Estimation of Shear Force Effects on Bristol's Transverse Dynamic Force Microscope

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Objectives

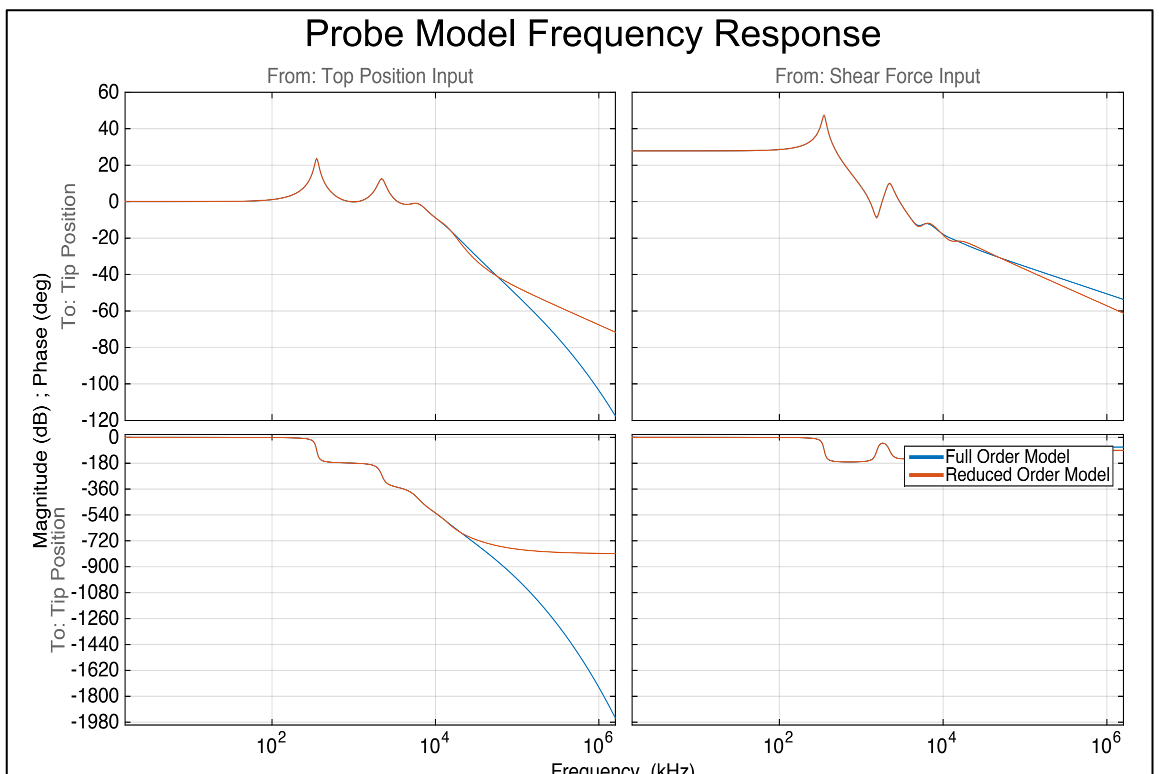
- Develop an estimator to recover the otherwise unknown shear force on the probe of a Transverse Dynamic Force Microscope (TDFM)
- Investigate discretisation with the aim of real time implementation on an integrated circuit

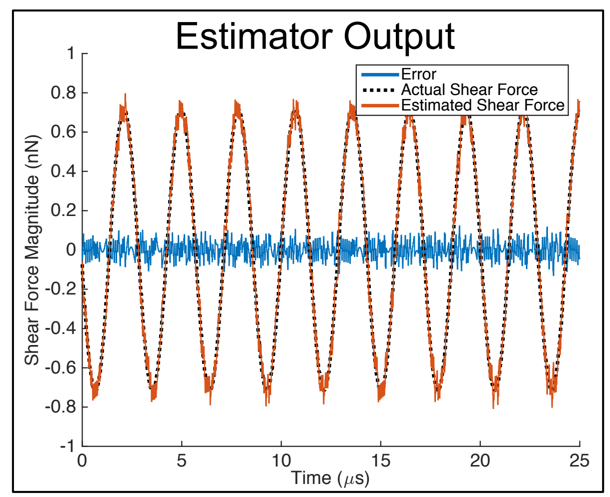
1. Probe Model

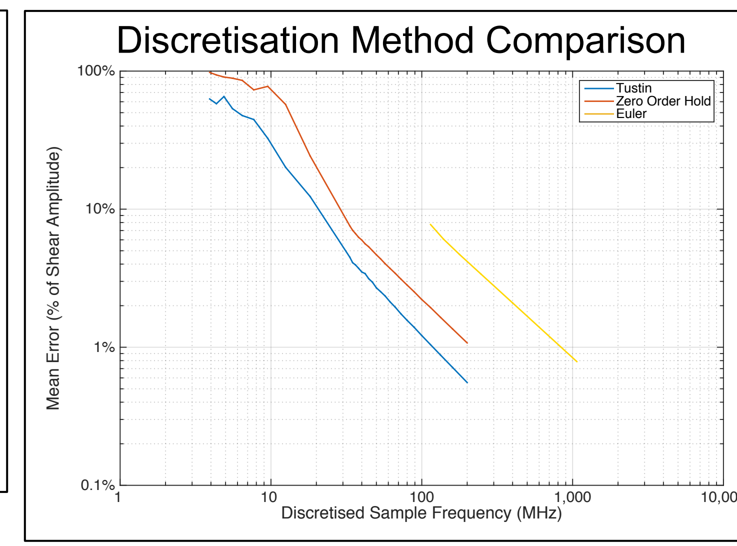
The probe was modelled as a Timoshenko beam, with a 4th order Partial Differential Equation. The method of lines was then used to discretise the spatial derivatives, creating a system of Ordinary Differential Equations. The model was then simplified using Model Order Reduction techniques, and the reduced and full order models compared to ensure a true representation.

2. Discretisation & Simulation

The model was discretised using several proposed methods. A simulation was then performed in MATLAB's *Simulink* to compare the estimated shear force with the known original. A metric was devised to quantify the error between the signals. This was repeated with various frequencies and methods of discretisation to study stability and variation in error magnitude.







Conclusions

The sliding mode estimator is shown to be stable, and has acceptable accuracy with a sampling frequency of at least 30MHz. Further work will be necessary to lower this frequency requirement in order to allow integrated circuit implementation.

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