Nonlinear Vibrations of Aerospace Structures



T08 Nonlinear Vibrations Course at ULiège

Application to a Real-life Structure: F-16 Fighter



F-16 aircraft, Saffraanberg, Belgium.



Nonlinear connection instrumented on both sides.

Import LMS Measurement Geometry and Recorded Data

NI2D: New model								\times	
User models	Spring/mass system	MCK matrices	Finite element model	DAQ model	Mea	sured sig	gnals		
	Model:		F16_Geometry.xlsx		2	۲			
	Measure:		F16_Data.mat		2				
	NI2D: messag	je		_			Х		
	Sensor(s) below a	re not linked to ge	eometry nodes.						
Shaker/	SE DP_RIGHT:-Z,RP +Z,LPYL_WS:+X,I	DP_RIGHT:-Z,RPYL_WS:+X,RPYL_WS:+Y,RPYL_WS:+Z,RPYL_PS:+X,RPYL_PS:+Y,RPYL_PS: +Z,LPYL_WS:+X,LPYL_WS:+Y,LPYL_WS:+Z,LPYL_PS:+X,LPYL_PS:+Y,LPYL_PS:+Z							
Number	Sa They will not be via circle (in Model tab of	sible on the mode	el geometry but only on the	e sensors	_		_		
	Continue >			Abort					

The F-16 Measurement Geometry Is Visualised



Nonlinearity in the Back Connection of the Right Wing

Remember: ASM characterises the nonlinearity between two nodes.



$$g_i(q_i-q_j,\dot{q}_i-\dot{q}_j)\cong -\ddot{q}_i$$

i refers to sensor #1 and *j* to sensor #2

Menu: sensor RMIS_MS:1004:+Z	
View signal	
Wavelet transform [+ <control> for params]</control>	
Frequency filter	
Instant frequency	
Select	
Color	
User colors	>
Predefined colors	>
-> ASM: sensor #1	
-> ASM: sensor #2	

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Select ASM in the Solver List



Qualitative Stiffness Nonlinearity around One Mode



Qualitative Damping Nonlinearity around One Mode



ASM Applied over Two Modes Leads to Unclear Results



Nonlinearities in complex structures can be visualised!

The NI2D software provides a user-friendly platform to apply ASM:

- Selection of the modes of interest;
- Zero-velocity slices ;
- Stiffness and damping curves.