

Relationship between Subjective Driving-Stress and Multiple Physiological Indicators in Driving Experiment

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Abstract— This study analyzes subjective driving-stress to assess road structure and traffic condition. Six drivers put on the sensors which can measure biological indicators (i.e. brain blood flow, heartbeat, respiration, temperature, mental sweating) and drove several times a predefined route in Nagoya city. Participants reported their stress points where they felt subjectively. We examine the relationship of subjective driving-stress and physiological indicators by structural equation model.

I. INTRODUCTION

Advances in information and communication technology can monitor physiological data and discuss the comfort or stress during driving. Although travel time is a significant indicator to evaluate the transportation policies, we believe that a route navigation customized for each driver's comfort or stress is useful as a next generation vehicle system, and a harmonized drivers' stress-less navigation system will achieve a goal to reduce the number of traffic accidents.

In this study, we try to objectively understand the stress in driving. Therefore, we conducted driving experiments in real road condition to get physiological data with several sensors (i.e. brain blood flow, heartbeat, respiration, temperature, mental sweating), and the subjective stress points by participant's self-reporting. And we examine the relationship of subjective driving-stress and physiological indicators by structural equation model.

II. DRIVING EXPERIMENTS [1]

Driving experiments in general road network are conducted. We developed an experiment environment to collect 1) brain blood flow, 2) heartbeat, 3) respiration, 4) temperature, 5) mental sweating as shown in Figure 1. Moreover, the stress points in driving are expressed by pushing a button which is connected to CAN (controller area network) system in vehicle, and are modified and labeled after driving. Vehicle performance data (e.g., velocity, acceleration, wheel angle and braking) can be used in this study.

The number of participants is only six (three drivers in the 20s and the rest in the 60s), but the total number of experiments in driving pre-defined route (80 minutes per one experiment) is 24 to examine the relationship of subjective driving-stress and physiological indicators.

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Figure 1. Experiment environment

III. DATA ANALYSIS

The physiological data are pre-processed to analyze relationship between subjective stress points and objective variables (i.e., the physiological data and the vehicle performance data). All data are handled every one-second data such as mean and standard deviation although measurement interval is one millisecond. From results of correlation analysis, there are no significant variables to reproduce the stress points by itself (e.g., the max of coefficient value is about 0.2 by using Oxy-Hb).

Next, we develop 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. We assume that formative indicators may be the vehicle performance data, reflective indicators are the physiological data and the reported subjective driving-stress, and the latent endogenous variable representing the latent driving-stress.

From the result of goodness-of-fit of MIMIC model, our assumption is fine (i.e., the number of sample is 8,337, and goodness-of-fit index are as follows: CFI=0.67, AGFI=0.96, RMSEA=0.04). The reported subjective driving-stress is a part of the latent driving-stress as same as 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.

As future work, we should analyze more detail the factors of the latent stress points by using all physiological data and vehicle performance data. And we should discuss the optimal and customized route navigation system.

REFERENCES

- [1] R. Kanamori et.al.: Preliminary Study on Driving-Stress with multiple physiological indicators in driving experiment, The 3rd IEEE International Conference on Biomedical and Health Informatics (BHI2016), February 2016.