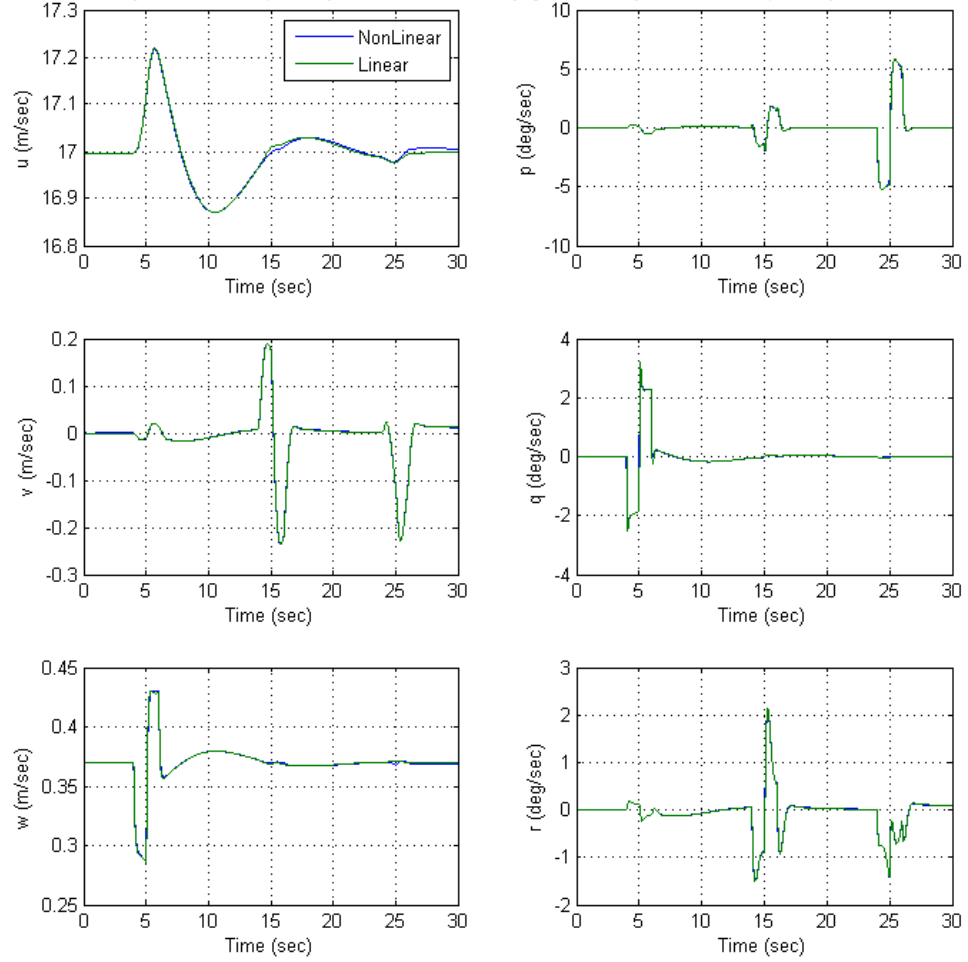
#### Observation matrix: $C =$

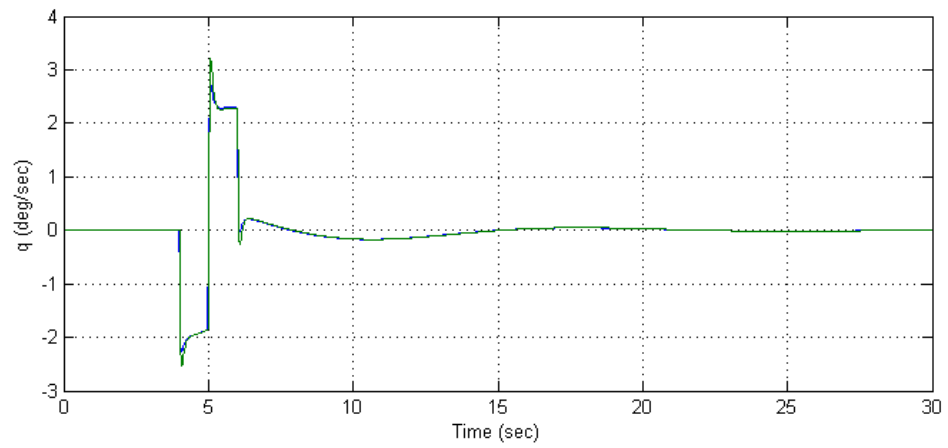
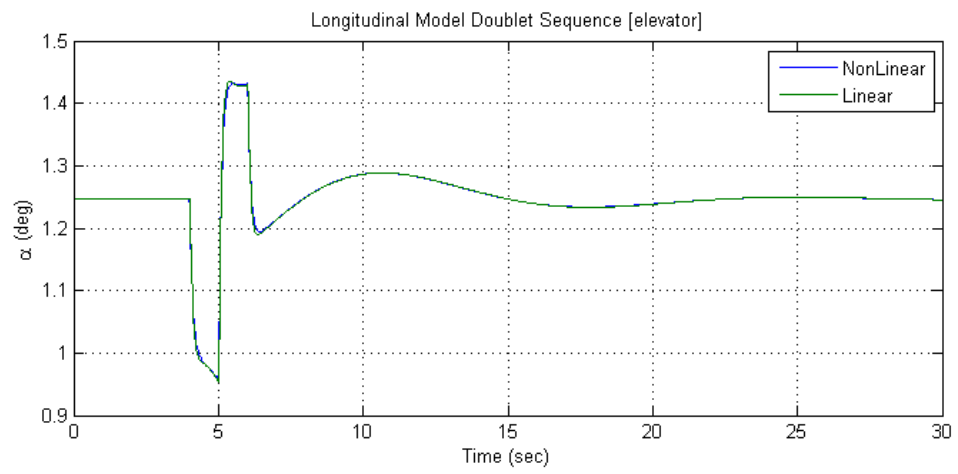
0.0588	0	0	0	0
0	1.0000	0	0	0
0	0	1.0000	0	0
0	0	0	1.0000	0
0	0	0	0	1.0000

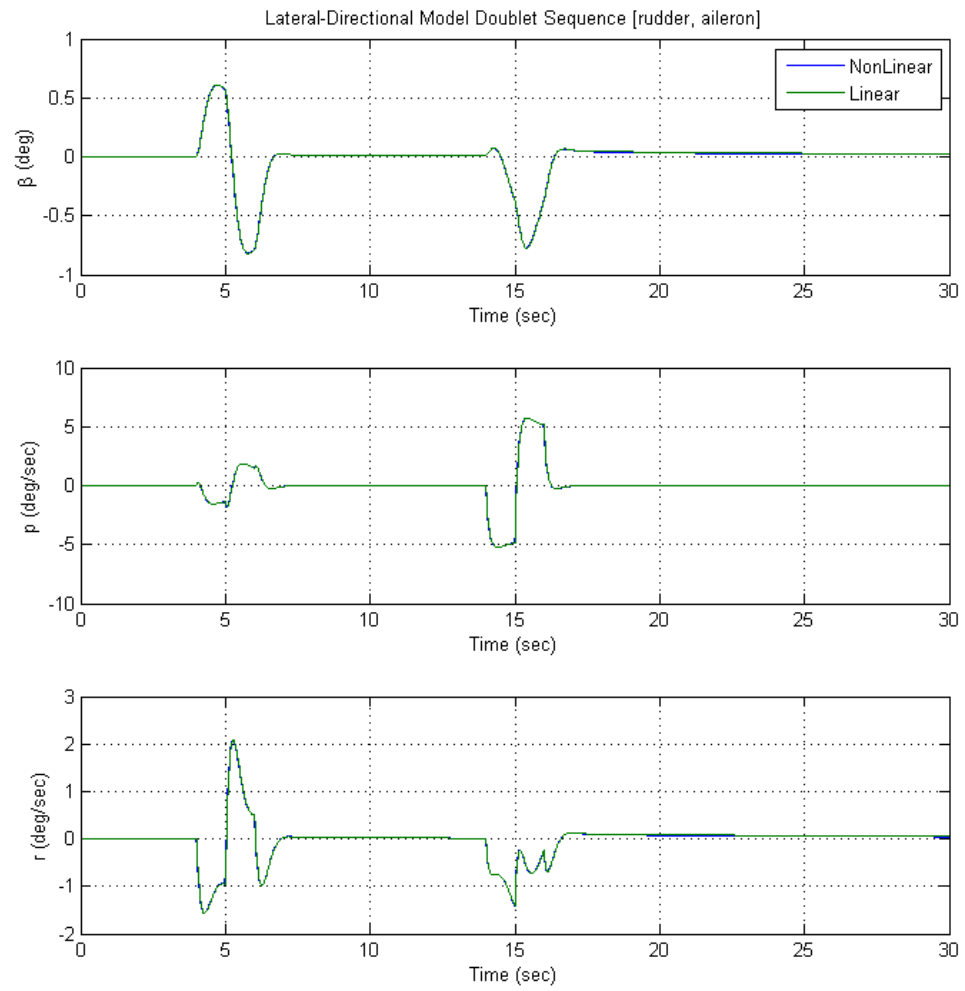
Eigenvalue: -11.0134  
 Time constant = 0.0908 s  
 Eigenvalue:  $-3.9883 \pm 3.3627 i$   
 Damping = 0.7645, natural frequency = 5.2167 rad/s, period = 1.8685 s  
 Eigenvalue: -0.0579  
 Time constant = 17.2664 s

Warning: UAV\_NL.mdl, line 18749: "UAV\_NL/Nonlinear UAV Model" is a parameterized link. To view, discard, or propagate the changes for this link, use the "Link Options" menu item

Linear Velocity to Doublet Sequence [elevator,rudder,aileron] Angular Velocity to Doublet Sequence [elevator,rudder,aileron]





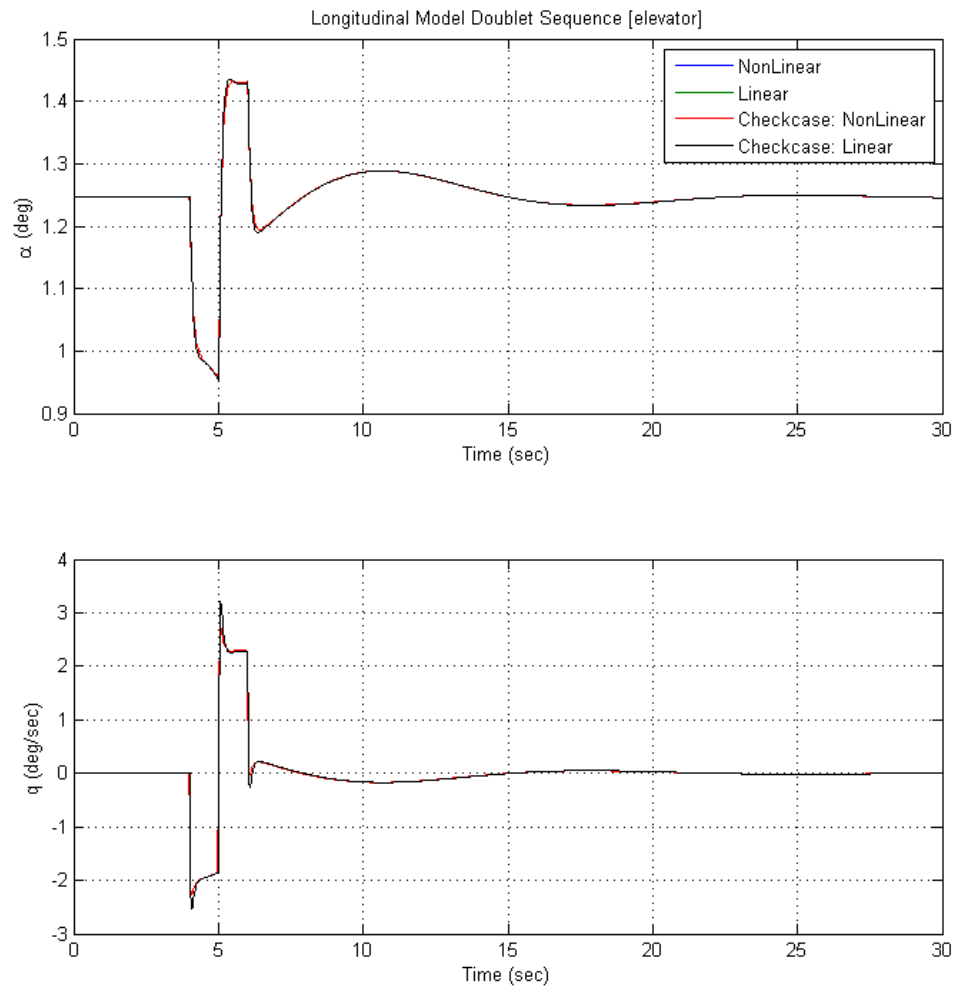


## Full Linear Model

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

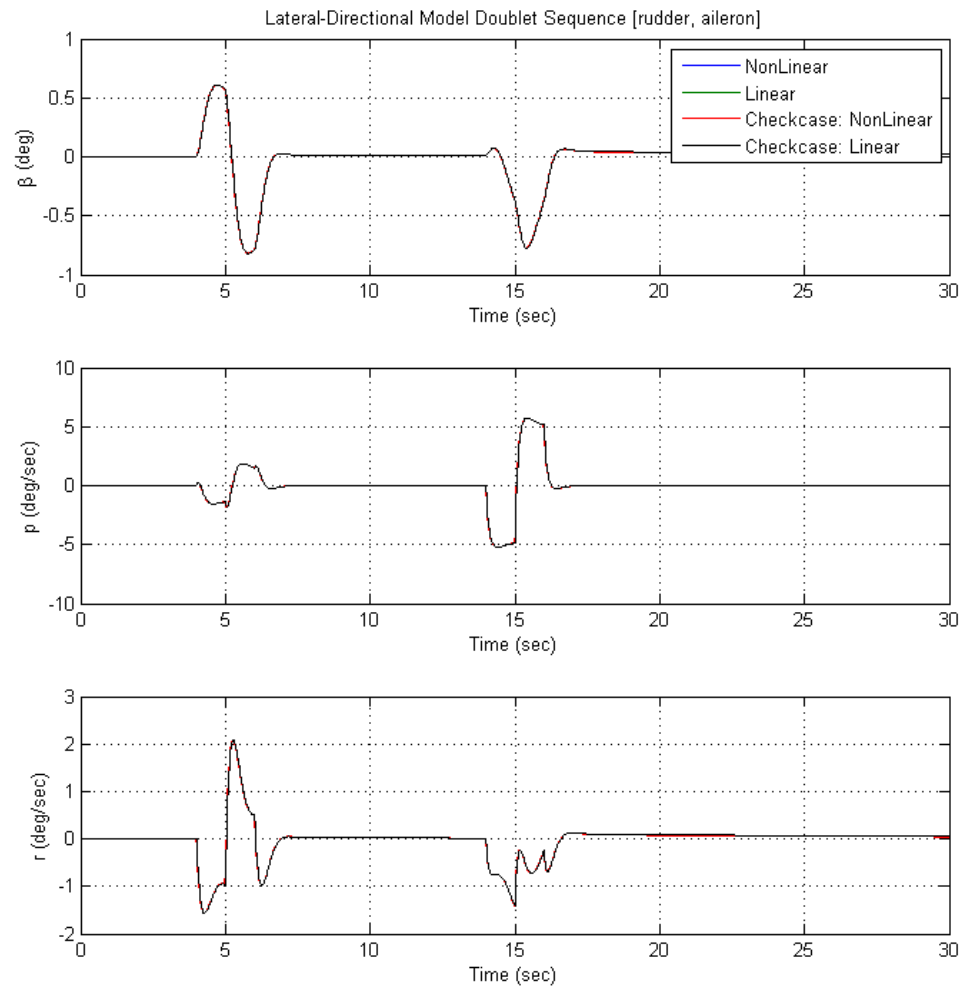






## Lateral-Directional Linear Model

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



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