

Vibration Control using Shunted Piezoelectric and Electromagnetic Transducers

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*To my parents
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Declaration

I hereby certify that the work embodied in this thesis is the result of original research and has not been submitted for a higher degree to any other University or Institution.

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Abstract

Mechanical structures encounter vibration in response to environmental conditions and dynamic loads. In most circumstances, vibration contributes to mechanical fatigue which can eventually lead to catastrophic failure. Consequently, vibration control is a necessity for prolonging the operational life of structures.

Piezoelectric and electromagnetic transducers have been used for control of vibration for many years. They normally sense mechanical vibration and generate an opposing vibration through another piezoelectric and electromagnetic transducer. This is usually referred to as active feedback vibration control.

Another vibration control strategy senses and actuates simultaneously through an appropriately designed electrical impedance which is connected to the terminals of a single transducer. This technique requires no additional sensor, has improved robustness and stability, and a similar feedback structure compared to active feedback vibration control.

The objective of this thesis is to develop new vibration control techniques by expanding on both the previously mentioned strategies.

The first part of this thesis considers connecting an electrical impedance to a piezoelectric transducer to control vibration. This part reinforces that this vibration control strategy can be modelled as a variation of active feedback vibration control whereby the impedance parameterises the effective controller. A series of new vibration controllers are then presented.

Applying the knowledge gained in the first part of this thesis, the second part considers replacing the piezoelectric transducer with an electromagnetic transducer. Although the underlying dynamics and physical properties of the transducers are different, the feedback structures are remarkably similar to that of active feedback vibration control. A number of new vibration control strategies are proposed for a variety of mechanical systems.

Throughout the thesis, theoretical ideas and concepts are experimentally compared and validated on simple mechanical apparatuses to evaluate their vibration control performance.

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Contents

Abstract	iii
Acknowledgments	v
1 Introduction	1
1.1 Present Vibration Control Techniques	1
1.2 Problem Statement and Motivation	4
1.3 Thesis Overview and Contributions	4
1.3.1 Publications	6
I Piezoelectric Shunt Control	11
2 Piezoelectric Shunt Damping	13
2.1 Piezoelectric Transducers	13
2.1.1 Modelling a Piezoelectric Transducer	14
2.2 Review of Piezoelectric Shunt Damping	15
2.3 Review of Synthetic Impedance Device	18
2.4 Modelling a Mechanical System	21

2.4.1	Modelling the Presence of Shunt Circuit	23
2.5	Proposed Shunt Controllers	25
2.5.1	Current-Flowing Shunt Controller	26
2.5.2	Series-Parallel Shunt Controller	29
2.5.3	Resonant Shunt Controllers	31
2.5.4	Robust Passive Shunt Controller	37
2.6	Experimental Verification	39
2.6.1	Piezoelectric Experimental Apparatuses	39
2.6.2	Shunt Controllers	43
2.7	Discussions	64
3	Multivariable Piezoelectric Shunt Control	67
3.1	Dynamics of a Multivariable System	67
3.2	Stability of the Multivariable Shunted System	71
3.3	Propose Decentralised Shunt Controllers	75
3.4	Experimental Verification	76
3.4.1	Multivariable Experimental Apparatus	76
3.4.2	Model Identification for Multivariable System	77
3.4.3	Implementation of a Multiport Synthetic Admittance	79
3.4.4	Experimental Verification	81
3.5	Discussion	83

II Electromagnetic Shunt Control	87
4 Electromagnetic Shunt Damping	89
4.1 Background	89
4.2 Electromagnetic Transducers	90
4.2.1 Modelling	91
4.3 Modelling a Mechanical System	92
4.3.1 Shunted Composite Electromechanical System	94
4.3.2 State-space Shunted Composite Electromechanical System	96
4.4 Proposed Shunt Controllers	99
4.4.1 Capacitor-Resistor Controller	99
4.4.2 Ideal Negative Inductor-Resistor Controller	102
4.4.3 Impedance Synthesis	104
4.5 Experimental Verification	105
4.5.1 Electromagnetic Apparatus	106
4.5.2 Implementing Electromagnetic Shunt Controllers	108
4.5.3 Shunt Controllers	108
4.6 Discussions	122
5 Electromagnetic Shunt Isolation	125
5.1 Background	125
5.2 Modelling	126
5.2.1 Shunted Composite Electromechanical System	129
5.2.2 State-space Shunted Composite Electromechanical System	132

5.3	Proposed Shunt Controllers	134
5.3.1	Capacitor-Resistor Controller	135
5.3.2	Ideal Controller	136
5.3.3	Impedance Synthesis	136
5.4	Experimental Verification	138
5.4.1	Electromagnetic Isolation Apparatus	138
5.4.2	Shunt Controllers	142
5.5	Discussions	154
6	Proof-Mass Inertial Vibration Control	157
6.1	Background	157
6.2	Modelling	158
6.2.1	Electromagnetic Transducer Dynamics	159
6.2.2	Mechanical System	159
6.2.3	Shunted Composite Electromechanical System	161
6.3	Impedance Synthesis Controller Design	163
6.3.1	Observer Design	165
6.4	Experimental Verification	167
6.4.1	Proof-Mass Inertial Experimental Apparatus	167
6.4.2	Impedance Synthesis	168
6.5	Discussions	172
7	Conclusions	177

