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Reduction of Driver Mental Strain by Situation-adaptive Control of In-Vehicle Illumination

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Introduction: It has been proposed to control the stimulus of the five senses, such as illumination, air conditioning, music, fragrance in the cabin, and to enhance and relax passengers' mood. On the other hand, depending on driving conditions, there is a concern that the application of stimulus may affect the driver mental strain. To provide information such as screen display and voice, it has been examined to estimate the load of the driving condition (driving workload) and to control the presentation information of on-board equipment (information equipment) according to the estimation result. Similarly, it seems desirable to control the stimulus of the five senses by the driving workload, but it is not known whether it actually contributes to the reduction of driver mental strain. The purpose of this study is to construct the stimulus intensity control by the driving workload estimation, taking the in-vehicle illumination as an example, and to verify the reduction effect of the driver mental strain caused by the stimulus.

Outline and construction of the in-vehicle illumination intensity control: The aim of the in-vehicle illumination intensity control is to reduce the driver mental strain of the illumination by changing the luminance as the stimulus intensity of the illumination. In this control, the control object is the luminance, and the lower and the upper limit value of the in-vehicle illumination luminance are set for each outside brightness condition. The luminance is changed according to the driving workload level within the range (Fig. 1). The data of the luminance value corresponding to the following conditions are examined for each representative point of the brightness outside the vehicle. The lower and the upper limit value are set from the distribution of the data (n = 23). : (1) "Brightness at which you notice lighting of illumination while driving" (lower limit value), (2) "Upper limit of brightness at which lighting of illumination does not interfere with driving" (upper limit value). In-vehicle illumination luminance is determined from illuminance value above the vehicle and the driving workload level output from the driving workload estimation algorithm.

Verification of effect of the in-vehicle illumination intensity control:

Method) On the in-vehicle illumination luminance control by the driving workload estimation, the effect of the illumination is examined from the viewpoint of driving performance and subjective mental strain. The participants drove under three conditions of the in-vehicle illumination (n = 8, Table1). The following items were measured to evaluate driving performance and subjective mental strain during driving. Driving performance: vehicle speed, longitudinal and lateral acceleration, steering angle, steering angular velocity. Subjective mental strain: questionnaire (NASA-TLX, Simplified NASA-TLX). The experimental course includes curves and intersections where the driving workload level by the driving workload estimation algorithm is liable to change, and a straight line where the level hardly change. The section to change the lane was set on the expressway.

Result) Driving performance: There were no differences in the modified steering and smoothness of behavior between the three conditions of C1, C2 and C3. Subjective mental strain: C3 over C2 tended to decrease the mental strain, but contrary to expectations, C3 over C1 tended to decrease the mental strain (This is considered to be due to the effect of the in-vehicle illumination luminance control by the driving workload estimation and the effect of the in-vehicle illumination itself).

Summary:

(1) The luminance range of the in-vehicle illumination was set experimentally, and the in-vehicle illumination luminance control by the driving workload estimation was constructed.

(2) It was verified that the luminance control by the driving workload estimation reduces the driver mental strain caused by in-vehicle illumination.

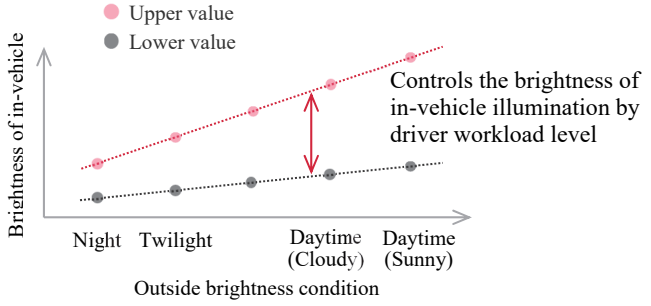

Fig.1 Outline of the in-vehicle illumination intensity control

Table1 Lighting conditions for in-vehicle illumination

Condition	Description
C1	Do not turn on in-vehicle illumination
C2	Luminance of in-vehicle illumination is controlled only by illuminance above the vehicle, no luminance control by driver workload estimation
C3	Luminance of in-vehicle illumination is controlled by illuminance above the vehicle and driver workload estimation.