（様式 5）

| 指導教員<br>承認印 | |
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# 学位（博士）論文要旨

(Doctoral thesis abstract)

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| 論 文 題 目<br>(Title) | Operator-based robust nonlinear vibration control for flexible plate with piezoelectric actuator<br>「オペレータ理論に基づく圧電アクチュエータを用いた平板構造物の非線形振動制御に関する研究」 |

論文要旨（2000 字程度）
(Abstract(400 words))
※欧文・和文どちらでもよい。但し、和文の場合は英訳を付すこと。
(in English or in Japanese)

## ABSTRACT

This dissertation discusses the operator-based nonlinear vibration control problems for a flexible plate using piezoelectric actuator with hysteresis nonlinearity. By using operator theory, bounded input bounded output (BIBO) stability of the designed nonlinear vibration control systems is guaranteed, and the desired vibration control performance is ensured by the proposed control schemes. In this dissertation, to address the hysteresis nonlinearity of the piezoelectric actuator, Prandtl-Ishlinskii (P-I) hysteresis model is considered. The model of flexible plate is considered by theory of thin plates. Based on operator theory, nonlinear vibration control schemes are proposed in this dissertation.

First, for plate with a free vibration and perturbations case, operator-based controllers are designed to guarantee the robust stability of the nonlinear control system. Simultaneously, for ensuring the desired vibration control performance, operator-based compensation method is given. In the designed compensator, the desired compensation performances of tracking and of perturbations are obtained by increasing the number of designed n-times feedback loops. Second, for plate with a

forced vibration case, operator-based nonlinear vibration control scheme is given. At the step of designing the controller to satisfy stability, a controller including characteristics of PID controller is designed. The designed controller can be controlled by only one design parameter without adjusting PID parameters. After that, for compensating the forced vibration to improve the vibration control performance, the compensator is given by designed operators. Third, operator-based some vibration control approaches are introduced. For improving vibration control performance, the time-varying unimodular function based robust right coprime factorization approach is considered. The system mismatching compensation approach is designed for plate with a forced vibration. Operator-based estimation structure is considered in unknown input nonlinearity compensation approach for reducing the effect of unknown input nonlinearity to improving the vibration control performance. For confirming effectiveness of the proposed control schemes, both numerical simulation results and experiment results are shown, respectively.

By using the designed controllers based on the concept of Lipschitz operator and robust right coprime factorization condition, the nonlinear vibration control systems are BIBO stable and the desired vibration control performances are realized.

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