

Drive Monitoring System Based on Non-contact Measurement System of Driver's Focus of Visual Attention

Nara Institute of Science and Technology
 Robotics Lab.
 D2 Kentaro TAKEMURA

Outline

- Motivation
- Related Works on Monitoring the Fixation Point
- Approach
- System configuration
- Methods of treating gaze information
- Experiment
 - Experiment of lane changes
 - Experiment of driving at a curve
- Conclusion & Future works

Motivation

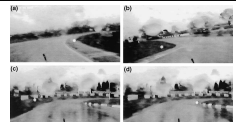
- People use visual information everywhere.
 - Human-Human communication, Human-Computer interaction, Human-Robot interaction
- In order to develop interactive systems, we focus on using attention-related information such as head pose, gaze direction and fixation point.
- We focus on interactive systems such as driving support and meeting support.



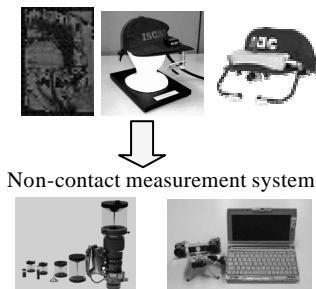
Related Works

“Monitoring the fixation point of the driver”

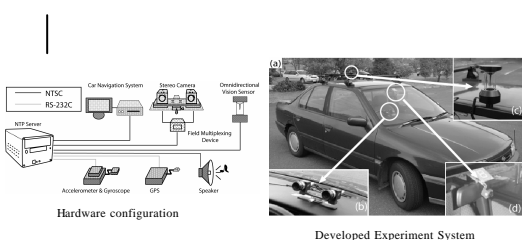
- M. F. Land et al. (Sussex, 1992)
 - A driver is gazing at the tangent point while driving at a curve.
- A. Liu et al. (MIT, 1999)
 - The ratio of time to look at the objects (rear-view mirror, side mirror) varies during lane changing.
- G. Salgian et al. (Rochester, 1997)
 - The fixation point switches back and forth between the stop sign and the white line. The switch frequency increases as the vehicle gets closer to the intersection.



Approach



Non-Contact Measurement System



Real-time Face Measurement System

Stereo Camera **In the daytime** **In the night**
(Use of infrared LEDs)

System feature

- Processing Speed 30[Hz]
- Measurable range ±30[deg]
- Accuracy of measurement
 - face position ±2 [mm]
 - face direction ±2 [deg]
 - gaze direction ±5 [deg]

2004/05/27 NAIST COE 2nd Meeting 7

Method 1: Using Gaze Information Inside the Car Recognition of Fixed Object

$$\tan^{-1}\left(\frac{L}{2P}\right) - \cos^{-1}\left(\frac{P \cdot G}{|P| |G|}\right) \geq 0$$

The result of estimation

2004/05/27 NAIST COE 2nd Meeting 8

Method 1: Using Gaze Information Inside the Car Recognition of Fixed Object

□ Video

2004/05/27 NAIST COE 2nd Meeting 9

Method 2: Using Gaze Information Outside the Car Panoramic Image with Superimposed Face and Gaze Direction

□ The panoramic image is utilized to show the gaze information.

□ The scene cameras can be fixed to the vehicle, therefore it becomes relatively easy to extract environment information.

2004/05/27 NAIST COE 2nd Meeting 10

Method 2: Using Gaze Information Outside the Car Quantification of the eye-movement of a driver

□ It is important to record the road scene together with the fixation point.

□ The eye-movement of the fixation point is rather desultory.

Reference: <http://www.eyemark.jp/>

□ Fixation map: the histogram of the distribution of the fixation point (D.S. Wooding et al.)

□ Fixation map is method of quantifying eye-movement traces

$$f_n(x, y) = g_n + \sum_{m=1}^{n-1} f_m(x, y) \quad 0 < x < 1$$

$$f_1(x, y) = 0 \quad (n=1, 2, 3, \dots)$$

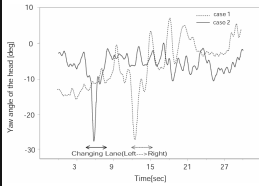
2004/05/27 NAIST COE 2nd Meeting 11

Experiment of lane changing

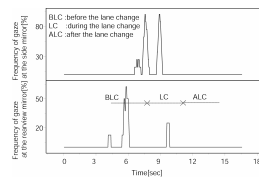
□ Video

2004/05/27 NAIST COE 2nd Meeting 12

Experiment of lane changes



Head movement during lane changing



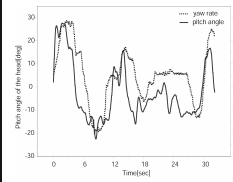
Frequency of gaze at the side mirror and rear-view mirror

2004/05/27

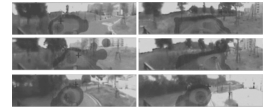
NAIST COE 2nd Meeting

13

Experiment of driving at a curve



Relation between the direction of a head and the yaw rate of the vehicle



Fixation maps while the vehicle is moving into the curve

- High correlation between the yaw rate the head motion
- Concentrating at tangent point

2004/05/27

NAIST COE 2nd Meeting

14

Conclusion & Future Works

- We proposed a driver monitoring system which utilizes a vision-based non-contact face tracking system together with omni-directional camera.
- The similar results reported in previous research was able to be measured by our non-contact measurement system.
- Since the system does not require any contact devices, it is suitable to develop a human interface for the driver.
- We plan to apply developed measurement system to driver assistance

2004/05/27

NAIST COE 2nd Meeting

15

Thank you for your attention