

A Study on Design Factors of Gas Pedal Operation

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ABSTRACT

Lateral distance from the center of a driver's seating position to the gas and brake pedals is one of the main design factors that relates to the ease of stepping on the pedals from one and the other. It is important to keep a certain distance between the pedals to prevent erroneous operations or to reduce the driver's anxiety.

In this paper, we explain that the distance between the pedals is affected by the driver's seating height. In other words, if the driver sits lower, the accuracy of stepping on the pedals from the gas pedal to the brake pedal will increase compared to the higher seating position. In addition, we found out that providing auxiliary parts for the leg support enhances the accuracy of the pedal operations.

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INTRODUCTION

The layout between each device, such as a steering wheel and a gas pedal, and a driver's position needs to be optimally designed in order for the driver to be able to operate or control the vehicle at will. In particular, the operation of stepping on the pedals from the gas pedal to the brake pedal should be safe, precise and comfortable among such devices. It is vital to keep a certain distance from the driver's seating position to the pedals mentioned above to prevent erroneous operations or to reduce the driver's anxiety when he/she operates them.

As one of the brake operation studies, Wu et al. previously examined and measured drivers' operation and behavior characteristics in a car when they faced to an emergency situation, such as they needed to hit the brake hard to avoid a collision. Their report clarified the relationship among the leg muscles' activity, the reaction time until the drivers applied the brake and the brake operation time [1]. Yang et al. investigated the reaction time to apply the brake in an emergency situation base on one layout of the gas and the brake pedals [2]. However, they did not examine the effect of the gas and brake pedals' position changes. On the other hand, many studies have focused on the pedal layout and driver's foot movements between the pedals. Ronald et al. measured the time of the foot movements, changing a brake pedal to a gas into three longitudinal

positions in combination with two lateral ones [3]. As the result, the case in which a brake pedal was placed closer to a driver than a gas needed the longest time for him/her to react. These studies discussed on the dimensions between pedals, but did not touch their relation to driver's seating position.

This report presents that the ease of pedal operation is influenced by the lateral layout between the pedals and a driver and by his/her seating height. In comparison with the higher seating position, the lower seating position provides more accurate pedal operations when stepping on the pedals from the gas pedal to the brake pedal. We also demonstrate that the auxiliary parts to support a leg help a driver to accurately move his/her foot between the pedals.

METHOD

A mock-up consisted of two pedals, a foot-rest and a seat was used in this study as shown in Fig.1. Each component is adjustable to any position and any angle. Pedal operation force is also adjustable by adding springs and weights to the mock-up.

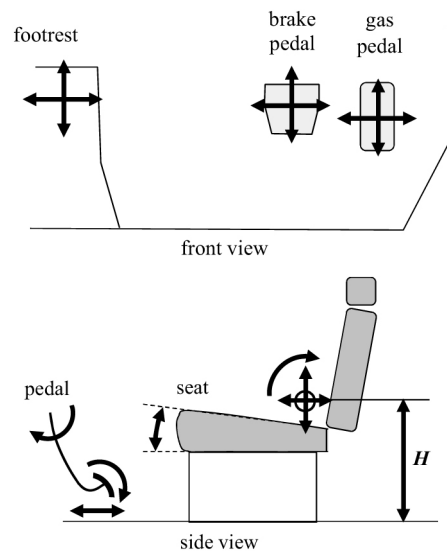


Figure 1. The mock-up used in this study

(1). Effect of the Seating Height

We used two seating height H conditions, at 145mm and 260mm. The lateral distance d from the center of the driver's seating position to the left margin of the gas pedal was set at 60mm, 80mm, 100mm, 120mm and 150mm for the each seating height. The distance between the gas pedal and the brake pedal was maintained at 70mm (Fig.2).

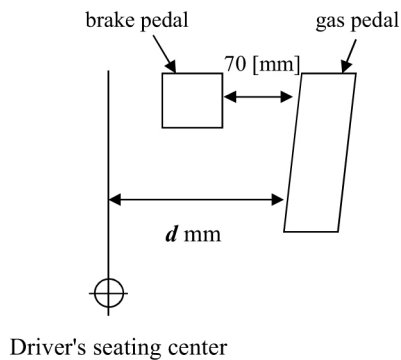


Figure 2. The pedal layout condition

Ten Japanese participants were recruited with informed consent for the study. Their height range was between 1500mm and 1920mm and the age range was between 26 to 62 years. They were asked to move their foot from the gas pedal to the brake pedal as fast as they can and press the brake pedal down as if they made a hard stop to avoid a collision. They were also instructed to step on the center of the brake pedal. Five trials were provided for each condition. The gap e between the center of the brake pedal and the center of the re-stepped foot was recorded as an indicator of operation accuracy (Fig.3). The participants also conducted a subjective evaluation regarding the ease of the pedal operation in five scales, which is described in Fig.4.

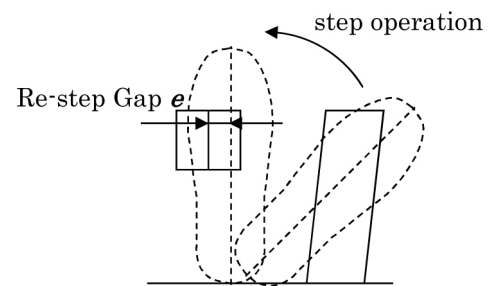


Figure 3. The definition of the re-stepped gap e

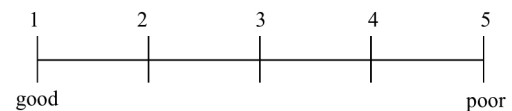


Figure 4. The evaluation scale for the ease of operation

(2). Effect of the Auxiliary Parts

As a study condition, the seating height H was set at 145mm. Other than that, the study conditions were the same as those described in 2-(1). The participants were asked to adjust the amount and the location of the leg supports to make their gas pedal operation comfortable. The leg supports used in this study were foam pads and metal plates to support a thigh and knee, respectively. The pad thickness and the plate position were determined by the participants base on their preference.

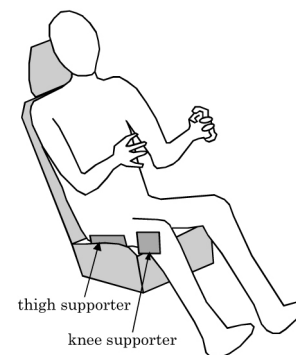


Figure 5. Supporters for thigh and knee

RESULT

(1). Effect of Seating Height

We determined the averages of the ten participants' re-stepped gap e at $(H, d) = (260, 150)$ as 0. Based on the point, Fig.6 shows that the normalized values of the re-stepped gap e for the each height is shown according to d , the distance between the center of the driver's seating position and the edge of the gas pedal. In most of the cases, when the distance