ActuatorSelection_Test3_2

October 21, 2021

1 Benefit of Multiplicative (MPL) Models over Nominal (Nom) Models of Systems

Testing actuator selection and feedback of Nominal and MPL models on simulations of True system

Py Packages

```
[1]: import numpy as np
     from copy import deepcopy as dc
     %matplotlib widget

     from functionfile_system_definition import sys_from_file, system_display_matrix
     from functionfile_system_mplcost import simulation_nom_vs_mpl,␣
      →plot_simulation_nom_vs_mpl_1, plot_simulation_nom_vs_mpl_2,␣
      →actuator_comparison
```

1.1 Code

```
[2]: test_set = 'System Model 1'
     S_True = sys_from_file(test_set + ' True')
     S_MPL = sys_from_file(test_set + ' MPL')
     S_Nom = sys_from_file(test_set + ' Nominal')
```

```
System read from file @ system_model/System Model 1 True.pickle

System read from file @ system_model/System Model 1 MPL.pickle

System read from file @ system_model/System Model 1 Nominal.pickle
```

```
[3]: ret_sim = simulation_nom_vs_mpl(S_Nom, S_MPL, S_True)
```

1.2 Output

System Models

True System

```
[4]:
```

```
print('max(abs(eigvals(A)))= %.4f' % (np.max(np.abs(np.linalg.
  →eigvals(S_True['A'])))))
system_display_matrix(S_True)
```

max(abs(eigvals(A)))= 0.9500

Canvas(toolbar=Toolbar(toolitems=[('Home', 'Reset original view', 'home', ␣
  →'home'), ('Back', 'Back to previous …

Nominal Model

```
[5]: print('max(abs(eigvals(A)))= %.4f' % (np.max(np.abs(np.linalg.
  →eigvals(ret_sim['system_nom']['A'])))))
system_display_matrix(ret_sim['system_nom'])
```

max(abs(eigvals(A)))= 0.9500

Canvas(toolbar=Toolbar(toolitems=[('Home', 'Reset original view', 'home', ␣
  →'home'), ('Back', 'Back to previous …

Multiplicative Noise Model

```
[6]: print('max(abs(eigvals(A)))= %.4f' % (np.max(np.abs(np.linalg.
  →eigvals(ret_sim['system_mpl']['A'])))))
system_display_matrix(ret_sim['system_mpl'])
```

max(abs(eigvals(A)))= 0.9500

Canvas(toolbar=Toolbar(toolitems=[('Home', 'Reset original view', 'home', ␣
  →'home'), ('Back', 'Back to previous …

Simulation - Trajectory, Control Input and Costs

```
[7]: plot_simulation_nom_vs_mpl_1(ret_sim)
```

Canvas(toolbar=Toolbar(toolitems=[('Home', 'Reset original view', 'home', ␣
  →'home'), ('Back', 'Back to previous …

Actuator set comparison

```
[8]: actuator_comparison(ret_sim['system_mpl'], ret_sim['system_nom']);
# if ret_sim['act_check']:
#     print('Actuator sets are different')
#     print('Nominal B:\n', ret_sim['B_Nom'])
#     print('MPL B:\n', ret_sim['B_MPL'])
#     print('B diff (Nom - MPL):\n', ret_sim['B_Nom'] - ret_sim['B_MPL'])
# else:
#     print('Same actuator sets')
#     print('Nominal B = MPL B:\n', ret_sim['B_MPL'])
```

Control sets are different

Canvas(toolbar=Toolbar(toolitems=[('Home', 'Reset original view', 'home', ␣
  →'home'), ('Back', 'Back to previous …

Simulated costs

```
[9]: print('True simulation cost with <___> feedback (4decimal approx)')
     for key in ret_sim['T_Nom']['costs']:
         print ("|S|: %s | Nom: %.4f | MPL: %.4f | Diff (Nom-MPL) %.4f" % (key,
         ↪ret_sim['T_Nom']['costs'][key][-1], ret_sim['T_MPL']['costs'][key][-1],
         ↪ret_sim['T_Nom']['costs'][key][-1]-ret_sim['T_MPL']['costs'][key][-1]))
     #    print('|S|:', key, '| Nom:', ret_sim['T_Nom']['costs'][key][-1], '| MPL:
     ↪ ', ret_sim['T_MPL']['costs'][key][-1], ' | Diff (Nom-MPL):',
     ↪ret_sim['T_Nom']['costs'][key][-1]-ret_sim['T_MPL']['costs'][key][-1])
```

```
True simulation cost with <___> feedback (4decimal approx)
|S|: 1 | Nom: 26291.6224 | MPL: 26277.5096 | Diff (Nom-MPL) 14.1129
|S|: 2 | Nom: 19728.3951 | MPL: 19678.8618 | Diff (Nom-MPL) 49.5333
|S|: 3 | Nom: 15758.2399 | MPL: 14833.1283 | Diff (Nom-MPL) 925.1116
|S|: 4 | Nom: 15037.7818 | MPL: 13434.0968 | Diff (Nom-MPL) 1603.6850
|S|: 5 | Nom: 13415.9116 | MPL: 12664.6753 | Diff (Nom-MPL) 751.2363
|S|: 6 | Nom: 12206.0345 | MPL: 11895.9663 | Diff (Nom-MPL) 310.0682
|S|: 7 | Nom: 11791.6587 | MPL: 11431.4561 | Diff (Nom-MPL) 360.2026
|S|: 8 | Nom: 11410.6990 | MPL: 11018.8946 | Diff (Nom-MPL) 391.8044
|S|: 9 | Nom: 10753.7986 | MPL: 10624.2851 | Diff (Nom-MPL) 129.5135
|S|: 10 | Nom: 10298.4039 | MPL: 10220.3008 | Diff (Nom-MPL) 78.1031
```

```
[10]: plot_simulation_nom_vs_mpl_2(ret_sim)
```

```
Canvas(toolbar=Toolbar(toolitems=[('Home', 'Reset original view', 'home',
↪ 'home'), ('Back', 'Back to previous …
```

1.3 Run Complete

```
[11]: print('Run Complete')
```

```
Run Complete
```