

On-Board Estimation of Vehicle Weight by Optimizing Signal Processing

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1. Introduction

In a vehicle control system whose performance is influenced by changes in the weight of the vehicle, it is important to be able to estimate the weight without the need for special sensors. When we use physical models to do this, we have to provide estimates for two or more unknown parameters. In addition, since this method is influenced by disturbances in the measured signals, as shown in **Fig. 1**, it is difficult to maintain its accuracy. So, by analyzing the physical phenomena, we developed a new method that eliminates the influence of the disturbances from the measured signals to construct an estimation system with a minimum number of unknown parameters.

2. Estimation method

2.1 Basic equation for estimation

We use the equation of motion for the longitudinal movement of a vehicle (Eq. (1)).

$$M\dot{v} = F - Mg \sin \theta \quad (1)$$

M : vehicle weight

v : vehicle speed

F : drive force

g : acceleration due to gravity

θ : road slope

The estimation system, in which only the vehicle weight is the unknown parameter, is constructed by removing the road slope resistance defined by the road profile and the vehicle speed (**Fig. 2**). Moreover, to control the influence of torsional vibration in the drive shaft, changes in the dynamics of the engine torque, rotational speed sensor noise,

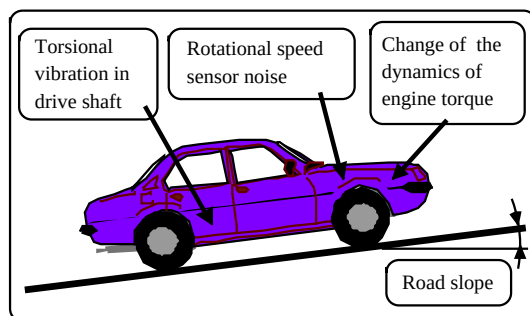


Fig. 1 Disturbances in estimating vehicle weight.

etc., each signal is integrated for a given time range as shown in **Fig. 3**. After signal processing and integration, the basic equation for the estimation is obtained, as shown in Eq. (2).

$$M\dot{v} = F \quad (2)$$

v, F : vehicle speed and drive force after signal processing, respectively

3. Result & conclusion

In a general on-the-road experiment with a commercial vehicle that experiences large changes in its weight, this estimation system produced the estimated accuracy of $\pm 15\%$ for starts where the acceleration is large, as shown in **Fig. 4**. The experiment was conducted at Aisin Seiki Co., Ltd.

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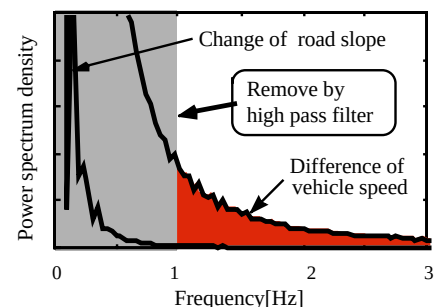


Fig. 2 Frequency characteristic of road slope.

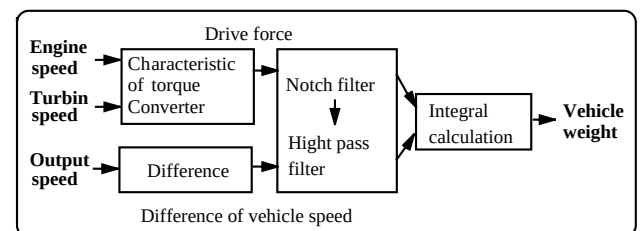


Fig. 3 Construction of estimation system.

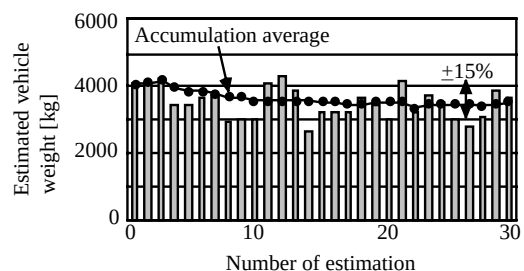


Fig. 4 Estimation result.