APPLICATIONS OF VR SYSTEMS FOR ROAD AND TRAFFIC SAFETY

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Virtual reality (VR) is the continuing standard in testing solutions for safety and other needs related to road and traffic planning. This is because of the cost effective nature and the ability to create an effective testing environment without compromising participant safety. This paper describes the components of a real-time VR simulation system, including: a software program for visualization, a comprehensive hardware system that can reproduce both the feeling and behaviors of a vehicle, and the force control loading system that links the driver and their actions to the hardware and software. Case studies from Meijo University, Japan's National Agency for Automotive Safety & Victim's Aid, and Kinki Regional Development Bureau will be presented, highlighting their diverse applications of VR systems for traffic and road safety.

Introduction

Virtual Reality (VR) technology, including software and hardware systems, continue to grow in usage and popularity among planners and developers from a wide range of industries, including traffic and road safety. VR technologies can provide opportunities to experience new plans and concepts for anything from new vehicle technology, to future road designs. Using VR as a tool to visualize and interact with these plans and concepts allows for a cost-effective and controlled way to determine in full 3D, how a system behaves and its effectiveness in a manner that is often more comprehensive than the interpretation of 2D plans alone. Further, this is useful when trying to understand effectiveness with varying publics as well, without the need to actually compromise safety to test. The integration of software and hardware systems is the key to creating meaningful VR experiences, which rely on the software to dictate the visual information while the hardware enables direct, real-time user interaction.

UC-win/Road (software) and the UC-win/Road Drive Simulator (hardware) together act as a total package for creating and then experiencing VR environments. Case studies made in Japan from Meijo University, the National Agency for Automotive Safety & Victim's Aid (NASVA), and the Kinki Regional Development Bureau present different strategies for improving safety through the application of VR solutions.

Software

UC-win/Road is a real-time, 3D VR software package which can be used as a tool to visualize environments from planning stages through realization [1]. The primary feature is the road editing toolset, used to create roads with alignments ranging in complexity. These roads are then represented in the VR space with 3D geometry and accompanying 2D textures.

AI based traffic simulations in UC-win/Road create traffic directly on the roads, following the alignments properly. Further, scenario editing tools allow for the creation of complex situations.

This can be especially effective for testing traffic and road safety through the use of scripted events as UC-win/Road allows users to assume a driver's perspective while navigating the VR space.

Finally, along with roads, additional visual information becomes necessary to create a holistic VR environment. With UC-win/Road, 3D buildings, trees, pedestrians and traffic related objects work in tandem to create a 'realistic' VR environment which is especially useful in public-oriented traffic safety testing by mitigating one's ability to perceive the VR space as fake.

[2] Simulation carried out at Daishi junction

[3] Ishikawa-cho Junction Simulation

Hardware

The UC-win/Road Drive Simulator is a complementing component to the UC-win/Road software, acting as the interactive device, which is in the familiar form of a car interior. A force control loading system then acts as the link between the hardware and the software, allowing the participants to interact directly with the software's VR environment.

A basic driving simulator, like the UC-win/Road Drive Simulator, features a 1/4 size car cabin, complete with an "active" steering wheel (force-feedback steering), working dashboard, gear shifter, and more. Additionally, advanced systems can include a platform for movement. Such motion platforms can provide 2 or more degrees-of-freedom (DOF), enhancing the users perception of the VR environment through added realism in interaction.

DS System with DOF motion platform

As the participant assumes control of a vehicle in UC-win/Road, they can navigate the roadways with the vehicle simulator, interacting as one would expect to do in a normal vehicle.

Case Studies

1. Driving Ability Measurement for Senior Citizen VR Simulation - Meijo University

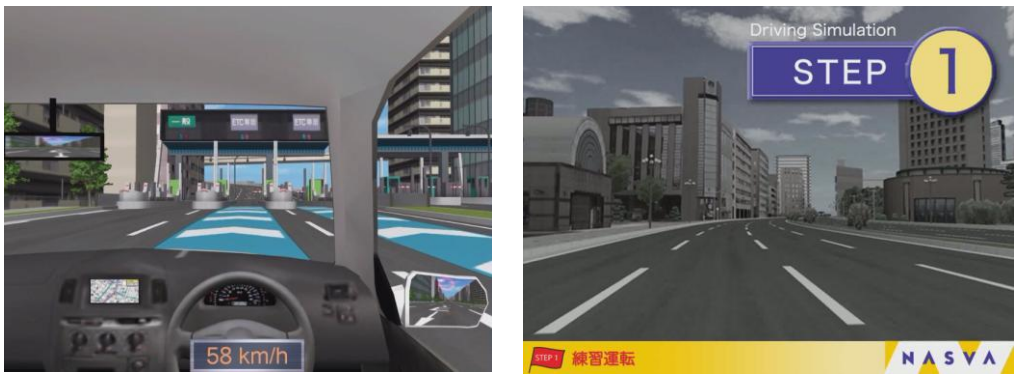
At Meijo University, a student and professor sought to gain an understanding of the driving behaviors of senior citizens. The resulting customized solution took advantage of a driving simulator and with the UC-win/Road software, a testing environment was crafted with specific scenarios geared at testing senior citizens. These tests focused on the following areas: reaction times (for pedestrians and other environmental factors, including traffic), braking times, and stopping distance. The VR system logged this information and provided quantitative data for analysis. [4]

[4] Driving Ability Measurement for Senior Citizen VR Simulation - Meijo University

2. Simulated driving diagnosis system using CG simulation - National Agency for Automotive Safety & Victim's Aid (NASVA)

Similar to Meijo University, NASVA sought to create a comprehensive and accessible system to collect information pertaining to driver habits and provide direct feedback. The goal was to reduce accidents by identifying negative behaviors associated with driving, targeting such individuals as professional drivers, elderly drivers, and new drivers. VR became the method of choice in understanding behaviors, and using a customised system, information on the way a driven vehicle moves through traffic and its associated actions within the VR space is recorded. Like Meijo University's research, scenarios are utilized to create specific events that allow for more structured testing of an individual's driving behavior.

For this case study, a unique system was developed for processing and giving feedback to its users in the form of NASVA NET. This improved on the original system because it can collect simulation data through an internet connection, reducing the need to travel to specific facilities for testing. Feedback on driver habits is provided directly through this internet system. [5]



[5] Simulated driving diagnosis system using CG simulation - NASVA

3. Fukui Coastal Route Drive - Kinki Regional Development Bureau

The Fukui Coastal highway in Japan is well known for its volume of traffic accidents. During reconstruction efforts to improve safety on this dangerous road, the Kinki Regional Development Bureau employed an unconventional method to improve safety through the use of a VR system, including both software and hardware.

With UC-win/Road, several kilometres of the new roadway plans were developed in VR. In an effort to inform the public of the new plans, a small stand-up simulator has been setup at a rest-stop to display the interactive data. The intention of this is to allow individuals to experience the new roads and gain an understanding of how to navigate them before actually doing so, increasing safety through education. Diverse weather conditions can also be experienced, which can affect visibility. [6]

References

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[5] Meijo University, Faculty of Science and Technology, Department of Information Engineering, Driving Ability Measurement for Senior Citizen VR Simulation (in Japanese). (2007)
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