Semi-automatic Identification and Representation of Subsystem Variability in Simulink Models

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Motivation

- Understanding how variability is handled in models can reduce maintenance efforts and facilitate bug detection early on.
- The creation of variability models allows for effective reuse of well-maintained models.
- Automating the process of variability modeling will greatly improve the efficiency of model development.

Variability Identification

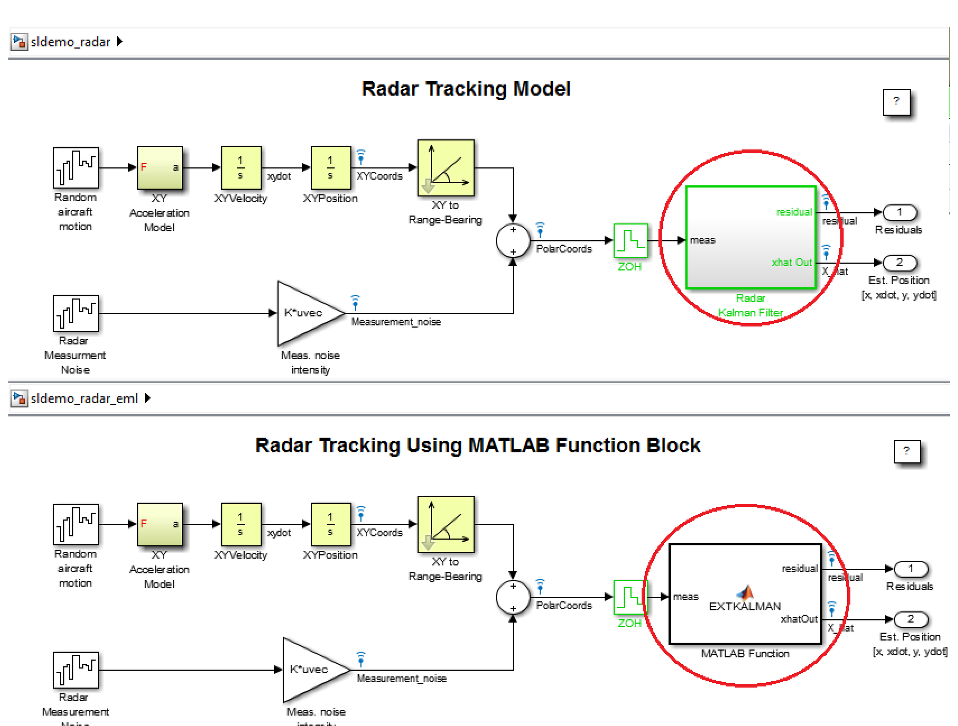
- We performed clone detection on six open source sets of Simulink Models using the Simone Clone Detector tool.
- The results are a number of "Clone Classes" that group models with a certain similarity – 80% in this case.
- The initial clustering provided by Simone allowed for a manual inspection of the clone classes in order to determine the five variability operators described below.

Observed Clones

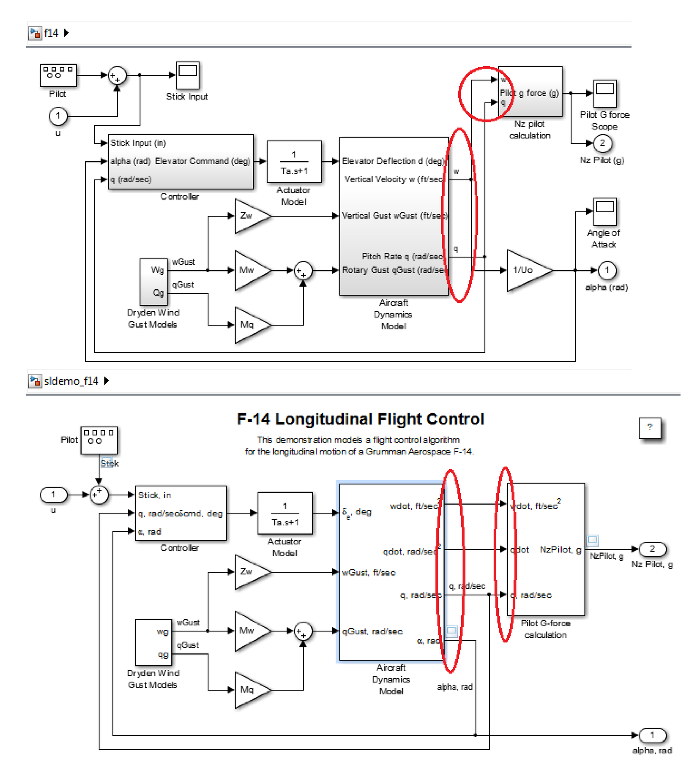
	# Subsystems	# Clone Pairs	# Clone Classes
Automotive	357	189	24
Aerospace	188	62	15
Industrial	16	4	2
Features	935	85	25
General	146	11	7
Others	28	6	4

Simone Clone Detection Results at a Difference Threshold of 20%

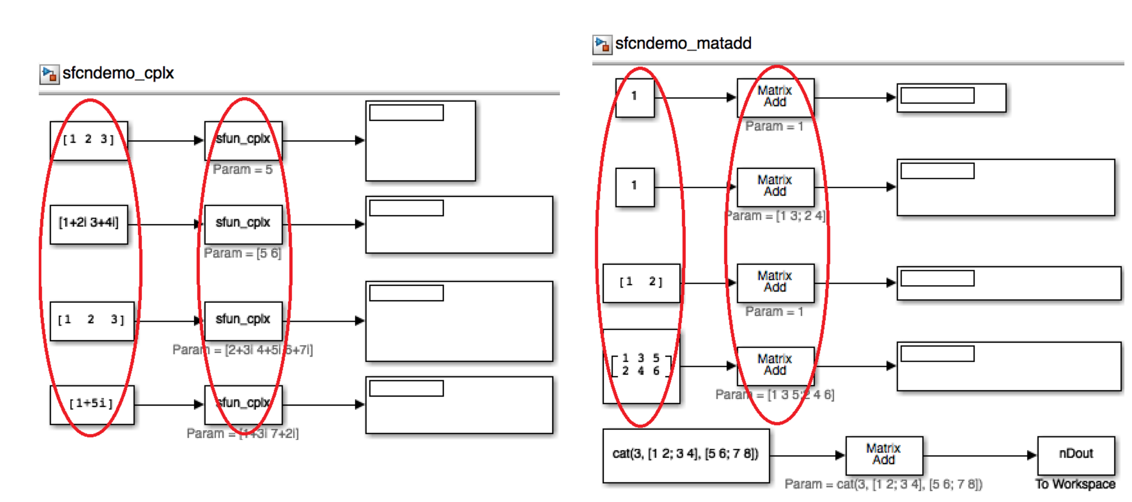
Variability Operators



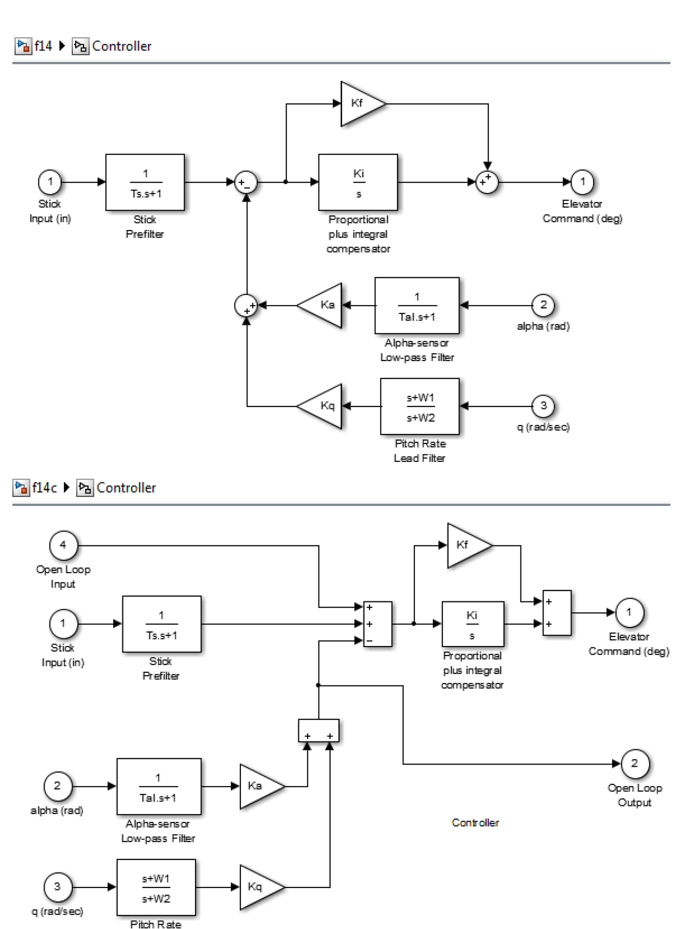
Block Variability



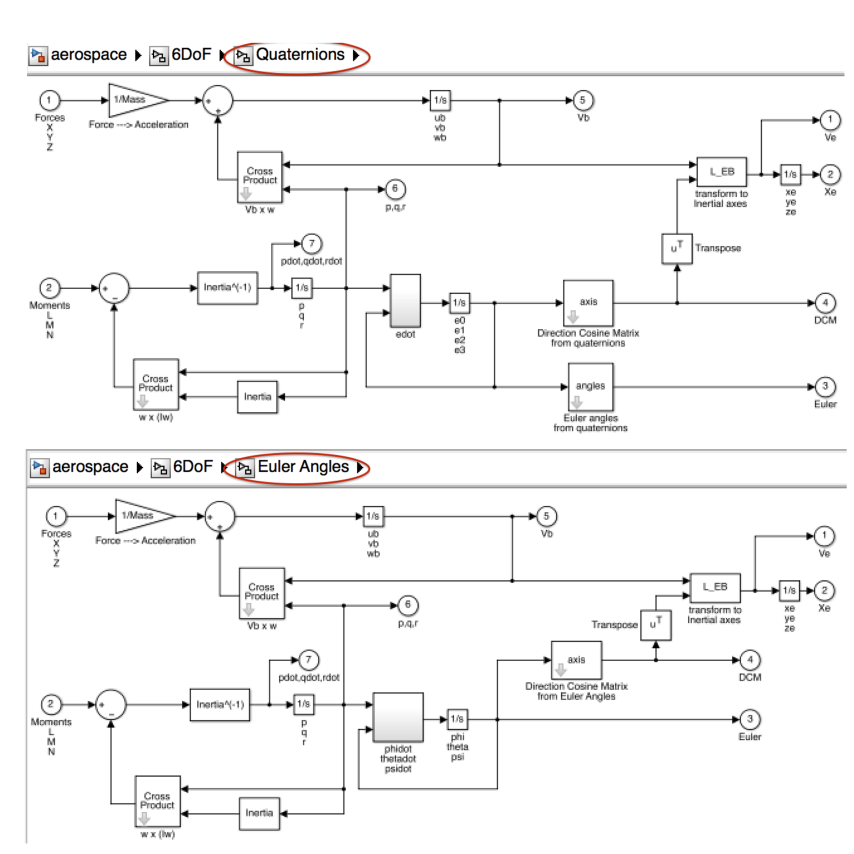
Input/Output Variability



Function Variability



Layout Variability

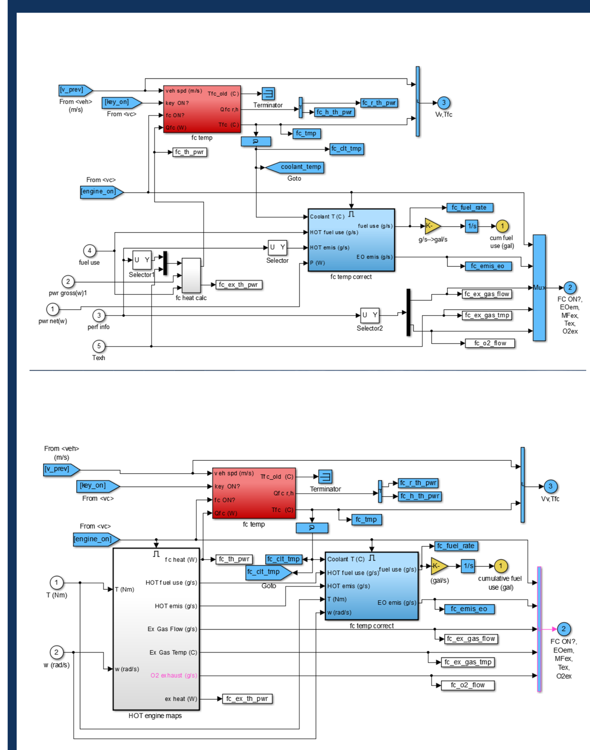


Subsystem Name Variability

	Block	I/O	Function	Layout	Subsystem Name
Automotive	10	6	1	3	8
Aerospace	5	17	2	4	13
Industrial	5	2	0	0	0
Features	22	22	17	2	4
General	5	3	1	1	1
Others	14	24	4	3	5
Total	61	74	25	13	31

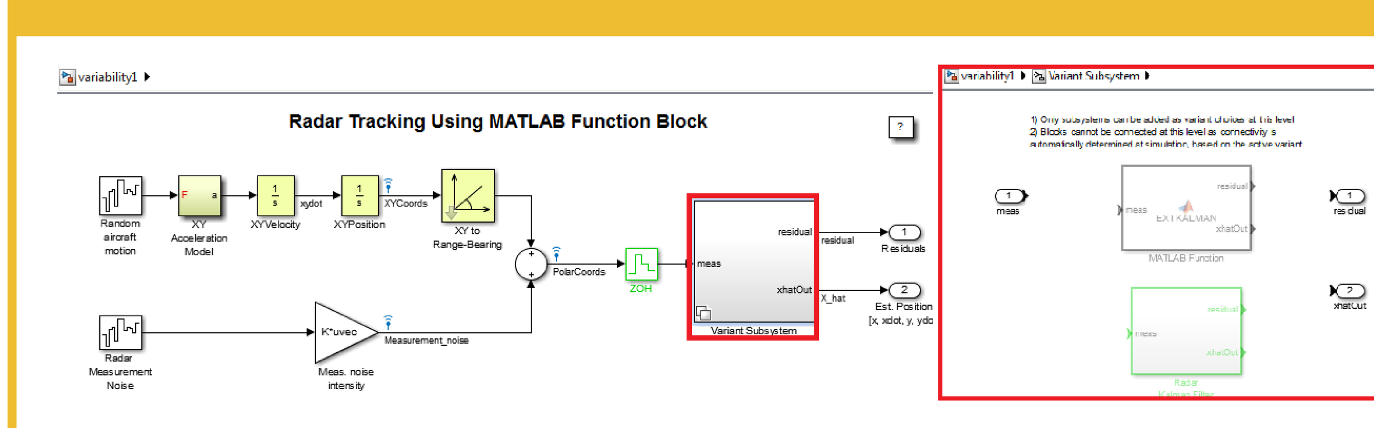
Observed Instances of Variability Operators

Tagging Variability



Common blocks are computed by a graph matching algorithm. First, the root block (red) is determined, then neighbouring blocks are recursively included first by strong match (blue) then by weak match (yellow).

Representing Variability



Through the use of Simulink Variant Subsystem Blocks, we are able to represent multiple variants of a given model within a single Simulink Model. This example shows the use of a Variant Subsystem Block to model the block variability demonstrated above.

References

1. M.H. Alalfi, E.J. Rapos, A. Stevenson, M. Stephan, T.R. Dean, and J.R. Cordy. Semi-automatic Identification and Representation of Subsystem Variability in Simulink Models. In *ICSME'14 - 30th Int. Conf. on Softw. Maint. & Evol.*, 2014. (to appear)
2. M.H. Alalfi, J.R. Cordy, T.R. Dean, M. Stephan, and A. Stevenson. Models are code too: Near-miss clone detection for Simulink models. In *ICSM'12 - 28th Int. Conf. on Softw. Maint.*, pp. 295–304, 2012.
3. J.R. Cordy. Submodel pattern extraction for Simulink models. In *SPLC'13 - 17th Int. Conf. on Softw. Product Lines*, pp. 7–10, 2013.