Breaking the computational barrier to simulating full road load signals in fatigue

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Extended Abstract

In this work, we present the Endurica EIE™ nonlinear load mapping procedure, which provides a means by which the strain/stress histories resulting from full road load signals can now be rapidly generated. The procedure utilizes a series of pre-computed finite element solutions to populate a nonlinear map relating global load/displacement inputs to local strains/stresses within each finite element. For each time step of the full road load signal, the nonlinear map is used to obtain stress/strain results via interpolation. Examples are provided for 1-, 2- and 3-channel signal inputs, and applied to the following automotive components: a sway bar link, a control arm bushing, and a transmission mount. Input signals of several durations were studied as follows: 1000, 10000 and 100000 time steps.

The results show that EIE can quickly compute strain histories interpolated from a precomputed set of results with an error that can be controlled to a desired accuracy via map discretization. EIE's benefit of efficiently interpolating results becomes more pronounced as signal length increases, in this study reaching nearly as high as a 4 orders of magnitude speed-up. However, EIE becomes less efficient as the number of problem dimensions increases (from one dimension to three dimensions). The lower benefit is due to the high cost of producing a higher dimensional map of FEA results for EIE to interpolate from. Even in this case, however, as seen for the 3D transmission mount analysis, the cost of creating the EIE map is still worthwhile when signal length is sufficiently long.

Table 1. Matrix of models, mappings, and signals evaluated.

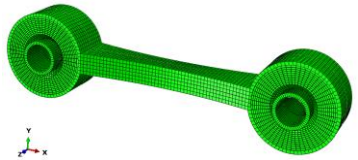
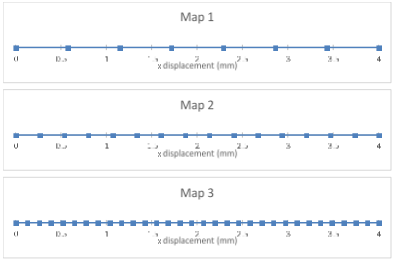
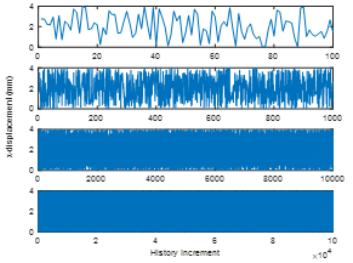
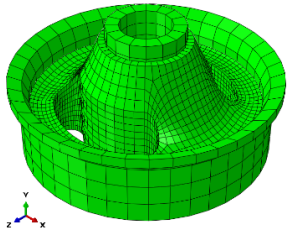
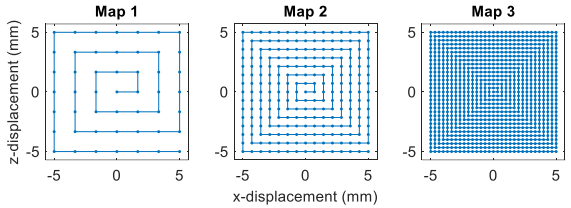
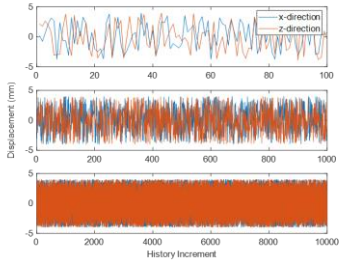
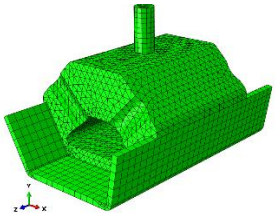
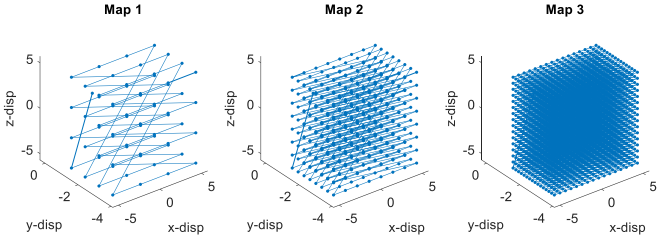
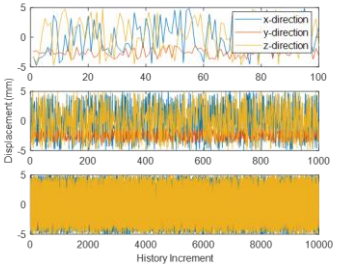
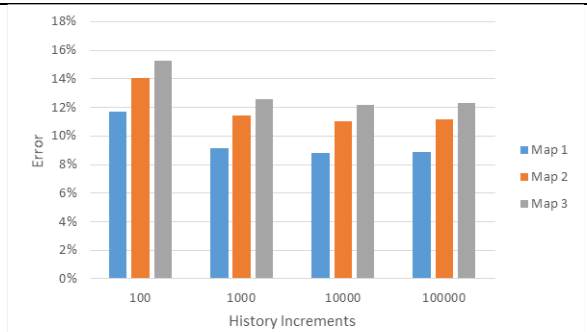
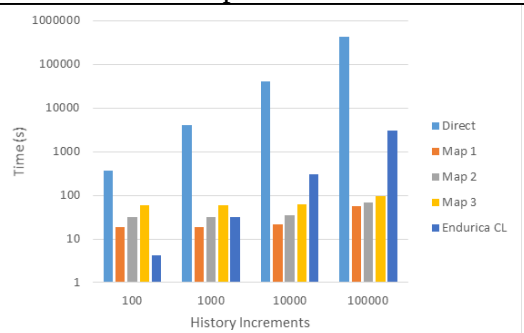
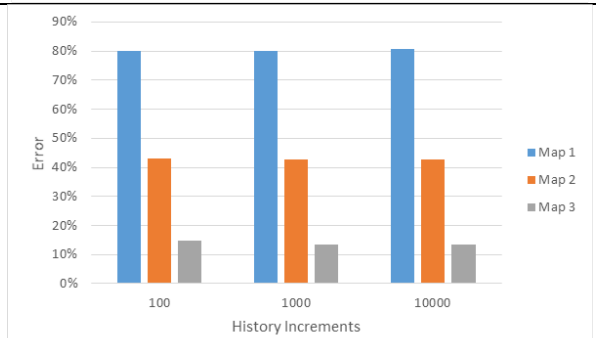
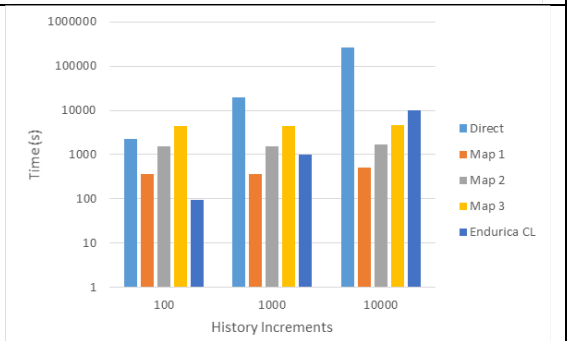
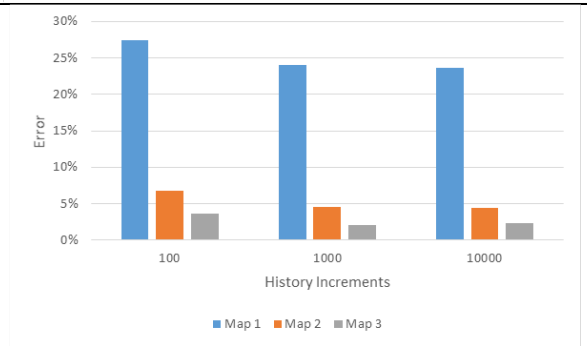
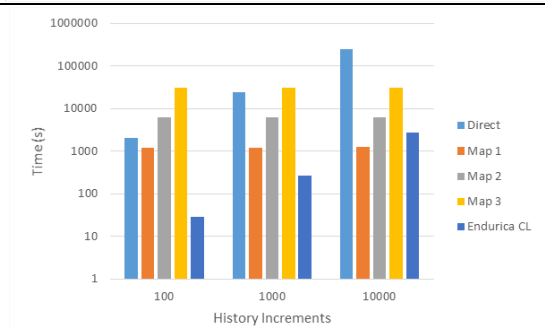
	Model	Displacement Space Mappings Evaluated	Signals Evaluated
1D sway bar link			
2D bushing			
3D Trans-mission mount			

Table 2. Benchmark results.

	Life Prediction Error	Compute Time
1D sway bar link		
2D bushing		
3D Trans-mission mount		

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