Driver's reliance on car crash-prevention systems

the 6th COE Postdoctoral and Doctoral Researchers Technical Presentation

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Background (1/2)

- Recently, due to development of automotive technology, many kinds of safety driving support systems are developed and equipped.
- These automotive technologies are of interest to the ubiquitous society
- Regardless of how efficient the support system is, it is essential to drive carefully.

Background (2/2)

- These technologies are not able to sense and avoid danger in an instant.

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At this point, one should not rely too much on the systems

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Measurement of Overdependent and Distrust

Overdependent & Distrust

Overdependent

Drivers may rely totally on the systems. As a result, some drivers may not be as careful as they normally are while driving.

Distrust

Drivers may refuse to use the systems because they feel these systems are unnecessary and useless if the timing for these systems to provide useful information for safety driving is, for example, too early, too late, or if the information is incorrect.

Driving Simulator (DS)

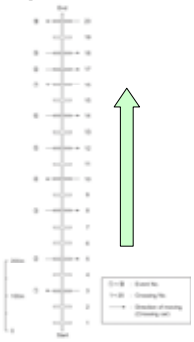
- HONDA driving simulator
  - 6-axis motion base
  - Function of scenario editor
    - Event, Environment
    - Other cars' movement
  - Logging data
    - Car movement
    - Car operation
    - Other cars' position

Experiment (1/4)

- 4 subjects (graduate students)
- 2 days
- Data Analysis
  - Braking control
  - Adaptive weight workload (AWWL)
  - Video data
  - Replay data (Function of DS)

Experiment (2/4)

– Test Course
- 20 intersections
- 10 events
- Speed limit set at 30km/h
- Total length of 800m



Experiment (3/4)

– Support System
- If there is a crossing vehicle, an alarm will sound at about 27.5 meters from the intersection

Experiment (4/4)

- Event

Day	Phase	Round	3	5	8	10	12	14	16	17	18	20
1	I	R1			●				●			
		R2						●				
		R3							●			
		R4			●							●
	II	R5		●								●
		R6			●				●			
		R7						●				
		R8		●					●			
		R9		●					●			
		R10			●					●		
		R11				●					●	
2	III	R12	●				×				●	
		R13			●						●	
		R14					▲					
		R15			▲			▲				▲
		R16					×				●	

● : Without system, ● : With system, ▲ : Incorrect alarm, × : Missing alarm

Results: Braking control (1/7)

- Braking at intersections (Phase I : S1, S2, S3)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
R1	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
R2	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
R3	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
R4	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

○ Safety driving ■ Crossing car

– In the case of “without system”, S1, S2 and S3 decreased the speed or stopped at the all intersection.

Results: Braking control (2/7)

- Braking at intersections (Phase I : S4)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
R1						○		○	(disrupted by accident)											
R2				○	○		○	○	○	○	○	○	○	○	○	○	○	○	○	○
R3			○		○			○	○	○		○	○	○		○		○		○
R4			○		○			○		○				○		○	○	○	○	○

○ Safety driving ■ Crossing car

– S4 didn’t decrease the speed at some intersections.

Results: Braking control (3/7)

- Braking at intersections (Phase II : S1, S2, S4)

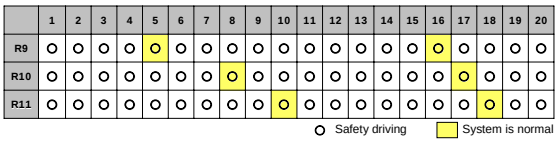
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
R9					○											○				
R10								○									○			○
R11										○								○		

○ Safety driving ■ System is normal

– In the case of “with system”, all S1, S2 and S4 passed almost all of the intersections without braking except when there was an alarm.

Results: Braking control (4/7)

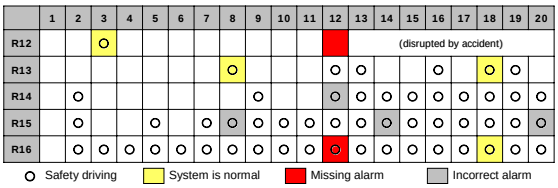
- Braking at intersections (Phase II : S3)



  - Regardless of whether there is a system or not, S3 decreased the speed or stopped at the all intersection.

Results: Braking control (5/7)

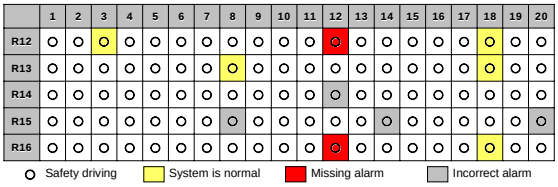
- Braking at intersections (Phase III : S1)



  - In the case of "system error", S1 decreased the speed or stopped at all the intersections after an incorrect alarm went off.

Results: Braking control (6/7)

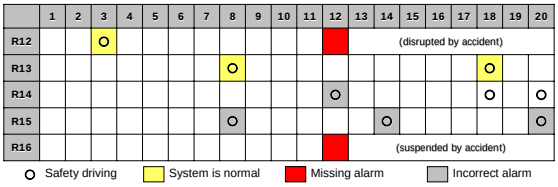
- Braking at intersections (Phase III : S3)



  - In the case of "system error", S3 decreased the speed or stopped at all the crossing.

Results: Braking control (7/7)

- Braking at intersections (Phase III : S2, S4)



  - S2 and S4 still went on relying this system even after an incorrect alarm went off.

Distrust

- Degree of distrust (distrustfulness)
  - Distrust of incorrect alarm (alarm ignorance ratio)

$$D_1 = \frac{a-b}{a}$$

a : Intersection with alarm
b : reaction
$b-a$: no reaction

  - Distrust of missing alarm

$$D_2 = \frac{c-d}{c}$$

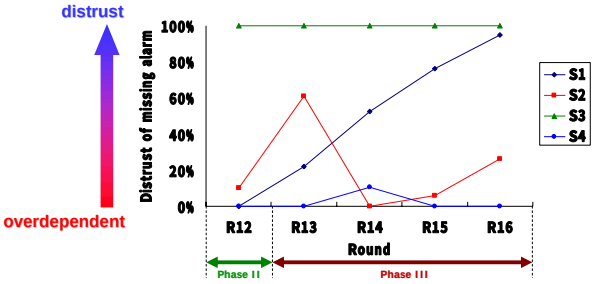
c : Intersection without alarm
d : no reaction
$c-d$: reaction (safety driving)

Results: Distrust (1/2)

- Distrust of incorrect alarm
  - All subjects decreased the speed or stopped at all the intersections with alarm. (0%)

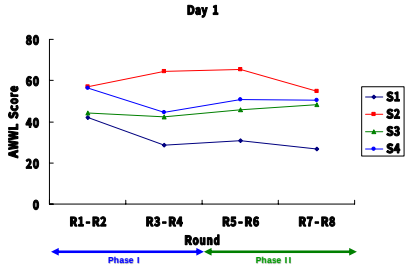
Results: Distrust (2/2)

- Distrust of missing alarm



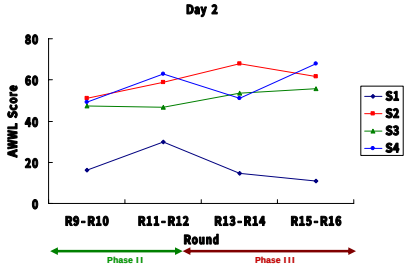
Results: Mental workload (1/2)

- AWWL (adaptive weight workload)



Results: Mental workload (2/2)

- AWWL (adaptive weight workload)



Summary

- The data of the DS's behaviors and task load index while driving are analyzed to estimate the degree of the subjects' reliance on the system.

Future Work

- Analyze the physiological data (lines of sight, electrocardiogram, electroencephalogram, etc.)
- To find a correlation between the results obtained and the above analysis
- Based on the physiological data, we perform a real-time measurement to analyze the degree of reliance.