SEAT BELT VIBRATION AS A STIMULATING DEVICE FOR AWAKENING DRIVERS

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Driving while drowsy is one of the main causes of car accidents. In order to prevent drivers from drowsy driving, strong demand has arisen for safety driving systems.

In the present research, a safety driving system that detects the driver’s drowsiness before it leads dangerous driving has been developed.
This system consists of three components:

- **Sensing**: The sensing component monitors the driver's physiological data and surroundings.

- **Evaluation**: The evaluation component determines whether or not the driver is drowsy.

- **Stimulation**: When the driver becomes drowsy, the stimulation component is activated to awaken the driver.
Fig: Structure of safety driving system
Methods for detecting driver's drowsiness can be classified into two categories:

1. Analysis of driver's body motion such as head motion and driving ability.
2. Analysis of physiological data such as saccadic eye movements and heart rate.

We have defined all alertness level indication KE by the following equation. The value of KE nears 1 when the driver becomes drowsy:

\[
KE = \frac{\text{Power (0~0.3 Hz)}}{\text{Power (0~0.3 Hz) + Power (3~10 Hz)}}
\]

We have chosen electrooculography (EOG) for measuring eye movements. The permanent electric potential difference between the cornea and the retina generates electrical field related to the orientation of the eyes in the surrounding tissues of the eyes.
A driving simulator was constructed from a complete set of a driving cockpit taken from a real car, including the dashboard, steering wheel, seat, seat belt, and pedals, as shown.

A screen was placed in front of the driver's seat to display a computer-generated motion picture of monotonous freeway driving, which induces drowsiness in the driver.

The simulator was covered with a curtain in order to insulate the driver from surrounding information. A projector was set outside the curtain, in order to prevent temperature rise in the simulator.

The seat was adjustable to the driver's body with reclining and sliding the seat as it is in the real vehicle. When the driver needed to stop the seat belt vibration, he/she could stop it by pushing the button, which was set beside the seat.
CONSTRUCTION OF A SEAT BELT MOTOR RETRACTOR

- We applied the seat belt motor retractor, which is currently being used for pretensioner in stock cars, to the driving stimulator.
- To develop the stimulator with a component of a real car is feasible for reducing driver's discomfort in a practical use.
- The seat belt motor retractor provided the stimulus to the driver's upper torso restraint portion.
- The fig shows the construction of the motor. The vibration stimulus was composed of pulsating tension in the seat belt.
- The control computer varied tension, period of tension, interval, and number of pulses to change the vibration patterns. The tension was adjusted by percentile of the maximum tension.
we examined the appropriate pattern of seat belt vibration while considering the effect of drowsiness prevention and discomfort.

The patterns of seat belt vibration can be varied by regulating four parameters of the seat belt motor retractor: magnitude of tension, period of a pulse, interval between pulses, and number of pulses.

We defined three target requirements:
1) raise no obstacles to driving;
2) reduce unnecessary discomfort;
3) awaken drivers comfortably within a short period of time.
The target duration was 15 min, which is the average time to reach the next rest stop on.

Effective duration of seat belt vibration was compared with the results of 13 other stimuli, which stimulated the five senses of humans.

For comparison, the same subjects were given the other 13 stimuli. The two subjects were in their 20s: a male and a female.

Drowsiness level was classified into five ratings as given in Table VI.
A subjective evaluation test and lane deviation analysis has demonstrated the effectiveness of seat belt vibration for preventing driver’s drowsiness. Exerting additional tension of 130 N for 3 cycles at duration and interval of 100 ms was the most effective pattern for awakening the driver without causing discomfort. The awakening effect lasted 8.5 min on average. This new safety feature will provide an added value to the safety systems for cars and encourage drivers to wear seat belt. We developed the driving simulator with the seat belt motor retractor, which was used in a commercial vehicle to provide the vibration stimulus to the drivers.
REFERENCES


THANK YOU
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