

Modeling Drivers' Cognitive Information Processing to Construct a Driving Support System

- In Case of Entering an Intersection -

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Background - Example of Application of Ubiquitous Computing to Driving Behavior -

- ITS (Intelligent Transport Systems) IS
 - an example of application of ubiquitous computing to driving behavior.
 - composed of 9 kinds of fields.
- VICS supplies information to drivers by using the navigation system. (Vehicle Information and Communication System)
- ETC collects toll charged for use of expressway automatically. (Electronic Toll Collection system)
- AHS supplies information of traffic condition and supports safety driving. (Advanced cruise-Highway Systems)
- The number of traffic accidents is still large.
 - It is hoped that the driving support systems like AHS enhance drivers' safety and reduce their cognitive and mental load.
- In case information that influences driving behavior is given to a driver, it is important when/how the information is given.
 - We should comprehend human behavior in driving to support their driving effectively.

Flow & Purpose of Our Study

- Analyzing Driving Behavior in Entering an Intersection
 - Systems and control lab. has been analyzed
 - the driving behavior with a driving simulator.
 - the causes of driving error which leads to traffic accidents.
- Modeling Drivers' Cognitive Information Processing
 - We will model the drivers' cognitive information processing.
 - This model will include the potential factors which affect the cognitive information processing.
 - A simulation based on the model can clarify how the potential factors affect the cognitive information processing quantitatively.
- Constructing Driving Support System
 - The driving support system
 - is intended to reduce the influence of the potential factors on dangerous driving.
 - is expected to support driving behavior and to suggest drivers how to drive safely.

Flow & Purpose of Our Study

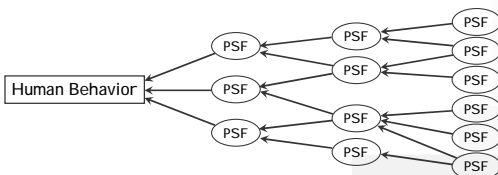
- Analyzing Driving Behavior in Entering an Intersection
- Modeling Drivers' Cognitive Information Processing
- Constructing Driving Support System



- This study**
- regards potential factors which can cause driving error as PSF (Performance Shaping Factor).
 - will model drivers' cognitive information processing which includes the PSF.
 - clarify the effects of the PSF on driving behavior through the computer simulation based on the model.

What is PSF ?

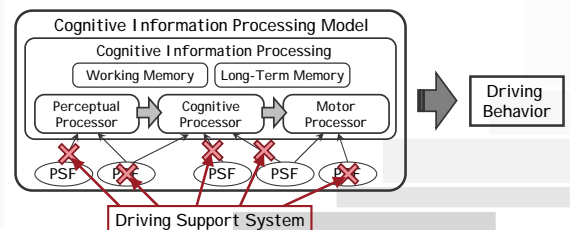
- "PSF" is the abbreviation of "Performance Shaping Factor".
- Originally, PSFs were meant as factors which increase the probability of human error in the Probabilistic Safety Assessment for nuclear power plants (Swain & Guttman, 1983).
- PSFs effect on each other, and effect on the human behavior eventually.



- In the field of Human Factors, it is very important
 - to specify PSFs exhaustively.
 - to clarify the structure.
 - to reduce their influence on human behavior.

Modeling Cognitive Information Processing Including PSFs

- This study
 - clarify the PSFs which exist in driving behavior.
 - model drivers' cognitive information processing including PSF.
- The goal of this study is to construct a driving support system which can reduce the influence of PSF on cognitive information processing.



Analyses of Human Driving in Systems & Control Lab.

Systems & Control Lab. has directed attention to driving behavior in entering an intersection, and has carried out some kinds of experiments with a driving simulator.

- (1) Analysis of safety driving in entering an intersection
- (2) Examination of driving behavior which causes traffic accident by eye tracking analysis
- (3) Analysis of drivers' physical and mental condition before the traffic accident happens



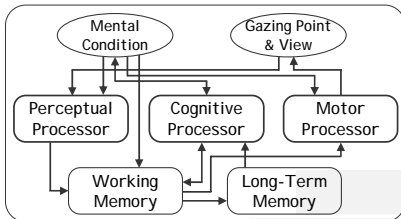
Analyses of Human Driving in Systems & Control Lab.

- The past study
 - analyzed the difference between skilled drivers' behavior and unskilled drivers' behavior
 - examined the cause of dangerous behavior
- Factors which can cause dangerous behavior are
 - uncertainty of confirming crossing cars and pedestrians
 - lack of assuming dangerous situation
- Accidents often occurs when drivers' heart rate is lower than usual before entering an intersection

→ Based on the results of these experiments, we will model drivers' cognitive information processing in entering an intersection, and specify PSFs which cause dangerous driving.

Outline of a Model of Drivers' Cognitive Information Processing

- Systems and Control Lab.
 - modeled operators' cognitive information processing in diagnosing faults in the plant operation.
 - examined the mechanism of human error occurrence.

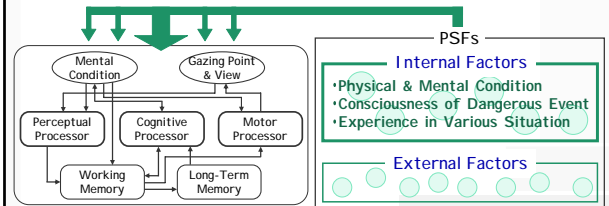


Structure of Operator Model (Nishitani, et al., 2002)

→ Apply this model to driving behavior in entering an intersection.

Outline of a Model of Drivers' Cognitive Information Processing

- We focus on the characteristics of drivers, and will make a model including PSFs, particularly, internal factors.
- We will simulate human behavior by using PSFs as the parameters.



Purpose of the simulation is

- to examine driving behavior when the value of each parameter is change.
- to make drivers recognize that there is something potentially dangerous in their driving.

Driving Support System With Ubiquitous Computing

- In the conventional thought of the driving support system of AHS, drivers get the information of the dangerous events passively.
- Ubiquitous Computing Environment
 - enables measuring drivers' physical and mental condition.
 - can store drivers' information of their driving experience.
 - can give drivers the information that helps them.
- Finally, Ubiquitous Computing Environment will realize the driving support system which can effectively help drivers



Summary

- We will be aimed at modeling drivers' cognitive information processing in entering an intersection in order to construct a driving support system using ubiquitous computing environment.
- This model
 - is based on the model of operators' cognitive information processing in diagnosing faults in the plant operation.
 - includes PSFs which can cause drivers' dangerous behavior.
- In the next stage, we will simulate human behavior using the model, and clarify cause of human error from the viewpoint of PSF.