NONLINEAR REAL-TIME HYBRID TESTING

Background
Real-time Hybrid Testing is an innovative means of testing large and/or expensive structures by splitting the system into a numerical substructure and a physical substructure to be run separately albeit in synchronisation. This relatively new approach enables systems to be tested prior to realisation of all parts and allows realistic operating conditions which cannot be replicated in a lab, to be achieved. There is also significant cost savings as only components with unknown dynamics have to be tested. Potential applications for Hybrid Testing come from a wide range of engineering disciplines include air-to-air refuelling systems, wave energy conversion devices, seismic integrity testing and virtual reality training simulators.

Motivation
The need for real-time communication between the numerical and physical substructures calls for a high fidelity interface or transfer system which often consists of actuators to apply displacements to the physical substructure and load cells to measure and feedback force to the numerical substructure. However, the response lags in actuators are often problematic when trying to replicate an emulated system thereby inducing the need for transfer dynamics cancellation. Existing transfer dynamics cancellation schemes rely on the physical substructure being linear and predictable which hinders the application of Hybrid Testing to nonlinear and/or discontinuous systems. The aim of this PhD is to develop high fidelity actuator control systems to enable reliable hybrid testing even for systems with highly nonlinear physical substructures.

Results and Future work
Electromagnetic actuators are used in this PhD. Currently, Hybrid Testing has commenced and state-of-the-art transfer dynamics cancellation schemes are being applied to the nonlinear mechanical hybrid system at hand. Controller fidelity and actuator responsiveness have been improved resulting in resiliency against cubic nonlinearity, however further improvement in actuator control is being sought for better performance in the presence of nonlinear friction.