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Improvement of Driving Stability with Active Suspension Using Finite-Time Settling Functions.

Shohei Hibino [1] **Shigeo Kotake** [1] **Taro Nakajima** [1]

1) Mie University,1557 Kurima-machiya-cho,Tsu,Mie

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Automatic driving vehicles do not need to transmit vibrations, which is necessary for conventional vehicles to understand the road surface condition, to the driver. It will ultimately require a vibration-free vehicle.

Our laboratory is conducting research using vibration manipulation function (VMF) under finite-time settling control. VMF is a trajectory of a root of a one-body oscillator to realize a transition from an arbitrary initial state to an arbitrary end state.

In this paper, the closed-loop finite-time settling control with vibration manipulation function is applied to an active suspension in a one-half vehicle body model. The behavior and operational stability of a vehicle passing over an uneven road surface in turn are evaluated in numerical simulation. The model is shown in Fig. 1.and Fig.2.

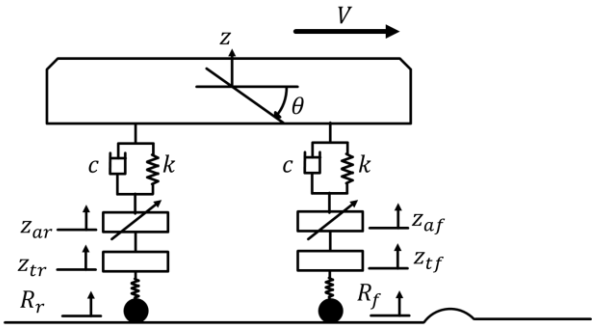


Fig. 1 a one-half vehicle body model from side view

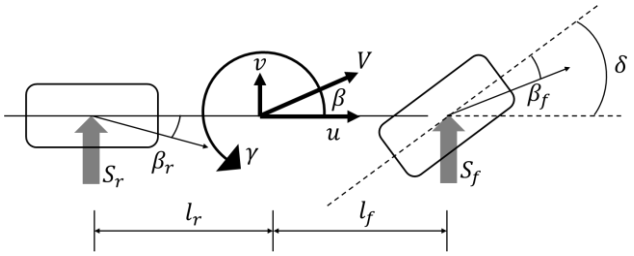
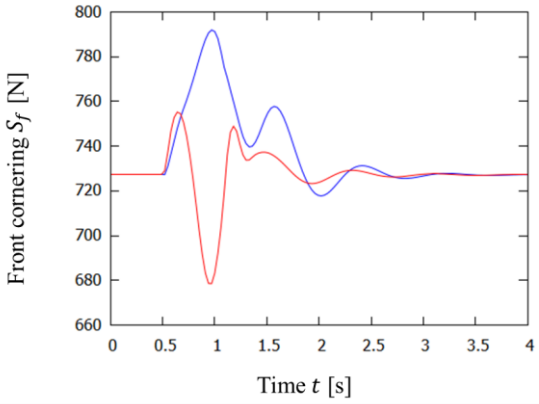


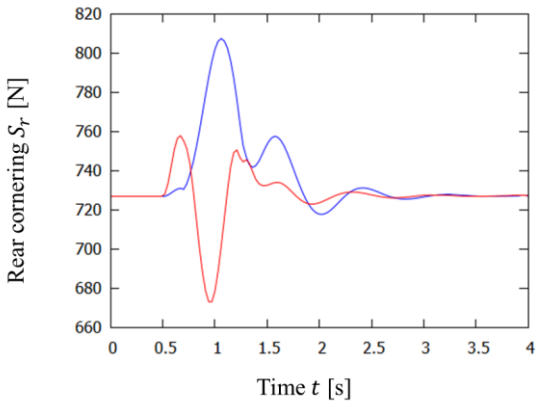
Fig. 2 a one-half vehicle body model from top view

The research results showed that the active suspension as an application of VMF exhibited higher stability of a sprung mass compared with skyhook theory. Moreover, both the vertical and pitching motions of the spring mass were suppressed with smaller fluctuations. The proposed active suspension also suppressed the slip angle and yaw rate fluctuations during turning.

Figure 3 shows that the cornering force of the active suspension with VMF was damped faster than that of the skyhook theory. However, the amount of fluctuation was about the same as skyhook theory. We believe that this is because VMF, which is intended to control the amount of the vibration of sprung mass, was not able to suppress load fluctuations. Residual vibration was also generated because VMF was made to treat an undamped oscillator.



(a)



(b)

Fig. 3 Responses of (a) front cornering and (b) rear cornering