Ride Comfort Control Using Actie Seat Suspension: Study on Vibration Damping Performance through Seat Surface Acceleration Feedback

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Abstract

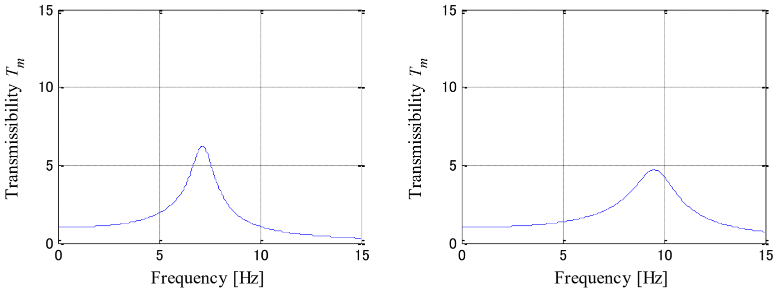
An active seat suspension was proposed to improve ride comfort of the ultra-compact vehicle. Discomfort vibration for vehicle occupants was reduced by active control of the seat suspension. In this study, a control system that directly feedback the absolute acceleration measured on the seat was proposed. To investigate the performance of vibration control, vibration response of this control system was measured using the experimental apparatus assumed the active seat suspension. In acceleration feedback control, improving the ride comfort by selecting proper feedback gain because characteristics of frequency was changed by gain.

1 Introduction

In recent years, there has been growing attention towards ultra-compact mobility as a new means of short-distance transportation. ultra-compact mobility vehicles are more susceptible to vibrations transmitted from the road, raising concerns about deteriorating ride comfort. To

Table 1 Parameters of vibration analysis.

Properties	Values
Mass *m* [kg]	0.339
Spring ratio *k* [N/m]	693.7
Damping coefficient *c* [N・m/s]	2.5
Acceleration feedback gain *Gf*	0, -0.15



(a) *Gf* = 0 (without acceleration feedback) (b) *Gf* = -0.15

Figure 1: Analyzed resonance curve.

address this issue, Oshinoya et al. proposed the use of an active seat suspension system to improve ride comfort [1]. Furthermore, the evaluation of ride comfort is performed using biological information that can be measured continuously and in real time. Using this biological information is employed to propose a control method that actively adjusts the vibrations input to the occupant based on their psychological state [2]. In this paper, a control system that directly provides feedback on the acceleration input to the occupant is developed, and the frequency response of the system is examined. To understand the impact of frequency response changes on vibration control, an analysis is conducted under realistic driving conditions to clarify the control performance.

2 Acceleration Feedback in a Single-Degree-of-Freedom System

In this experiment, an active seat suspension was modeled and the vibration characteristics of a one-degree-of-freedom damped vibration system were investigated. Table 1 shows the parameters set for each parameter. We varied the feedback gain, *Gf*, as follows: *Gf* = -0.15, 0, and Figure 1(a) represents the resonance curve when *Gf* = 0, meaning no acceleration feedback is applied. In this case, the natural frequency is around 7 Hz. By setting the acceleration feedback gain to a negative value, as shown in Figure 1(b), the peak frequency of the resonance curve shifted towards the higher frequency side.

3 Conclusion

In this study, we have investigated the feasibility of a ride comfort control method that directly feedbacks the acceleration experienced by each individual passenger, aiming to construct a ride comfort control system tailored to each passenger. We conducted simulations when the feedback gain of the acceleration is varied.

References

[1] Y. Oshinoya, H. Arai, K. Ishibashi, Experimental Study on Active Seat Suspension for a Small Vehicle. Int J Appl Electrom, 2004, pp. 437–443.

[2] A. Endo, K. Ikeda, M. Mashino, H. Kato, T. Narita, Ride comfort control system using driver's psychological state: Experimental consideration on heart rate variability. Int J Appl Electrom, 2019, pp. 977–984.