

A Method to Detect Inappropriate Postures Causing Distraction via Analysis of Pressure Distribution on the Driving Seat

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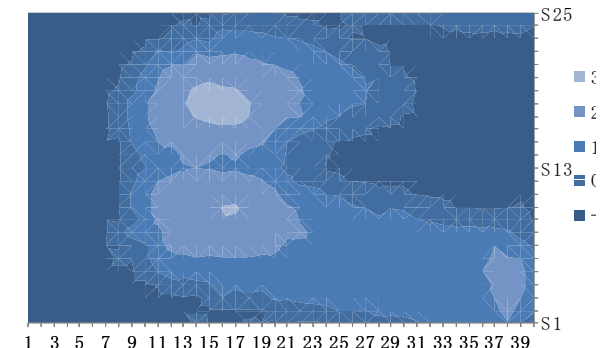
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Introduction

- Our purpose is to establish monitoring-based driver support systems. For this reason, it is important to develop methods for detecting driver distraction.
- The way of distraction detection depends on types of distractions, i.e., “auditory”, “cognitive”, “visual”, and “biomechanical” (Ranney et al., 2000)
- There are various researches on detection of
 - Auditory or cognitive distraction
 - Via analyses of psychophysiological indices, such as eye movement, blood pulse wave (plethysmogram), facial temperature, etc.
 - Visual distraction
 - Via analyses of head pose, etc.

Purpose

- Detecting inappropriate posture is vital but few.
 - Inappropriate posture causing distraction can be often observed in the real world.
 - Riener et al. (2007) suggested usefulness of pressure distribution on the driving seat for inferring driver posture.
 - We have been trying independently to use pressure distribution on the driving seat (Itoh et al. 2007; Itoh et al. 2008).
- In this talk, we introduce our approach to identify driver posture.



Posture recognition method

Training

Determine the classes and collect many training sample “image”s for each class.

A 35-dimensional HLAC feature (Otsu, Kurita, 1988) vector x is extracted from each “image.”

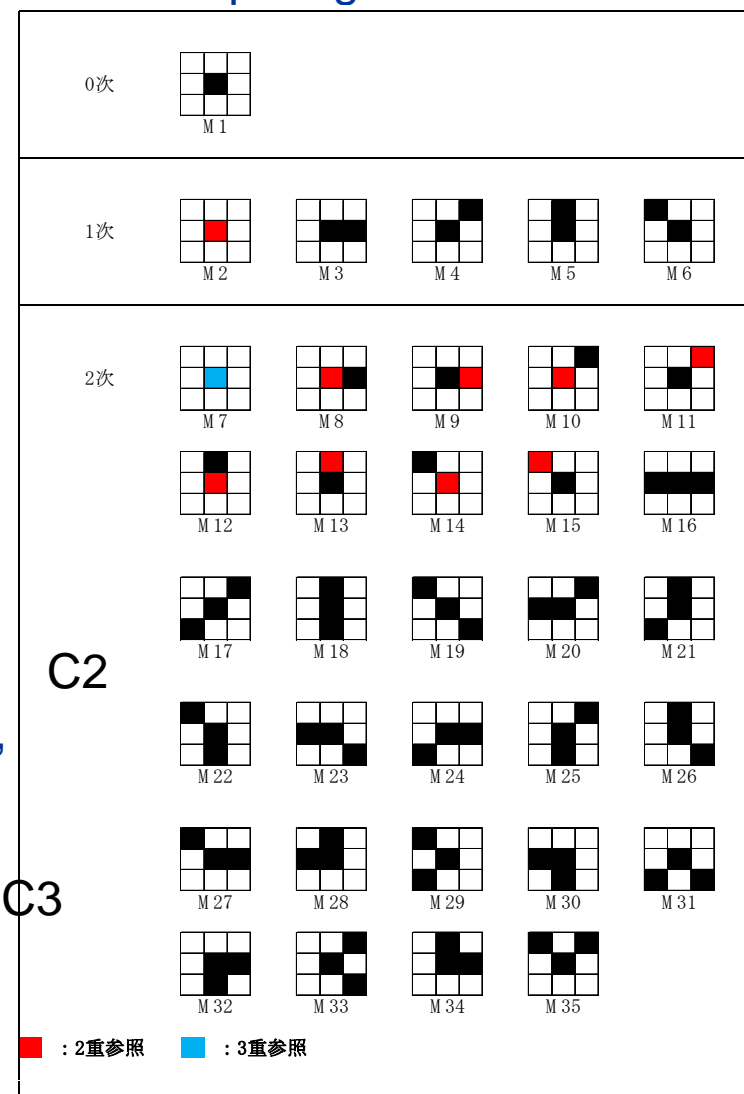
Each feature vector x is mapped to a vector y in a discriminant space made by Linear Discriminant Analysis.

$$y = A^T x$$

Test

An input vector for test, y' , is classified to the nearest class whose distance from the input vector to the mean vector of the class is minimal.

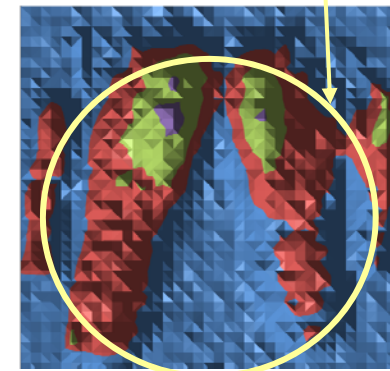
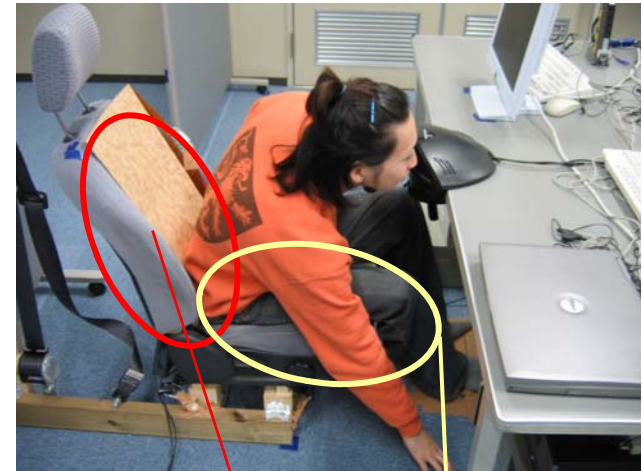
Local Mask Patterns for computing HLAC feature



- shift-invariant
- computationally inexpensive

Experiment

- Purpose
 - find a reliable and cost effective way to realize a detection system based on our proposed method.
- Possible related factors
 - The number of sensor sheets:
 - sensor on the seat cushion and/or sensor on the backrest
 - The resolution of the sensor sheets
 - Number of sensing points
 - Varieties of training samples
 - Collecting various training samples or not
 - Individualization
 - Common classifier or tailored one



Data collection for test (1/2)

- Participants
 - 5 females, and 5 males
 - Hold a valid driver license and drive daily
 - signed on an informed consent sheet
- Task
 - Posture to be classified :
 - C1: Take the normal driving posture
 - C2: Reach the left hand to the left as far as possible
 - C3: Touch the pocket on the back of the passenger seat
 - C4: Touch a navigation screen.
 - C5: Touch the floor.
 - Driving position is arranged by each participant
 - The arrangement is recorded and set as it recorded for every data collection.
 - No driving



C 2



C 3



C 4



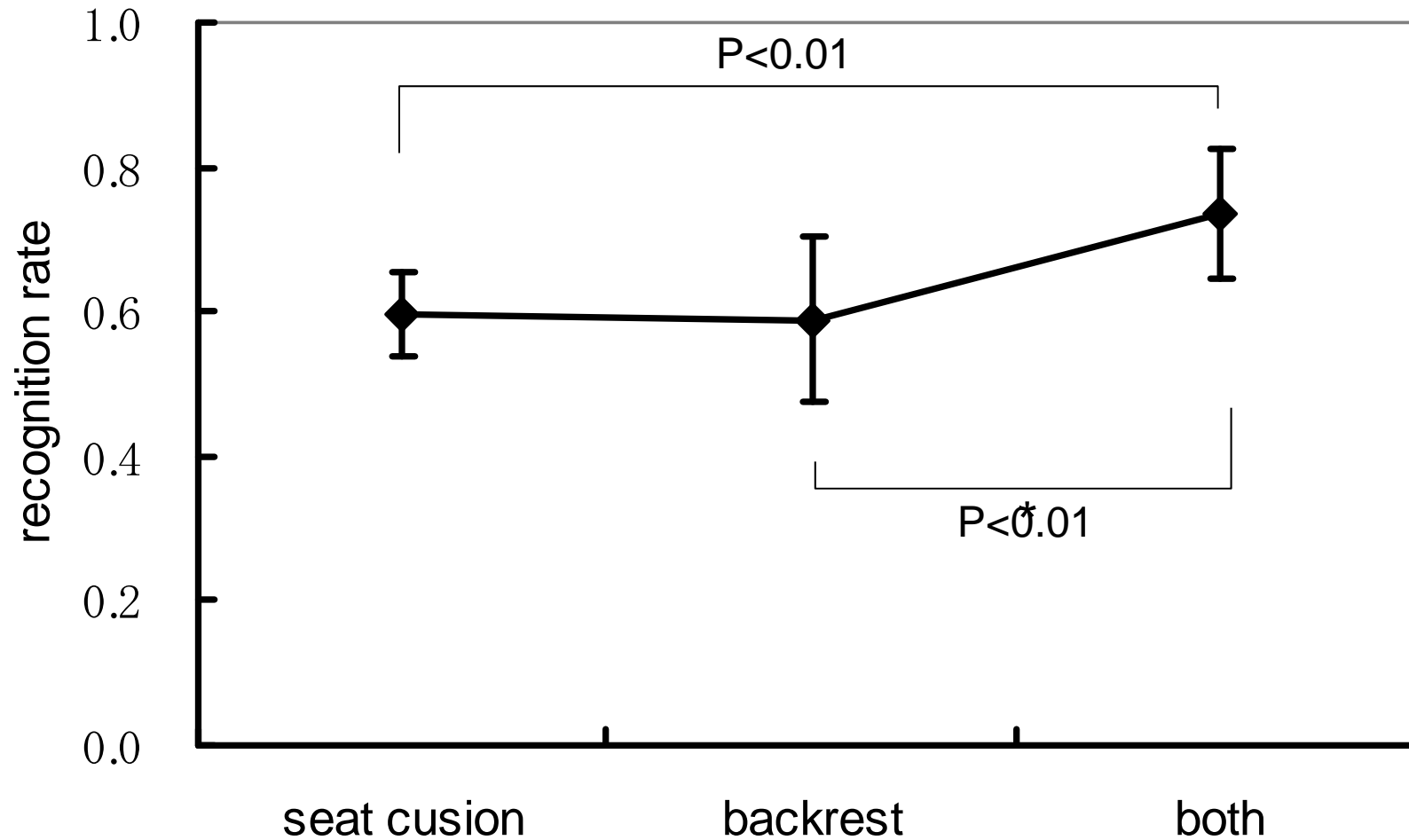
C 5

Data collection (2 /2)

- Number of days :
 - Three for each participant
- Data recorded for each day
 - Type A (small varieties in samples): 1 set
 - Take a posture only once for each category (C1-C5). 100 snapshots are taken for each.
 - Type B (large varieties in samples): 3 sets
 - Take 20 postures for each category (C2-C5). In between two consecutive postures, every participant takes C1 (normal posture)

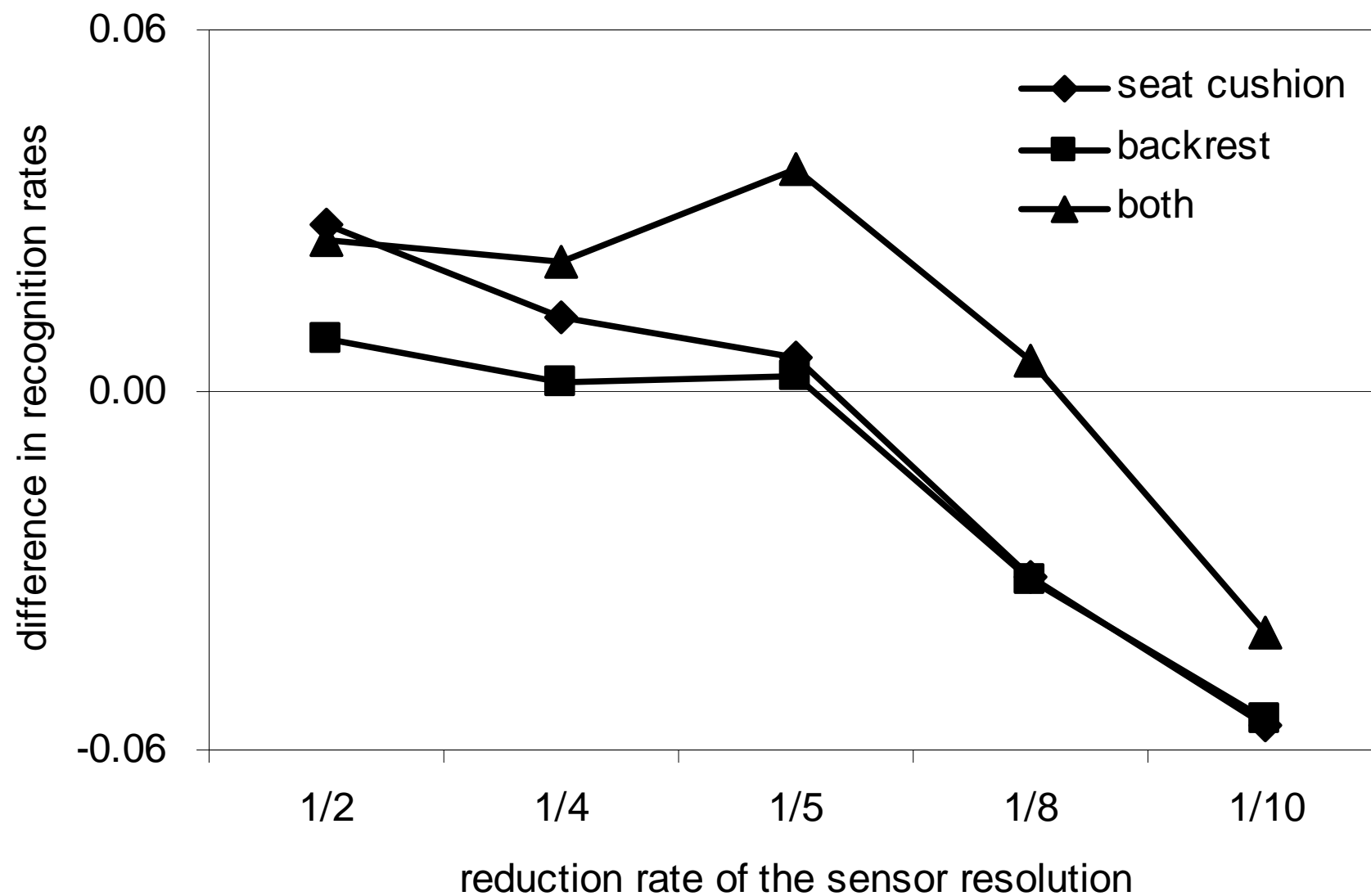
In sum, 3 sets for Type A, and 9 sets for Type B.

Results: Necessity of using both sensor sheets



Training was done with Type A data, and tests were done with Type B data.

Results: Effects of reducing resolution

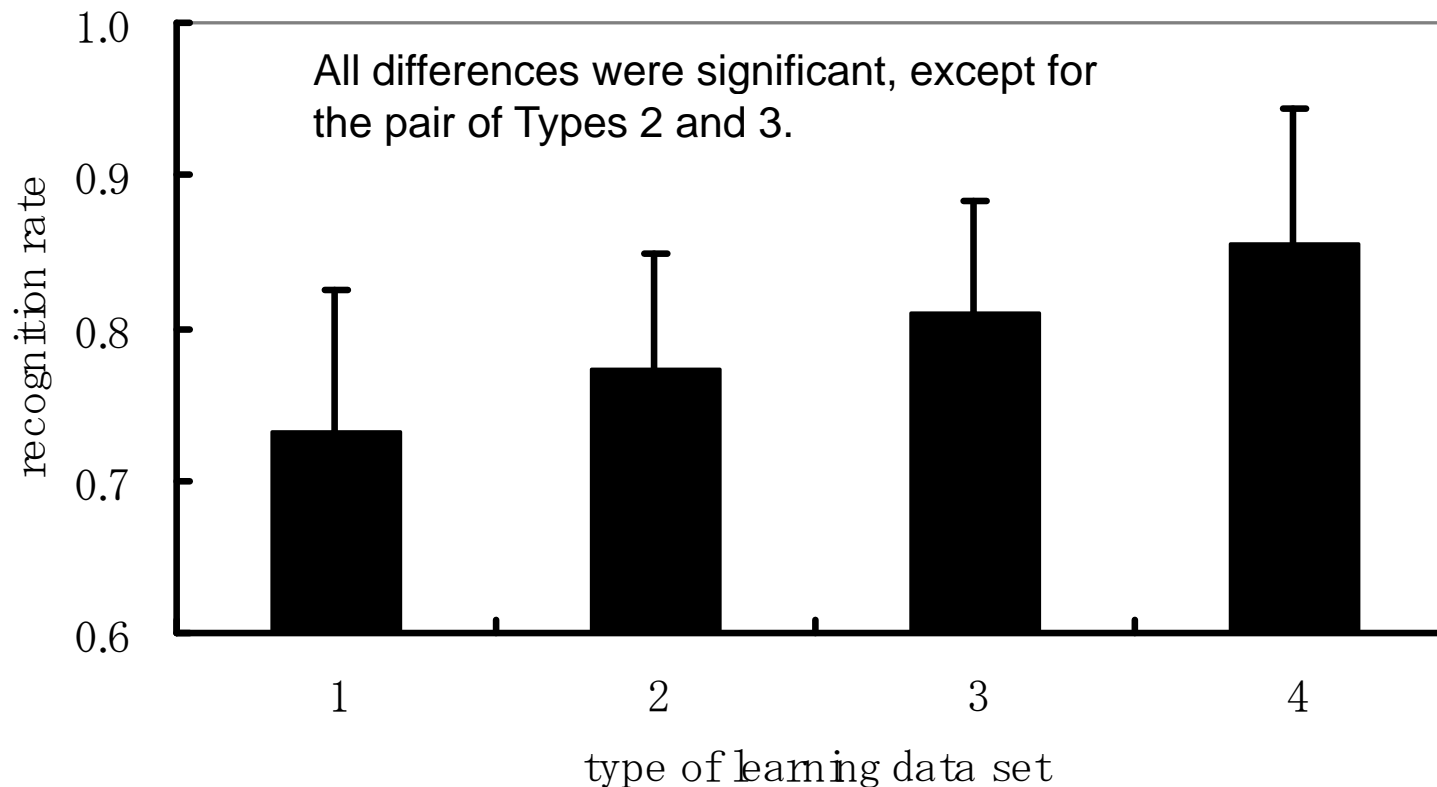


Results:

Effect of increasing varieties of training data

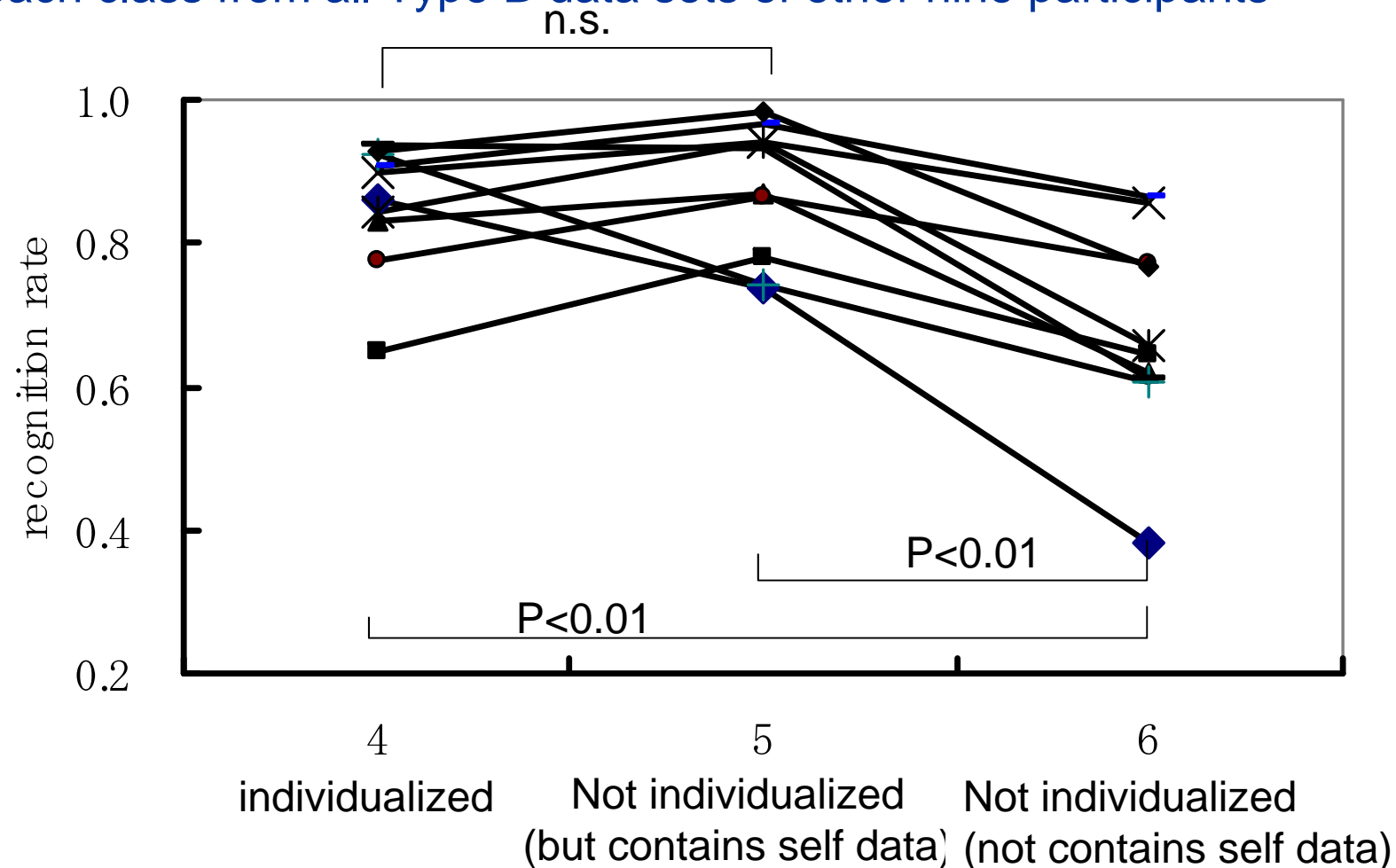
- Four types of training were compared: training was done with
 - Type 1: a single Type A data (taking a posture only once) set
 - Type 2: a single Type B data (taking a posture 20 times) set
 - Type 3: a mixture of two Type B data sets in one day
 - Type 4: a mixture of two Type B data sets from different days

less
↑
↓
more



Necessity of individualization

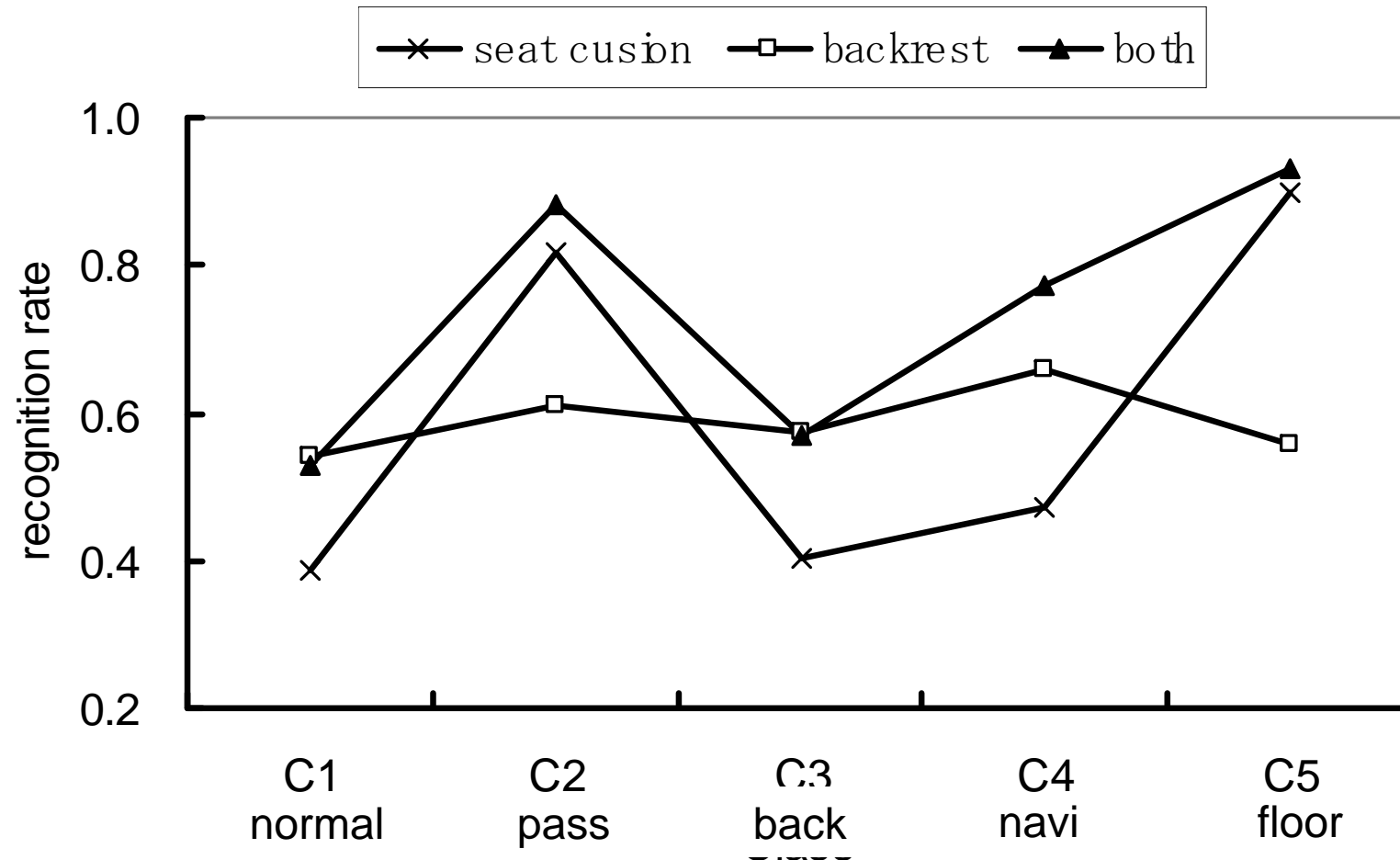
- Type 5: Training data consist of randomly chosen 100 samples for each class from all the Type B data sets of all participants
- Type 6: Training data consist of randomly chosen 100 samples for each class from all Type B data sets of other nine participants



Concluding remarks

- This paper proposed to apply an image recognition technique for identification of driver posture.
 - Extraction of HLAC feature -> Linear Discriminant Analysis
- The results of the experiment suggest
 - Both the sensor sheets on the seat cushion and the backrest are necessary
 - The number of sensing points might be reduced in order to save the costs.
 - In order to achieve robust recognition, wide variety of training samples is needed.
 - Individual training may not be necessary if we can categorize drivers into small number of groups.
- Further researches
 - Test on a moving vehicle
 - Identify which posture must be detected

Necessity of using both sensor sheets



Recognition for C4 (navi) was improved by using the both sensor sheets.

Effect of increasing varieties of training data

