Department of Industrial Engineering
Human Factors and HCI Lab
Ajou University

Vehicle Oriented Driver Using VR
(the aspect of HCI)

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Lab Introduction

- Name : Park Peom
- Dept : Ajou University Industrial & Information Systems Engineering
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- Education : (BS)1982 . 2. 20 – Ajou University Industrial Systems Engr.
  (MS)1988. 6. 11 – Ohio U(USA), industrial Systems Engr.
  (Ph.D) Iowa State U(USA), Industrial & Manufacturing Systems Engr.
- Activities : [1993 – 1995] ETRI(Electronics and Telecommunications research Institute Senior Researcher
  [1995 – 2000] ITU-T Information and Communications S.W Technology Research Subcommittee Member
  [1996 – 2004] ISO-TC 159, 204(Human Interface)Expert Adviser
  [1995 ~] Ajou University Industrial & Information Systems Engineering Professor
  [1996 ~] KIPS, ESK, KISTI, KSIE, ITS outside director, KOSHA, KATECH, ETRI, KISTEP Samsung, Hyundai Motors, Doosan Research Advisor
  [2010 ~] Seoul National University College of Medicine Visiting Professor

Lab Introduction

Recent Major research Activities

- Development of DIS Model and HMI Prototype to Advanced Vehicle as applied Telematics-(Hyundai Motors)
- A development of design guideline for user interface in vehicle information system-(Hyundai Motors)
- Research of Passenger static conduct package optimization-(Hyundai Motors)
- Quantification Research of Package Marketable(visibility)-(Hyundai Motors)
- Fine Health Care Service for Blue Color & Green Color Society(National Information Society Agency)
- Human Factor based Model Development and Design Guidelines for the Cockpit Design of the Industrial Lift Truck (Doosan)
- Research of the remotely pathology information integrated management system
- Research of the intelligent safety monitoring system modeling by USN and biological signal at the workplace(Korea Science and Engineering Foundation)
- System Biomedical Informatics Research Center- Phenomic Self: Data and measurement driven Discovery and understanding of Human Disorders(Ministry of Education Science and Technology)

Lab Introduction

- Ergonomics is the study of designing equipment and devices that fit the human body, its movements, and its cognitive abilities.
- Ergonomics, HCI(Human Computer Interface, HMI , Telematics, VR Ubiquitous Telemedicine, Cognitive Science, Industrial Safety

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Background/ Environment / Research Case

Research Outline

Paradigm shift in the automotive industry

- Automotives all around world tend to have same standard of Performance and Quality
- Competitive power in automotive industry will be depend on Possession of future technologies
- Automotive industry should collaborate with related industry to prepare paradigm changes in the next generation of automotive technology

Trade – Off : Including Human Factors Engineering + Design Aspects

- Driver interaction system based on advanced Ergonomic, cognitive evaluation, optimal and safety design is essential
- Effective trade-off and examination needed at engineering and design relating functionality, usability, safety, and emotional aspects etc.

Automotive model Developed through the Quantified Data

- Make criteria about specification before doing automotive design
- Necessary for automotive model development using packaging
- Examine existing evaluating tool through the quantified data

Research Outline

Increasing Convenient of Automotive interior space

▪Today's vehicles are considered not just as a means of moving but as a second living space having multiple functions and roles.

▪ In conjunction with the development of small electronic devices, communication with a variety of information and functions became available during driving

Increasing Risk of accidents by Careless driving

▪Lots of features that increase convenience for drivers Inside the vehicle could have a high possibility to cause driver's careless driving

▪ Car accidents due to careless driving have accounted for the largest proportion of total traffic accidents.

Relationship between using smart phone and driving automotive

▪Recently the growth of smart phone usage has been highly increased and it has various functions like navigation, video and playing music that can use during driving inside vehicle.

▪ In particular, smart phone could be used accidently due to the nature of communication devices

Research Outline

Hard Ware

Mock-up & HMD & Screen

steering wheel & pedal

Research Outline

VR simulation software

FORUM 8

Driving Simulator Software (UC-win/Road)

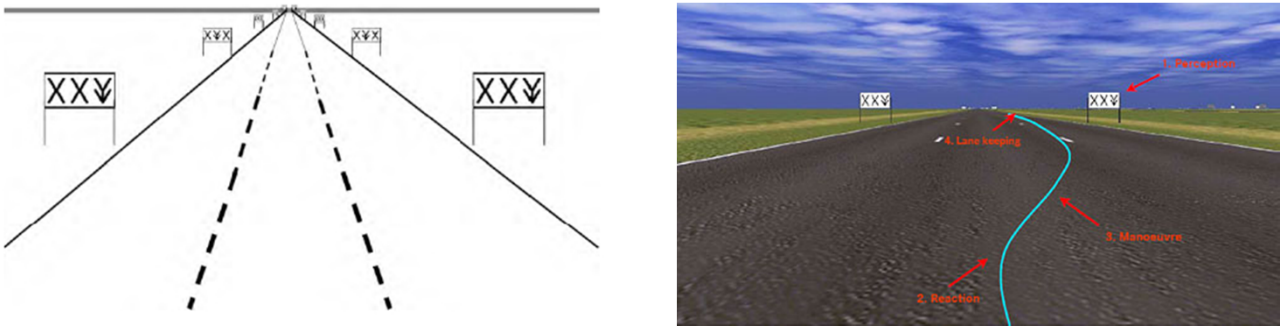
Key Feature

- 3D Driving Environment
- Scenarios Provide Customized
- Produce a variety of Situation
- Log Data(Speed, Coordinates Etc..)

Research Outline

Research case 01. Driving Skills Assessment using Lane Change Task

- Lane Change Task via a virtual reality environment is a analysis techniques to evaluate driver's driving skill depending on directions and reaction time to lane changes according to fixed road signs .
- It is widely used as an indicator of the driver's driving skills assessment , for example, Alcohol-related impairment in the Lane Change Task is used to evaluate driving skills in a drunken state .

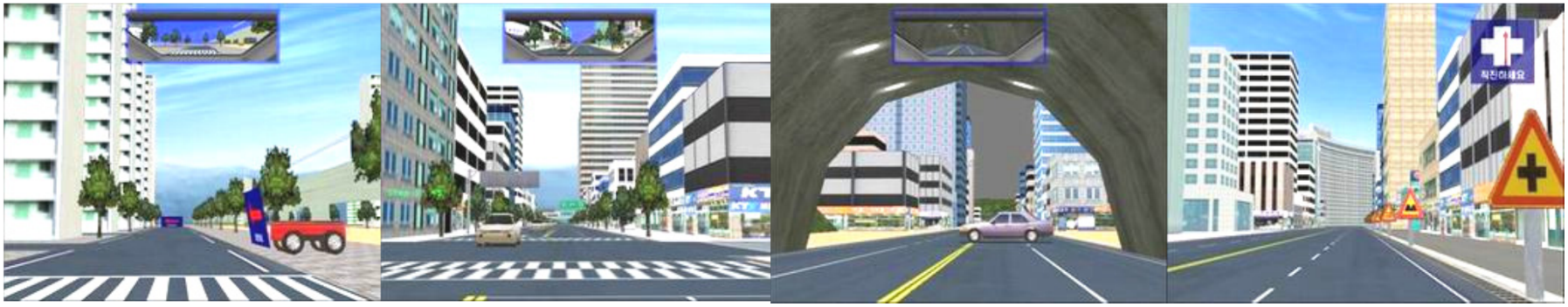


[Lane Change Task]

Research Outline

Research case 02. Driving ability and visibility assessment using a virtual reality

- Research using virtual reality provides not only simulations of real world but also experiences that seems difficult in the real world. Furthermore, it offers interoperability that the virtual reality world operates differently by responses of subjects.
- Three-dimensional space in computers called Cyber space can have diverse forms that categorized by the degree of three factors; presence(immersion), interactivity



[A virtual reality program]

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Background/ Object / Research Design / Conclusion

Research Case 1

Measuring driving skill changes by driver's negligence that caused

by smart phone usage

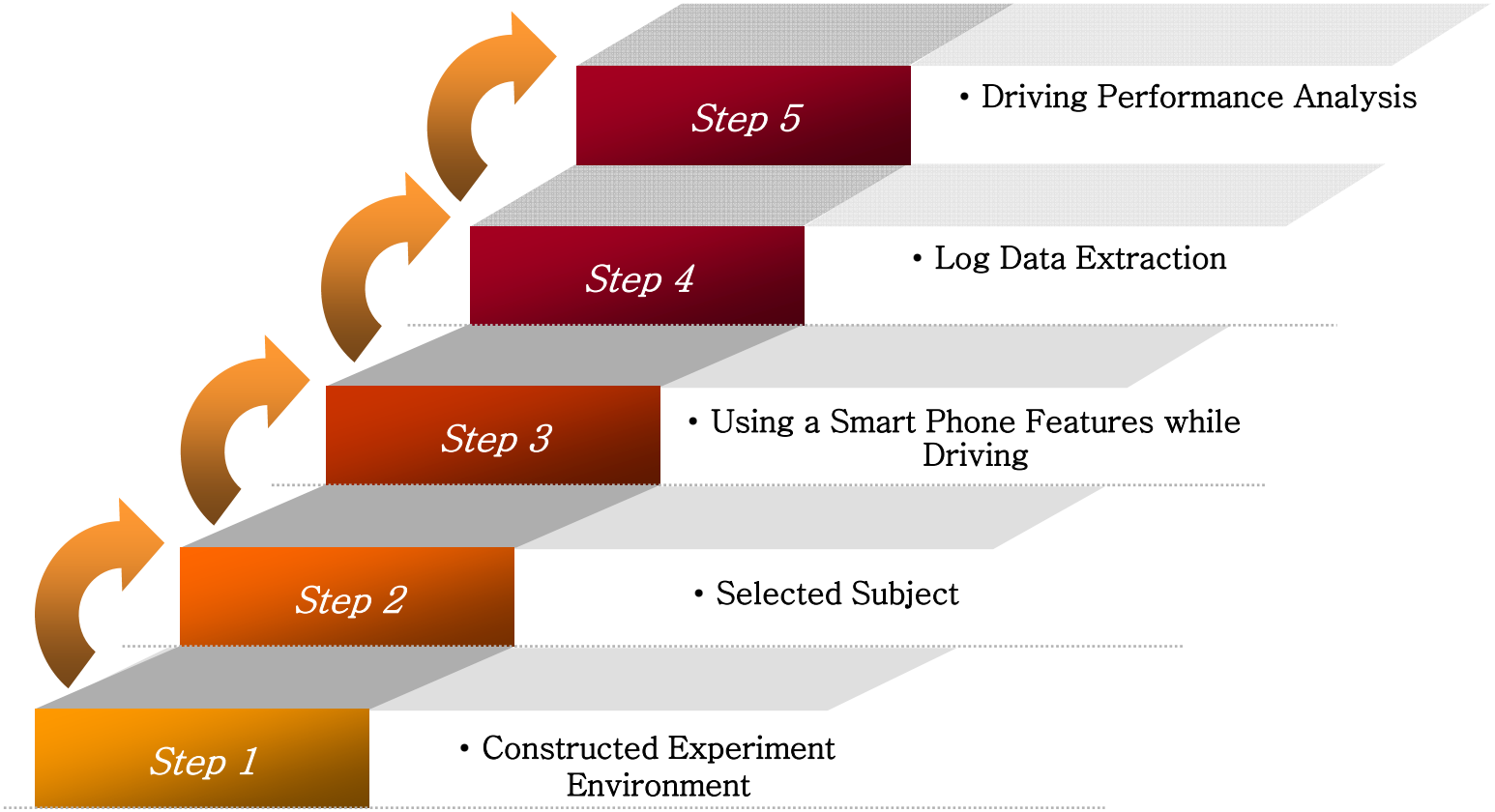
- Car accidents due to driver's careless driving have accounted for more than 60% of total traffic accidents.
- Smartphone includes a number of features which affect driver's careless driving and it can be a cause of the accident.
- Quantitative data required to measure how much the use of smartphone affect the driver's driving ability.

Research Case 1

- A driving skills assessment conducts by a virtual reality experiment using VR system
- Eliminating dangerous situations using VR system and getting quantitative data through Log Data
- While a driver uses main features of smart phones, conducts the driver's driving ability assessment.
- Getting quantitative data about that how the use of smart phone affect driver's driving ability.

Research Case 1

Research Process



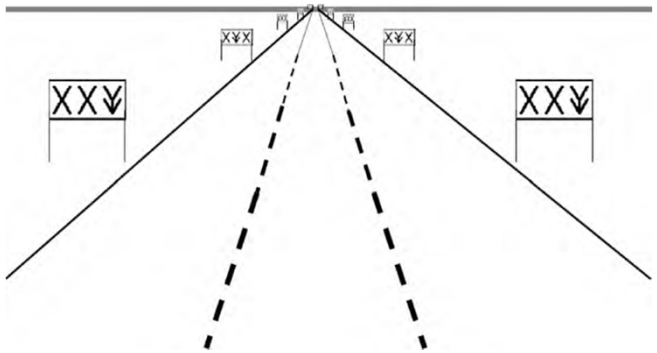
Research Case 1

Experimental Scenarios

- Written Questionnaire
- Adapted VR Environments & pilot test Progress
- The Experimental 1. Normal Driving
- The Experimental 2. Working document for Smart Phone (While Driving)
- The Experimental 3. Search the Internet for Smart Phone (While Driving)
- The Experimental 4. SNS Service for Smart Phone (While Driving)
- The End

Research Case 1

Conducting LCT (Lane Change Task)



• 20people(women and man) in their early-mid 20s participate a experiment that while using smart phone, change lanes following indications of simulation for certain amount of time.

• Analyzing driver's reaction rate and driving accuracy by comparing two group; one group in working condition using smart phone like messaging, internet browsing during driving and the other group just focus on their driving.

• experiments conduct in dangerous driving condition that might be impossible in the actual driving environment.

• Experiment participations use their own smart phone to eliminate interactions by familiarity with smart phone.

Research Case 1

Log Data (Example)

- Driving Time, Distance, Slope, , The amount of Brake & RPM etc..
- HMD & Sensor Log Data

Time	Name	ID	Description	Position (n	Y	Z	Yaw angle	Pitch angl	Roll angle	Is vehicle	Direction)	Y	Z	RPM	Gear num
0.00325	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.01911	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.03527	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.05141	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.06847	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.08443	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.10223	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.11795	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.13436	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.15109	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.16763	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.18435	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.20204	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.21777	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.23522	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.25129	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.26845	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.28445	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1
0.30217	4WD Blue	152	User's Veh	2001.62	5	1987.83	2.357	0	0	Yes	0.706	0	0.708	300	-1

Research Case 1

1. Analysis of results related to speed variation

• Verification using the basic ANOVA Table and the Tukey method, Duncan method based on speed changes in variation of log date.

• Experimental results verify the all three main features used in smartphone has an impact on careless driving and especially find out Internet surfing is the most impact on driving ability from this experiment.

Tukey Grouping		Mean	N	group
	A	60.122	52	1
	B	52.940	52	2
	B			
C	B	50.475	52	4
C				
C		45.582	52	3

Tukey analysis table

Duncan Grouping		Mean	N	group
	A	60.122	52	1
	B	52.940	52	2
	B			
C	B	50.475	52	4
C				
C		45.582	52	3

Duncan analysis table

Research Case 1

2. Analysis of results related to distance between the center of the road and vehicle.

• Verification using the basic ANOVA Table and the Tukey method, Duncan method based on Offset of road center in variation of log date.

• Experimental results verify the all three main features used in smartphone has an impact on careless driving and especially find out Internet surfing is the most impact on driving ability from this experiment.

Tukey Grouping		Mean	N	group
	A	-6.8072	52	1
	A	-7.8669	52	4
B	A			
B		-8.1478	52	2
B				
B		-89299	52	3
B				

Tukey analysis table

Duncan Grouping		Mean	N	group
	A	-6.8072	52	1
	B	-7.8669	52	4
	B			
C	B	-8.1478	52	2
C				
C		-89299	52	3

Duncan analysis table

Conclusion

- Concentration and distraction affected by tasks during driving decreases speed, lane-keeping ability and cognitive ability around objects.
- This research method can be used to verify driver's cognitive difficulty when they use new introduced information devices and system.
- It is required more study and review about various cognitive difficulties by Implementing a realistic driving situation such as roads, cars, traffic lights etc.
- It will be a reference to enact driving-related regulations especially about additional activities while driving.

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Background/ Object / Research Design / Future Plan

Research Case 2

The importance of Internal Design

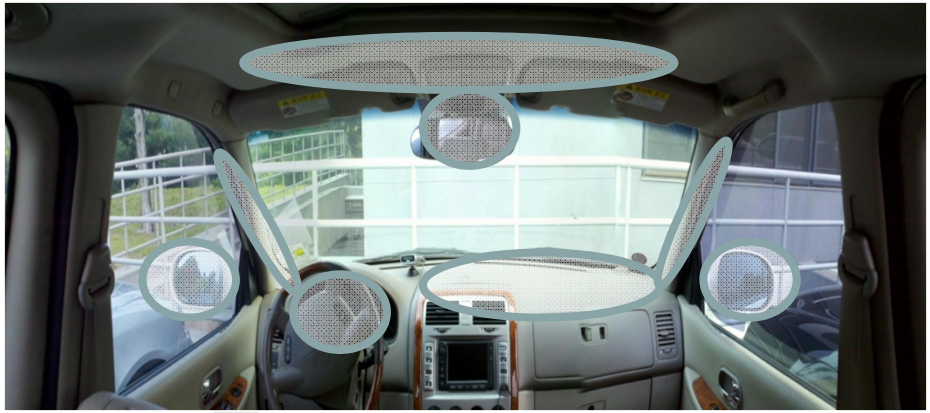
- Exterior Design-Oriented Design
- Need to Exterior Design based on Internal Design

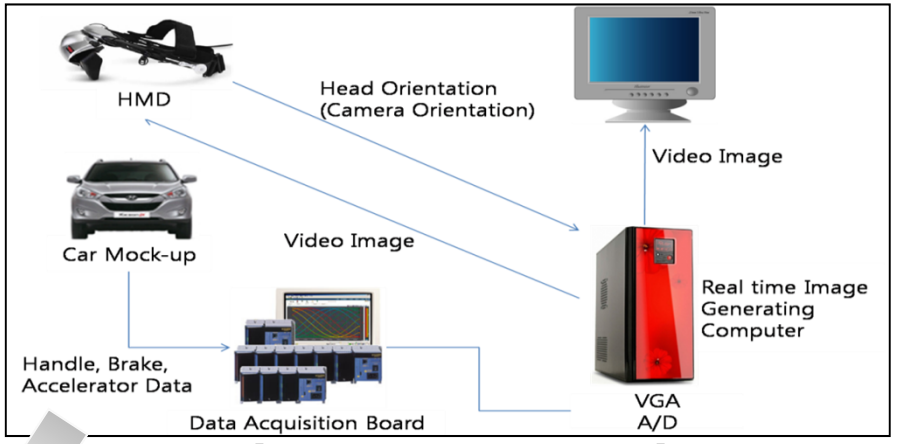
Research Case 2

Need to secure autonomy by visibility test and quantification

- Extracting packing factors related driving visibility and need study to identify the limits of each factor and quantify factors.
- Need to set the base of giving degrees of freedom of design and developing competitive model by limiting visibility factors related forward / backward / sideways / upward / downward.

Research Case 2





[System Configuration]

Selecting trial package factor for applying VR design through first, second experiments results

Adjustment available range of selected package factors for changing

Mock-up Design, Road Design for VR experiment scenarios (HMD(60°), Mock-up, Main Computer)

[VR Example]

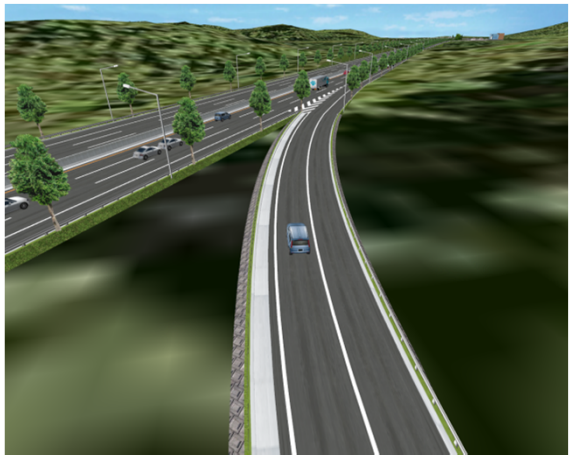
Research Case 2

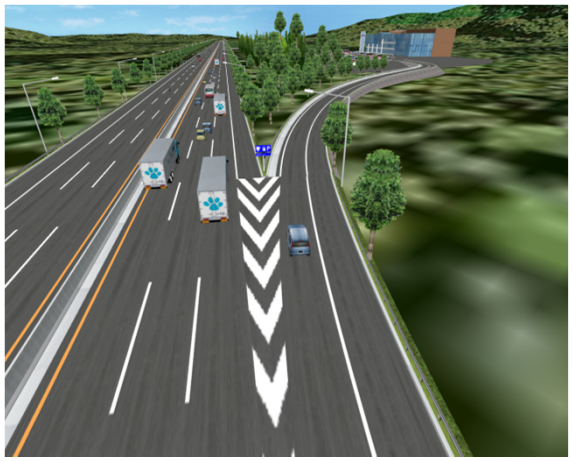
Change the Visibility factors

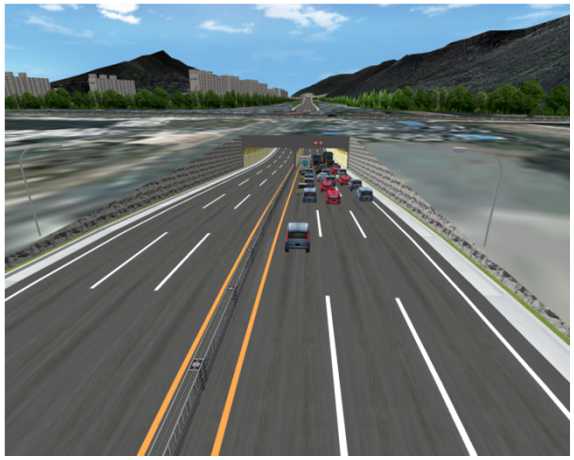
- Changed the A-Pillar, Out-Side Miller, Cowl & Hood Etc..

Research Case 2

Scenario Configuration





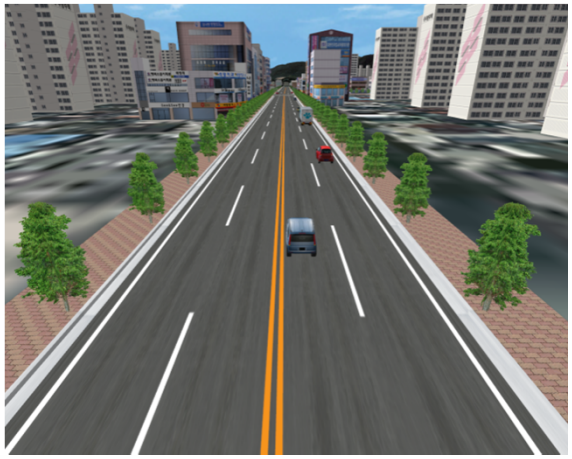


- Configuring the Highway Environment
  (Around the Vehicle, Expressway Rest Area, Signpost, Speed Camera Etc..)

- Configuring a Driveway Environment
  (Overpass, Underpass Etc..)

Research Case 2

Scenario Configuration



- Configuring the City Streets Environment (Pedestrian Traffic Lights, Turn Left & Right Etc..)

- Configuring the An Alley Environment (Turn Left & Right, Parking Etc..)

Research Case 2

Step 4 process

- Step 1, Confer the scope of effective limiting factor from the vehicle visibility package including analysis of literature related comprehensive visibility assessment.
- Step 2, Extracting limiting package factors, deciding the scope of limits of each factors, testing influence, analysis, Scholly method test and finding improvement solution through primary and secondary examination.
- Step 3, Implement VR system within the scope of the limits of limiting package factors for VR experiment and make experiment.
- Step 4, Find out quantitative result of front/rear/up/down/sideways visibility package limiting factors by extraction and analysis of quantitative date.

Research Case 2

- Identify and quantify visibility and limits of related package factors about characteristics of RV vehicle.
- Set the base of giving anatomy of design and developing competitive model by limiting package factors related forward / backward / sideways / upward / downward (sideways mirror, A-Pillar, Cowl, etc.)
- Verify and analyze Scholly Method, then make improvement solutions by complementing lack of points from the experiments.
- Proceeding detailed experiment by implementing VR system to conduct visibility assessment using virtual reality.
- Design VR system to easily change visibility limiting factor, then acquire data about limit and optimal value of limiting factors by quantitative analysis.

Research Case 2

Expected effect from study

Main results	Expected effects
• Extract package factors related visibility	• when design vehicles, can apply a larger degrees of freedom related visibility
• Derive influences and limits of related factors	• Get optimal specification by using quantified a basic package data
• Improved visibility test (factor weighted re-evaluation) design	• Improve vehicles by securing domestic standard
•Experiment and evaluate by each visibility factors using VR system	• Possible to visibility test for each vehicle type by improved Scholly method
• Acquire package limits and optimal of degrees of freedom related visibility	• Set detailed assessment process for developing a new car using precise package limits

Q & A

Thank you

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