Analysis of Characteristics of Physiological Indices to Detect Impatient State of Driver

Minori Fusaeda [1]   Masanori Takemoto [2]

1) Graduate School of Seikei University
3-3-1 Kichijoji-Kita-machi, Musashino-shi, Tokyo 180-8633, Japan
2) Seikei University
3-3-1 Kichijoji-Kita-machi, Musashino-shi, Tokyo 180-8633, Japan

Unsuitable driving states caused by driver's feelings of drowsiness, irritation and impatience are one of the major causes of violations of safe driving duty, such as improper driving operation and lack of safety confirmation.

A driving simulator (DS) was used to imitate the driving situation. In this experiment, the characteristics of physiological indices during "Normal Driving" and "Impatient Driving," which promotes feelings of impatience, were analyzed. Participants were asked to respond to a subjective evaluation of the degree of impatience. The subjective evaluation was made on a 5 point scale using the rating scale method.

In the DS environment, the driver's seat, steering wheel, and accelerator and brake pedals were placed in the center. Seven displays were placed around the driver's seat except in the rear. Two LCD monitors were placed to simulate side mirrors. The simulation software used was Sirius manufactured by Misaki Design LLC. A wearable small blood flow sensor manufactured by NTT Advanced Technology Corporation was used to measure the blood flow rate of the participants. The gaze measurement device, Tobii Pro Glass 3 manufactured by Tobii Technology K.K., was used to record the participants' gaze during driving operations.

In addition to the "Evaluation Scenes," which required additional driving operations compared to the single road driving, time constraints was set to promote participants to become impatient. Two evaluation scenarios were set up for each route. Route 1 consisted of "Parked Vehicle Scene" in which the driver passed by a parked vehicle, and "Left Turn Scene" in which the driver turned left at an intersection. Route 2 includes "Red Signal Scene" in which a driver's vehicle stops with a red signal and then departs, and "Lane Change Scene" in which a driver's vehicle must change lanes by two lanes. Route 3 includes "Pedestrian Scene" in which a pedestrian is passing near a pedestrian crossing and "Right Turn Scene" in which the driver turned right at an intersection with an oncoming vehicle.

FFT (Fast Fourier Transform) was used to analyze the measured data. The sampling period of the blood flow sensor was 0.1 second, and the number of sampling points used in the FFT was 1024. The FFT was applied to the time series data by cutting out 1024 data points, shifting the data by 10 points. By performing FFT analysis on blood flow, we thought there was a possibility of confirming the effect of heartbeat on blood flow. Therefore, the peak frequency in the range of 1.0~2.0 Hz was determined by weighted averaging. The obtained value was defined as the "Peak Frequency."

Based on the subjective evaluation values, the participants felt impatient in 23 of the 27 trials. To compare the subjective evaluation values of impatient state between Normal Driving and Impatient Driving, Paired-samples t-tests were performed on the Peak Frequency using data of all participants. The results showed no significant differences for each route. Then, the characteristics was analyzed in the data for each subject. As a result, as shonw in Fig.1, the mean value of the Peak Frequencytended to increase during Impatient Driving compared to Normal Driving.

Evaluation Scenes are classified into three types according to the objects in the traffic situation that may lead to an accident: existing hazard, hazard relating to predicition of other object's behavior, and potential hazard. The increase rate of average of the Peak Frequency, the Evaluation Scene, and the situation that prompted the feeling of impatience were cross checked. The results suggest that feelings of impatience tend to increase especially when the object to which attention should be directed is present in the field of vision. In other words, the existing hazard and the hazard relating to prediction of other object's behavior would be factors that increased feelings of impatience. In some cases, regardless of the hazard classification, the increase in feelings of impatience was related to the situation in which the driver was deprived of freedom of driving operation or was ureged to hurry up.

Focued on the data for each subject, the Peak Frequency of Blood Flow tends to increase in the states of impatience. In particular, the feeling of impatience tends to increase when the object to which attention should be paid is present in the field of vision. In addition, there would be individual differences in the situation where the feeling of impatience increases. Therefore, in addition to recording blood flow, it is necessary to record driving situations. In the future, it is desirable to use physiological indices that are both easy to use and accurate enough to be measured while driving.
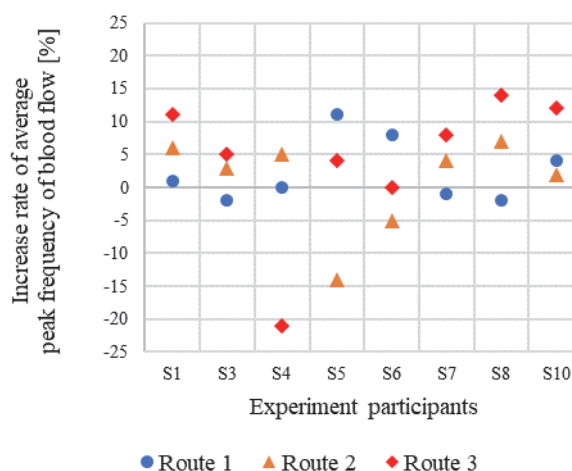

Fig.1 Increase the Rate of Average Peak Frequency