

# Research Proposal: Optimal Control of Tuned Mass Damper During Strong Earthquake

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## 1 Introduction

My thesis will develop an application of optimal control to a specific control system from structural engineering. With Professor Gu, I will first investigate optimal control from a mathematical standpoint and gain an understanding of the theory and techniques. Then, I will apply these techniques to the problem to be studied.

Optimal control is important as a method to create the provably best solution for control problems in engineering and science. By selecting an optimization function, the controller minimizing the function according to selected criteria can be determined.

## 2 Proposed Research

My thesis will determine an appropriate optimization function and the corresponding controller configuration and parameters for the control scheme presented by Sone, Yamamoto, and Masuda [1]. The controller is designed to minimize vibrational damage to a multistory building by providing an actively generated reaction force on the top floor of the building. The system is non-linear and requires state-space control techniques. The system proposed by Sone et. al. uses a linear approximation and does not appear to use optimal control techniques. My research will try to reduce the assumptions they employed as well as optimize their controlling system.

Although this project is interdisciplinary, my focus is on the mathematical developments and theoretical control of the building rather than the physical controller design. I plan to use numerical models to verify the performance of the controller.

## 3 Prior Research

The thesis will draw from the work developed by Sone, Yamamoto, and Masuda [1] as well as works cited by them for the configuration of the controller. For the mathematics I will draw from coursework in my previous three classes in the Engineering Systems series and my course in Advanced Linear Algebra. My prior reading in control systems includes Modern Control Engineering by Katsuhiko Ogata [2]. In addition, I will be working on math research this summer in optimal control.

## References

- [1] A. Sone, S. Yamamoto, & A. Masuda, *Sliding Mode Control for Building Using Tuned Mass Damper with Pendulum and Lever Mechanism during Strong Earthquake*, Copy available on request.
- [2] K. Ogata, *Modern Control Engineering*, Prentice Hall, 2001.