THE CONCEPT OF COOPERATIVE SIMULATORS

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Abstract: *To explore the characteristics and capabilities of the motor vehicle drivers as the optimal solution is to use interactive (full mission) simulators, which allow induction of both normal and abnormal situations arising on public roads. Needs to increase the credibility of environment simulation is necessary in addition to the model and the image of real environment to simulate a conventional car drivers and road users behavior as well. Mathematical models of the road user behaviors are far from the actual behavior of the current driver in real road traffic. Based on the experience, consultations and the conclusions of the ITEC and the I/ITSEC international conferences, appears as optimal design the external environment model with a number of cooperating entities produce situations like the actual traffic on public roads.*

Keywords: Advanced Distance Training, Virtual Simulators, 3D Visualization system.

INTRODUCTION

Technology is changing the way we live, work, and play. It comes as no surprise that it is also changing the way we train. The advent of the internet is changing just about every facet of our daily lives. The internet is bringing about a paradigm shift in the way people learn. The future is forecasted to grow e-training courses significantly over the next decade. While this paradigm shift is opening up many new business opportunities, it is also causing great concern for traditional training settings. Instructional Designers need to change the way they design instruction. Instructional materials are being designed in terms of reusable objects versus entire training courses or theory lessons.

1 Training of the military and civil driver professionals

There is possible to say, that especially the losses on roads, caused by vehicle accident, which are the daily reality in all the countries of word reach in sum more, than many of rarely appearing catastrophic events (the very rough estimation lead to the figure of more than 200 thousands killed people per year and more). In contrary to mentioned catastrophic events on the appearance the people have no (or only very small) influence, the accidents on roads are caused from 50% and more by faults of human factor. Therefore one sees here the challenge and necessity to try minimize the respective losses as much as possible. Along with this paradigm shift there is a strong focus in the training producers toward establishing “open” standards that would enable the distribution of learning over the Internet and World Wide Web. In fact the Advanced Distributed Training (ADT) initiative was established in 1997 to examine these issues. Before this time, there were several groups establishing such standards, including The Aviation Industry for Computer Based Training Council (AICC), and the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE).

At the core of all these efforts is the concept of reusable objects. While this concept is new to training, it is not new in other areas. This theory is based on the object-oriented paradigm of computer science. The concept is to build components or objects that can be reused in multiple contexts. The idea is that a producer can go to a list of objects that are already created and simply insert one into their program. These objects are developed one time, tagged and stored, and then used and reused as necessary. However, these objects must interact, so while they are independent entities, they must also be able to be combined with other objects in order to form a meaningful concept. Therefore, there is a need for a common definition of objects and properties, so that objects may be used interchangeably.

All of these developments have stirred a great debate in the "e-training " market concerning labeling these objects. Terms such as "Instructional Objects", and "Training Objects" have started to appear in a significant number of "e-training" publications. There is, however, no common definition of these terms; and to make matters worse, there is no common context in which these terms are used.

2 Virtual driving simulators

Driving simulators represent a very important tool, which give us a wide range of possible applications. They are successfully used for several decades especially in research and automotive industry for optimization and testing the car abilities and their furnishing by sets and alliances of driver assistance systems. They are also used for long time for driver training. Originally, they were being dominantly developed to help drivers to reach necessary basic driving skills. Then, they were mainly used for training of professional drivers of special vehicles to adapt on demanding situations. However, soon not only freshman but also skilled drivers were trained on simulators for improvement the safety and efficiency of their driving. This is important especially for professional drivers, namely of trucks.

We can find first steps of these activities already in the fifties of the twenty century e.g. by VW, BMW and Ford. Their blossoming appears in the 1970's. Nowadays, the high quality driving simulators are widely considered as very valid devices for both for training drivers under situations in heavy and demanding conditions, but also for research and investigations concerning the reliability of driver-car interaction, for solving the large variety of human-machine interaction problems (HMI) and car-cockpit and assistance systems optimization. Their theory, methodology of use, design, construction and operation require a very wide range of knowledge, from neurology, psychology, control engineering electronics, informatics, mathematics and mechanical engineering to transportation sciences. *The driving simulators and the driving simulation technology are said to be a "royal discipline" within the scope of the simulation devices.*

The key role of the perfect driving simulator plays visualization system and tools for creation of assets constituting scenarios. Those are mainly modeling of 3D objects and tools for automation of such a process and databases (storages) of modeled objects. Each object in virtual reality is accompanied by a texture or a set of textures. The texture is a picture which simplifies the 3D object creation because the geometry of any real object is very complex and on the other hand it is possible to replace it with a very simple geometry covered by a worked out digital photography. The textures can be of different types; general which are tillable (i.e. repeatable - like grass, road surface etc.) and the unique ones (houses, signs etc.). The amount of textures over one scenario could be very high but lots of them could be reused on several different pieces of geometry. For that reason it is also very practical to have apart the databases of the terrain, the 3D models (objects) and also of textures.

2.1 Distributed interactive simulation

For training and developing skills of motor vehicle driver as the optimal solution appears to use interactive (full mission) simulator. The interactive simulator allows the induction of both normal and abnormal situations arising on public roads. Needs to increase the credibility of environment simulation is necessary in addition to the model and the image of real environment to simulate a conventional car drivers and road users behavior as well. Mathematical models of the road user behaviors are far from the actual behavior of the current driver in real road traffic. Based on the experience, consultations and the conclusions of the ITEC and the I/ITSEC international conferences, appears as optimal design the external environment model with a number of cooperating entities produce situations like the actual traffic on public roads.

Cooperating objects in the model of the external environment may be model of behaving according to a deterministic algorithm with implemented semi-automatic or heuristic behavior. The behavior of these models is design formerly and their responses can be expected in many cases over a longer practice. For maximum similarity to the normal traffic on public roads should be a cooperative objects set up another simulator (or group of simulators) operated by another driver - operator. This simulator is not necessarily full mission simulator. Regarding the situation of examining the behavior of one driver, simplest handlers known from computer games are sufficient.

The fundamental problem with this solution is to create a realistic model of the external environment, the development of mechanisms for using this environment by cooperative objects and, ultimately, build a credible model of the test vehicle. Plenty of studies, proposed and concrete solutions of simulators were executed. Also, in modeling the external environment was made a number of realizations. Need for cooperation of multiple types of simulators have been implemented in a number of international technology and standards efforts, which resulted in the definition of group of protocols. For the cooperation of independent objects are very often use the Distributed Interactive Simulation protocol (DIS) and more actual High Level Architecture protocol (HLA). For modeling the external environment are arising SEDRIS standards.

The competitor of the DIS is the ALSP protocol, which is not so widespread. Advantages of both ones were taken over and the HLA protocol was achieved as a standard. The development of HLA protocol is very closely follows, but the most widespread protocol is currently DIS. In its favor, unlike HLA, also speaks that it is accepted as standard (standardization process of the HLA proceeds - its notation should bear shortcut IEEE 1516). DIS protocol is aimed at data exchanging and its focus is on working with data (as it organized, how it to send, how it to decode). DIS places no requirements on the internal architecture of simulation software. In development of the simulator the working is focused at lower levels of communication than in HLA. HLA, unlike DIS, disposes of a communication subsystem that is part of its RTI (Runtime Infrastructure). Simulation does not have to worry about how and where to send information. HLA provides the ability to use the services described in the HLA specification and application communicates only with RTI. Both forms of distributed simulation have their advantages and disadvantages. HLA is comfortable (even if the obligations to be met is a great amount), but DIS operates much more quickly again (no overhead communication between RTI simulators). In the present situation is such that even though there is a more modern version for distributed simulation, DIS is not dead protocol. Twice a year in Orlando, Florida on University of Central Florida held meeting of experts who have continuously improved the DIS protocol and expanding it. See the completion of the IEEE 1278.1a in August 1998. Nevertheless, the DIS protocol options are limited. But there are a number of practical applications and therefore is clear that in the foreseeable future will not be abandoned.

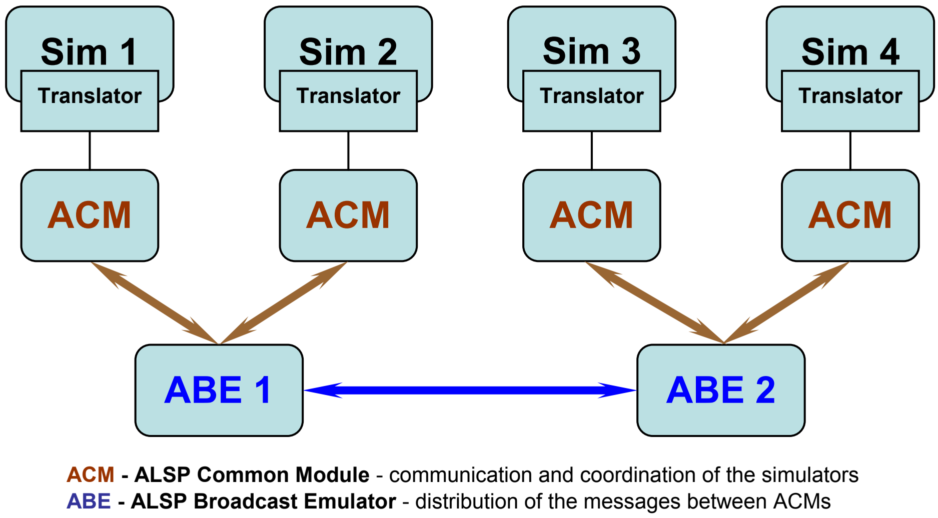

Figure 1: Interconnection scheme by the distributed simulation

Standardization of the external environment models and its properties with regard to the weather is not quite finished yet. There are many unsolved problems of compatibility of data sources and database of terrain and weather. The lack of standards greatly complicates the development of compatible with other simulation systems.

For the preparation of experimental research can be implemented relatively affordable DIS for the following reasons:

- in the Czech are organizations that have the tools for creating models of cooperating objects,
- creating of terrain databases, models of the external environment and its visualization for vehicle simulators is satisfactorily resolved,
- there is no fundamental problem to extend the existing hardware simulators by interactive extension.

2.2 Visualization system of the virtual driver simulator

Graphical information can be displayed in several ways - as 2D or 3D visualization system.

2.2.1 2D visualization system

Basically is a display one image on a monitor or a projector. You can adjust the resolution and color depth and change the parameters of the virtual camera which presents a virtual environment. More sophisticated method is to use multiple display monitors and one virtual camera. This method of display may be implemented by dividing the output of a graphics accelerator with using special equipment into two or three outputs. These outputs can be connected to monitors or projectors. The visualization system uses a virtual camera and graphics accelerator output is set at a higher resolution corresponding to the multiple outputs.

Another way to view is use of two virtual cameras and two outputs. Each of these cameras send images to your independent graphics output. This output can be further divided up into three outputs. So you can reach the six monitors or projectors. Cameras can be completely independent (for two independent views of the virtual scene) or can be connected together and controlled as a whole (for example, to extend the viewing angle over all outputs).

Figure 2. Configuration of the visualization system on the vehicle simulator Škoda Octavia in the area of Faculty of Military Technology

2.2.2 3D visualization system

This method is modification of the appearance of the two outputs and two stereoscopic cameras. Stereoscopic view allows to cause the spatial perception for observers. The presentation principle is based to use two cameras watching the virtual scene and located so as to mimic the location of the human eyes. One camera shows the scene from the perspective of the left eye and the second camera from the perspective of the right eye. The output from each camera goes into a separate graphic output from which goes to a special display device capable of stereoscopic views or projection (such as stereo monitor or projector, screen or head set).

To obtain a correct stereoscopic image, which bothered the eyes of the observer is important to properly set the virtual camera. Individual objects must be displayed on the images for the left and right eye moved in a horizontal plane. The size of the shift depends on their distance from the camera (depth of the scene). This size shift is called parallax and stereoscopic depth perception determines the image. We distinguish four types of parallax - zero, positive, negative and divergent parallax.

Figure 3. Disposition of vehicle simulators Škoda Fabia and Škoda Octavia in the area of Faculty of Military Technology.

In terms of stereoscopic effect when viewing objects in the scene is a significant positive and negative parallax. In a positive parallax depth perception is similar to the real world, objects appear to be located beyond the plane of imaging (eg screen). In view of this landscape is visualized image appears as if the screen was a window into the landscape. Negative parallax causes the displayed objects appear to upstream screen - stand out from the image toward the observer.

Visualization system for implementing stereoscopic pair of identical bound virtual cameras. Set stereoscopic projection is affected by two parameters:

- the distance of virtual cameras,
- cross-angle optical axes virtual cameras (convergence).

The optimal settings for the computer-generated stereoscopic view are when the optical axis of the virtual cameras are parallel to each other. With this setting can be changed the parallax value by changing the virtual cameras distance (mutual displacement). This shift can change the parallax from the positive to the negative and change the stereoscopic view (depth effect).

Stereoscopic projection was successfully validated with the 3D projector company Projection Design AS3D, type F10 which offers separate inputs for both left and right eye. The projector uses so-called active DLP projection, which alternately project images for the left and right eye and with active glasses observes stereoscopic image. The galsse are synchronized by an infrared beam and alternately obscure the left and right window in sync with the projector.

3 Research project ME 949 and MESPIN

The above findings are used in project *Analysis of the negative effects on the driver's attention*. The main investigator is Faculty of Transportation Science, Czech Technical University in Prague and cooperators are Defense University and the Masaryk University. The project is designed in the years 2008 - 2011.

3.1 Project goals

The project aims is to develop methods and procedures for the analysis of the effects of internal and external factors on the drivers' attention and validation of one. Second aim is development of methods for drivers training to increase their resistance to decrease attention and optimizing equipment of the transport routes.

To meet the objectives of the project it is necessary to design a virtual car simulator that allows to perform measurements and analysis. Therefore, part of the project is the construction of heavy-simulator on the chassis of the Škoda Octavia car and and light simulator based on the trainer Škoda Fabia car. During construction of these simulators was developed the original visualization system, physical model of the vehicle, the inteconection of both simulators, the system controls and sensors and their connection to the car control unit. An important benefit is the deal with the problem of cocpit microclimate simulation.

CONCLUSION

In this project, the visualization system is used as a tool for visualization simulator Škoda Octavia. For this simulator was used a specific solutions of the video output. To view the driver's view through the windshield was used three projectors that screen on a broken screen. These projectors are connected to one output visualization system with high resolution (3840 to 1024), which is divided into three outputs for projectors, each with 1280 points na1024.

The second output of a visualization system uses three separate virtual camera. One virtual camera displays images behind the vehicle and is connected to a projector that projects the image on the screen located behind the vehicle (the driver it monitore by means of internal mirrors or turning the head through the rear car window). The other two virtual cameras simulate left and right rear-view mirror. These virtual cameras are connected to the LCD screens mounted on the car mirror.

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