Evaluation of driver’s stress while using an eco-drive assistant system for heavy trucks

Cooperated with Hino Motors

Background

To prevent global warming, reduction of greenhouse gas emissions become one of social demands and responsibilities all over the world. As one of the resolution, attention is currently focused on eco-drive assistant system in transportation section. The eco-drive assistant system automatically controls the accelerometer pedal position to realize low-fuel consumption driving. However, as the eco-drive assistant system operates regardless of driver’s intention, it may put stress on the drivers.

Objective

The stress of three professional truck drivers travelling on express way and ordinary road with the eco-drive assistant system is evaluated.

Loaded vehicle experiment

The driving course is composed by a national road (19 km), an express highway (23 km), and another national road (7 km). The truck drivers travel the course twice for each condition when the eco-drive assistant system is on and off.

Manipulating variables of the drivers and state variables of the truck were measured with CAN device. Pedal pressure is estimated from strain of a gas pedal measure with strain gauges. Surface electromyography (EMG) of triceps surae muscle of the drivers is measured when pressing the gas pedal, and an eye-mark recorder is also utilized to track gaze of eyes of the drivers.

Results

When the subjects, numbered 2 and 3, were driving with the eco-drive system on, the truck produce more acceleration when they increased the speed. Specifically, the driver pressed the gas pedal more even if the gas pedal was fully pushed. From the date measured by the eye-mark recorder, it is shown that the driver moves their eyes on the meters on the information panel of the truck with the motion of their head when the eco-drive assistant system was on. The above motions are considered to show the increase of stress of the drivers.

Conclusions

The results of the experiments show that the acceleration when increasing the speed, pedal effort, EMG values, and movement of the eye to check the meter driver’s stress increases when the eco-drive assistant system is turned on. This indicates the drivers feel stressed when the eco-driving system turned on.
Electromyography responses of sternocleidomastoid muscles to acceleration of a car

Collaborative research with Toyota Motor Corporation

Objectives

Ride comfort of automobile becomes one of the most important evaluation factors. We discuss the possibility of passenger’s electromyography (EMG) of sternocleidomastoid (SCM) muscles as an objective evaluation indicator to vehicle dynamics. The SCM is in the neck, and its main function is keeping the head in the appropriate position.

Experiments of actual vehicles

Two same cars are prepared for the experiments. One is the normal car, and another car is the modified car and its body rigidity was improved.

Relative accelerations are defined as the difference of the two accelerations respectively in the front and rear parts. The front and rear relative accelerations of the normal car are apparently larger than the modified car.

While the actual vehicles were driven at the speed of 65km/h in a slalom course of 30m intervals, the EMGs were measured.

By the root mean square (RMS) values of the EMG in 0.1s range it is shown that the RMS values are smaller in the modified car than in the normal car.

Conclusions

For the normal and modified cars, the EMG signals of SCM muscles are significantly different. Through the experiments, it is shown that the reasonability of SCM muscle as an evaluation indicator to vehicle dynamics is validated.
EEG analysis of a driver manipulating a driving simulator using PARAFAC

Driving simulator (DS)
To carry out the study, we utilized a driving simulator developed by Suda laboratory, which is composed of a six-degree-of-freedom motion platform with a turntable and an image generation system using 9 projectors to produce realistic all-round view. This simulator can provide a subject manipulating it with realistic feeling to drive a car. EEG is recorded when the subject drives the simulator and it is analyzed with PARAFAC.

Experiments
EEG Recorder : Polymate AP1132+AP-U040, Teac.
Arrangement of electrodes : 10-20 system; additional four electrodes are placed around eyes to indentify eye blinks.

Oval course and an example of measured EEG.

Discussion
1. When the driver runs on the oval course, alpha waves sometimes appear on EEG, while no alpha waves are observed when driving at Tanimachi junction.
2. EEG indicates the driver drowsed when driving on the oval course.