

F18 Analysis Folder Description

This file explains the contents and objectives of each of the F18 Analysis folders that are provided.

NOTE: Users who are not interested in model development and formulation can skip folders 1 and 2. They can use the plants given in folder 3 and proceed with the analysis in folders 4-6.

Contents

- [Folder 1: 1_F18FullModel](#)
- [Folder 2: 2_F18ReducedModel](#)
- [Folder 2a: Nonlinear Model](#)
- [Folder 2b: LinearModel](#)
- [Folder 3: 3_F18AnalysisPlants](#)
- [Folder 4: 4_LinearAnalysis](#)
- [Folder 5: 5_MonteCarlo](#)
- [Folder 6: 6_ROAAnalysis](#)

Folder 1: 1_F18FullModel

Description:

This folder contains a detailed and full 6 degree-of-freedom 9 State description of the F/A-18 aircraft, including the aerodynamic equations and physical parameters of the aircraft.

USAGE:

Run `runf18full.m` to generate initial condition response of the F/A-18 aircraft.

Files:

NOTE: This model has been reduced further to perform all the analyses. We have not used this model for any of the analyses /results presented here. This model is given only for completeness. None of the analyses have been performed on this full model.

f18full.m This file describes a 6 DoF / 9 state F/A-18 nonlinear model. This also includes the aerodynamic data and physical parameters of the aircraft.

runf18full.m: This file simulates initial condition response of the F/A-18 model described in f18full.m.

Folder 2: 2_F18ReducedModel

This folder formulates and develops the reduced order model for analysis. The models generated from this folder have been included in Folder 3: F18 Analysis Plants. This section can be skipped if model formulation is not of interest.

Folder 2a: Nonlinear Model

Description:

This folder contains multiple files. Each file will be described below. The subsequent

analysis compares the stability properties of two different control laws: (i) Baseline , and (ii) Revised control law. This file generates cubic order reduced models for the F/A-18 open loop plant and for the closed-loop systems with the baseline and revised controllers.

USAGE:

(a) Run **F18CubicNL_BaseLine.m** to generate Cubic Degree Polynomial Closed Loop Baseline model.

(b) Run **F18CubicNL_Revised.m** to generate Cubic Degree Polynomial Closed Loop Revised model.

Files:

NOTE : The following files require the Multipoly toolbox.

F18CubicNL_OLoop.m: This file generates a polynomial open loop nonlinear F/A-18 model.

F18CubicNL_BaseLine.m: This file generates the Baseline Closed Loop cubic order F/A-18 model.

LS_xcldot_BaseLine.m: This file is being used by the F18Clp_BaseLine.m file to perform the least square approximation.

F18CubicNL_Revised.m: This file generates the Revised Closed Loop cubic order F/A-18 model.

LS_xcldot_Revised.m: This file is being used by the F18Clp_Revised.m file to perform the least square approximation.

f18_data.m: This file contains all the physical parameters of the F/A-18. The Velocity state which assumed to be constant is also included there.

AeroApprox.m: This file contains approximation of some of the aerodynamic coefficients.

Folder 2b: LinearModel

Description:

This folder contains multiple files. Each files will be described below. This folder generates the open loop linear model for the F/A-18 aircraft.

USAGE:

(a) Run **Lin_F18.m** to generate open loop linear F/A-18 plant for flight condition described inside this file.

Files:

Lin_F18.m: This file will trim & generate the open loop linear model for F/A-18 aircraft. The trimming and linearization is done based on the nonlinear plant 'F18Reduced_OLoop.m' described in the "2_F18ReducedModel /NonlinearModel" Folder.

f18_plant.m: This file contains the nonlinear plant 'F18CubicNL_OLoop.m' described in the "2_F18ReducedModel /NonlinearModel" Folder. This file can be used to simulate open loop response.

f18_sfcn.m: This is a S-function for performing trimming. This file is being used in the Lin_F18.m file.

f18_trim.mdl: This is a Simulink file, also used for trimming. This file is being used in the Lin_F18.m file.

Folder 3: 3_F18AnalysisPlants

Description:

This folder contains all the linear and nonlinear plants for analysis. For detailed description on how these models have been generated refer to Folder 2 and its subfolders.

Files:

F18BaselineCubic.MAT: This MAT file contains the cubic order F/A-18 baseline closed loop model. This will be used for nonlinear analysis.

F18RevisedCubic.MAT: This MAT file contains the cubic order F/A-18 revised closed loop model. This will be used for nonlinear analysis.

LinF18OLoop---.MAT: These MAT files (starting with 'LinF18OLoop...') contain two open loop linear plants. The difference in these two linear plants are in the output equation ($y = Cx + Du$), as each control law uses different feedback channels. The plant named "Pss_Baseline" will be used to construct the baseline model whereas plant "Pss_Revised" is used for building up the revised model.

Folder 4: 4_LinearAnalysis

Description:

This folder generates the closed loop linear (i) baseline, (ii) revised models. Then, linear robustness analysis have been performed on these two plants.

USAGE:

(a) Run **F18_Lin_Analysis.m**: to perform linear analysis on both the linearized baseline and revised model. This file generates the linear closed loop plants and perform all the robustness analysis.

Files:

F18_Lin_Analysis.m: Run this file to performs linear robustness analysis on the two closed loop linear models specified above.

Gen_LinF18Clps.m: This file generates closed loop F/A-18 models given the open loop plants. The open loop plant(s) should be named in the following way :
Pdata.Pss_Baseline Pdata.Pss_Revised

NOTE: Use "2_F18ReducedModel/LinearModel/Lin_f18.m"
for generating both (i) baseline (ii) revised open loop l
models with correct ordering of state, input and output.

Gen_LinF18ClpPlants.m: This file generates both (i) baseline and (ii) revised closed loop linear models for all the linear plants provided in the "3_F18AnalysisPlants" folder as |**LinF18OLoop.MAT**:| files.

Folder 5: 5_MonteCarlo

Description:

This folder contains files that will run Monte Carlo simulation on the closed loop nonlinear plants provided in the "3_F18AnalysisPlants" Folder.

USAGE:

Both the files can be executed to perform the tasks mentioned below.

Files:

Search4UnstableTraj.m: This file solves the following via Monte Carlo $\min x_0^T N x_0$ ($N :=$ shape factor) subject to: $dx/dt = f(x)$ diverges from the initial condition x_0 .

Search4VdotPos.m: This file attempts to solve via Monte Carlo search: $\min x_0^T N x_0$ subject to: $dV/dt = \text{grad}(V)(x) * f(x) > 0$

Folder 6: 6_ROAAnalysis**Description:**

This folder contains files that will perform the region-of-attraction analysis on the cubic order polynomial models described in the Folder 1-3.

USAGE:

Both the files can be executed to perform the tasks mentioned below.

Files:

ROA1_F18_LinearizedLyap.m: This file computes an estimate of the region of attraction for the F/A-18 using the Lyapunov function obtained via linearization.

ROA2_F18_VSIteration.m: This file computes an estimate of the region of attraction for F/A-18 using the V-S Iteration.