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“Technical Research and Development for Road Policy Quality Improvement”
Study Summary

No.	Title	Principal Researcher
No.26 - 1	Development of evaluation method of mobility space for the next-generation mobility society	Nagoya Univ. Prof. Toshiyuki Yamamoto

In order to realize a society with stress-free mobility space and zero-accident, we conducted a driving experiment to measure a subjective driving-stress and physiological indicators in a real road network, and then examined a relationship of subjective driving-stress and physiological indicators by structural equation model. We also developed a discrimination model of road sections with high driving-stress.

1. Backgrounds and Objects

In the past, it has been difficult to quantify comfort and stress during driving a car. In this study, we develop a method for evaluating the quality of mobility space by using a subjective driving-stress and physiological indicators. Information on physiological indicators is also expected to be countermeasures of traffic accidents. Therefore, we develop an optimal index for subjective evaluation (e.g., satisfaction with questionnaires, etc.) and various biological phenomena such as heartbeat and pulse, and provide an evaluation method that are easy to understand by policy makers.

2. Activities in Research Period

[2014]

Driving experiment in real road network (predefined route) to measure driving-stress in Nagoya and Toyota, Aichi

-Physiological indicators:
We developed an experiment environment to collect 1) brain blood flow, 2) heartbeat, 3) respiration, 4) skin temperature, 5) mental sweating, 6) saliva.

-Vehicle performance data: Velocity, acceleration, wheel angle and braking from CAN.

-Subjects: Six participants (three male students and three male whose age is over 60)

-Results: We examined the measurement possibility of driving-stress from physiological indicators.

[2015]

Exchange of Information on driving-stress
Hearing with road managers on a practical use of driving-stress and physiological indicators.

Data analysis
We defined a driving-stress which consist of “anxiety” and “discomfort”, and developed the models with structure equation model and machine learning method to understand the relationship between subjective driving-stress and the characteristics of road environment and driving behaviors.

[2016]

Driving experiment in real road network (non-predefined route) to measure driving-stress in Saitama

-Subjects: 61 participants collecting heartbeat for two weeks

-Results: We developed the evaluation model of driving-stress, which utilizes road environment and dynamic factors as well as heartbeat data.

Manual preparation on how to measure physiological indicators and analyze driving-stress

3. Study Results

We developed the model to understand the stress points by structural equation model. Multiple Indicators and Multiple Causes (MIMIC) model, in which the influences of formative indicators on unobservable latent variables are assessed through their impact on the reflective indicators, is adopted in this study.

From the result of goodness-of-fit of MIMIC model, our assumption is accepted (i.e., the number of sample is 8,337, and goodness-of-fit index are as follows: CFI=0.82, RMSEA=0.04). The reported subjective driving-stress is a part of the latent driving-stress consistent with the physiological data. The latent driving-stress value can be calculated from the MIMIC model by using the physiological data and the vehicle performance data.

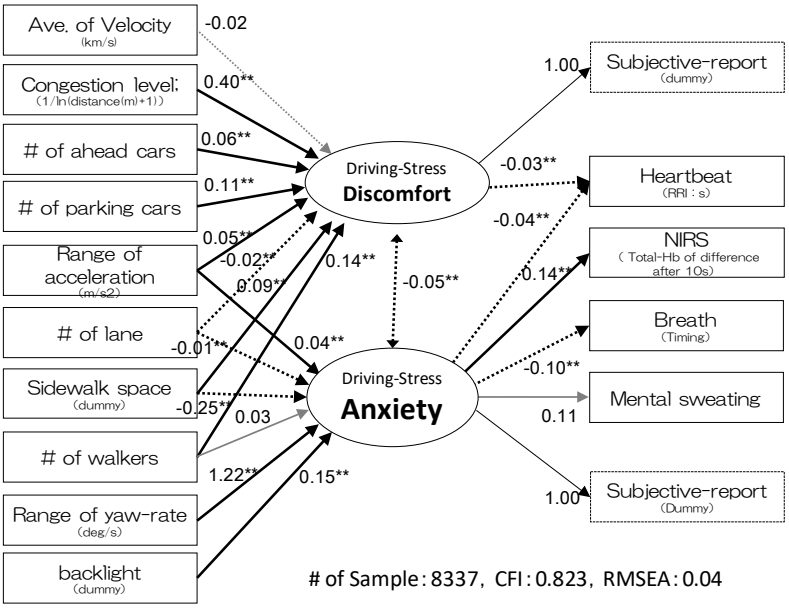

Fig. Structure equation model of driving-stress

4. Papers for Presentation

[1] Ryo KANAMORI, Akira Ando, Toshiyuki Yamamoto, Takayuki Morikawa: Preliminary Study on Driving-Stress with multiple physiological indicators in driving experiments, IEEE International Conference on Biomedical and Health Informatics (BHI2016), Feb 2016.

[2] Ryo KANAMORI, Akira Ando, Toshiyuki Yamamoto, Takayuki Morikawa: Relationship between Subjective Driving-Stress and Multiple Physiological Indicators in Driving Experiment, IEEE International Conference on Biomedical and Health Informatics (BHI2017), Feb 2017.

5. Study Development and Future Issues

Although the effectiveness of driving-stress measurement is confirmed in this study, we need to verify this result with larger sample.

For a practical application, it is necessary to examine the procedure to obtain physiological data and CAN data efficiently (e.g., cooperation with ETC 2.0 data system).

6. Contribution to Road Policy Quality Improvement

As a preventive knowledge of traffic accidents, it is useful to apply this driving-stress to road managers. For future practical applications, it is necessary to cooperate with the Ministry of Land, Infrastructure, Transport and Tourism.

7. References, Websites, etc.

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