State of the art in Driving Simulators: Results of the Humanist Driving Simulators Inventory

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Abstract

This paper presents the results of the first activity of Humanist TFG has resulted in the preparation of an inventory of existing simulation and multimedia tools for driver training and education. This information is intended to provide the background for the assessment of the current situation in this field and to identify future research needs.

A survey of the existing applications in simulation and multimedia tools for driver education was conducted with the objective of gathering relevant information on ITS applications to train drivers. Two questionnaires were prepared and sent to TFG partners and other Humanist partners selected to represent all the countries that are part of the consortium. As a result data on 35 driving simulators and 7 e-learning applications has been obtained. The results of the survey has been supplemented with the information gathered in previous research projects (TRAINER) in which 21 additional simulators and 17 E-learning applications had been identified…

Introduction

Simulators and interactive multimedia training tools are starting to be used to train drivers paying significant attention to the enhancement of risk awareness and to improve driver training under high risk situations or certain difficult decisions to make that cannot be expected to emerge when training in real traffic. In addition to the application of ITS to train novice and professional drivers, other field that is being explored is the training of elderly and disabled people. In this context simulators can be of great use in helping the subjects to gain functional awareness of their abilities and to adapt their driving behaviour to them without being exposed to the risks of real traffic.

Simulators hold considerable promise for enhancing driver training, testing, and licensing and in consequence for improving driver performance and highway safety. One of Humanist TFG objectives is to assess the present state of the art in the application of driver simulators to driver training, and to identify what additional R&D effort is needed to achieve the potential effectiveness in using simulators to improve the driver training process at a European level with harmonized procedures.

New communication technologies may also be applied to enhance the effectiveness of driver training and education. E-learning techniques are starting to be used in this field. In general e-learning denotes all kinds of techniques using electronic means or multimedia to enhance traffic safety through improvement of drivers skills and knowledge. As such e-learning techniques can employ strategies, which ranges from training of certain skills or techniques to improvements in awareness of special subjects.

As means for training or knowledge enhancement e-learning is regarded as both an efficient and cost effective alternative to driving simulators. It is often proposed that within certain areas of driver training use of e-learning are better learned or that the format of e-learning is sufficient for particular skills or knowledge. Similarly, e-learning is also considered an alternative to human instructions in theoretical issues of driving or driving laws and regulations.

Humanist Task Force G aims at describing and continuously updating the ”state-of-the-art” on the application of ITS technologies to driver training and education by exchanging knowledge and experiences within the network. The first result of TFG activity was the Inventory of Existing Simulation and Multimedia Tools for Driver Training and Education. This task was intended to provide the background for the assessment of the current situation in this field and to identify future research needs which is the next step in TFG work plan.

A survey of the existing applications in simulation and multimedia tools for driver education was conducted with the objective of gathering relevant information on ITS applications to train drivers. Two questionnaires were prepared and sent to TFG partners and other Humanist partners selected to represent all the countries that are part of the consortium. As a result data on 35 driving simulators and 7 e-learning applications has been obtained. The results of the survey has been supplemented with the information gathered in previous research projects (TRAINER) in which 21 additional simulators and 17 E-learning applications had been identified.

Trainer developed two types of cost-effective driving simulators (a static and a semi-dynamic one) for driving school, able to support the driver in understanding the basic control actions, learn to drive in an economic and ecological way, acquire the right visual cues patterns and to provide him/her some didactic feedback on situation with enhanced risk (i.e. low visibility, friction due to rain, fog or snow, obstacle avoidance manoeuvres, including interaction with vulnerable road users and animals, simulation of drunk driving etc). The semi-dynamic one supports on enhanced visual field and simulates also lateral forces effect to make its use more realistic. Major findings of the project will also be traced.

The TRAINER project intended to enlarge novice drivers´ skills by improving their training using novel methodologies and tools, and aimed to contribute to technological progress by providing high quality software tools. The main goal of the TRAINER project was to develop a new cost-effective pan-European driver training methodology that is constituted on computer based interactive multimedia and simulator technology. In another words, TRAINER intended to develop a new, improved training curriculum for driver trainees, using modern training tools and innovative educational scenarios, which intend to enhance risk awareness and permit a safe use of on-board driver assistance systems.

SURVEY

A survey of the existing applications in simulation and multimedia tools for driver education was conducted with the objective of gathering relevant information on ITS applications to train drivers. The results of the survey have been reported in document GUPM-040830-T1-DA(1) “Collation of information on existing simulation and multimedia tools for driver training and education”.

Out of 35 simulators included in the Humanist survey 10 are distributed as commercial products for driver training; 8 are used in company for professional drivers training; 1 is used for the rehabilitation of drivers with disabilities training; 13 are used mainly for research, 2 for industrial products development and testing and 1 for road safety demonstrations.

The vast majority of the simulators is adaptable to be used in driver training. In total, 31 of the simulators are used or may be adapted for driver training, in 3 cases the adaptation is considered possible, and only in 1 case the response was that the adaptation is not possible.

On the contrary, the existence of well adapted simulators for persons with special needs is very limited. Only 3 simulators (9%) are adapted, while in 1 more the adaptation would be possible.

Concerning validation of the simulators, 6 have been validated to some extent in research projects (5 in Trainer, Agile and 1 in other projects). In addition, 12 have been validated by the customer (10 of them by public institutions and 2 by private companies), and 2 by the simulator developer. In 2 cases validation is under way, while 12 simulators (34%) have not been validated at all. Even in the cases in which some kind of validation has been conducted, no common protocol or procedure has been applied.

The summary of the technical characteristics of the 35 simulators is:

a) Image

29 simulators (77%) use white screens as main projection device, while only 6 (23%) use monitors. The number of projectors varies from 1 in the more simple solutions to 8 in the most sofisticated. The vertical field of view ranges from 50º to 270º, while the horizontal field of view ranges from 30º to 50º.

32 simulators (91%) admit at least two different sight conditions, and 17 (49%) are able to reproduce clear, night, rain, and fog conditions.

b) Sound feed back to drivers

All the simulators provide some sound feedback to the drivers. The most common is the engine sound, supported in all cases. Other sounds that are included in the simulation are those originated by the tyres (43%), by other vehicles (71%), by radios or CD players (26%), and by rain or other weather conditions (20%). In addition, 28 simulators (80%) are able to transmit voice messages from instructors.

c) Virtual reality devices

Only 9 simulators incorporate some kind of virtual reality devices. The most common are head trackers.

d) Road and roadside environment modelling

The road and roadside modelling presents flexibility in most simulators. 27 (77%) admit changes in road curvature, although in 8 cases a special tool is required to implement

the changes. 26 (74%) support changes in road friction and the number of lanes. 30 simulators (86%) include scenarios located in freeways, 30 in urban areas (86%), 28 in residential areas (71%), and 25 in industrial areas.

Scenarios include other road users in most cases. 30 simulators include other cars in their simulation (71%): 25 include trucks and buses (71%), 19 bicycles (54%), 25 pedestrians (71%), and 5 animals (14%).

e) Vehicle and base

27 simulators (77%) use passenger cars as base vehicle, 5 are designed for trucks primarily, 1 for buses, 1 for trams, and 1 for military tanks. In 18 simulators it is possible to change the base vehicle to an alternative of a different class (from light vehicle to heavy vehicle). The simulator cabin is a full car in 18 simulators (51%), half car in 10 (29%), a cabin reproduction in 9 (26%), a cabin simplification in 5 (14%). Only 4 simulators do not incorporate a cabin (11%).

13 simulators (35%) have a fixed base without a motion system., while 14 (40%) have a 6 degrees of freedom hydraulic platform. The rest have simpler motion systems with fewer degrees of freedom.

18 simulators (51%) support vehicle headlight simulation in night time driving conditions.

d) Computer and software

18 simulators (51%) are based on personal computer with MS Windows. 9 (26%) use PCs with other operating systems, 4 (11%) are Onyx based.

The software scenarios admit minor changes in 6 simulators (17%); 18 simulators (51%) only admit changing complete scenarios, while in 9 (26%) cases scenarios cannot be modified.

In 26 simulators (74%) it is fully possible to incorporate ITS in vehicle devices to the simulation, while in 5 cases (14%) the ITS devices would not be coordinated with scenarios, and in 2 it is not possible (6%).

Conclusions

The results of the driving simulator survey shows that a wide variety of driving simulators is available nowadays. They are already being used in driver training, both of novice drivers and of professional drivers, as well as for research, and other applications. On the contrary, there are few alternatives to cover the needs of disabled drivers. This is a field that requires further development.

The technical characteristics of the simulators cover a wide range of specifications. The present state of the technology seems to make it possible to implement different driver training applications with a growing level of complexity and fidelity to real driving conditions. Nevertheless, there is a lack of common technical specifications both at national level and at European level that define the minimum conditions that a simulator should have to be suitable for use in the different levels of driver training applications. A framework for this specifications needs to be defined.

The validation of simulators is also an area were there is still a need for further advance. There have been some efforts in this field, but without a systematic approach that enables to compare results or to derive general conclusions. A methodological approach to driver simulator validation for driver training is required as a key step towards extended use of simulators as standard tools in the driver training process in Europe.

As the applications do not seem to stand alone but are either used a supplement or based on existing schemes they target groups of drivers who traditionally are already targeted in training, typically novice or professional drivers.

In this survey elderly drivers, impaired drivers or drivers with special needs are not targeted in any of these applications though many of these driver groups could potentially benefit from certain elements of these applications. As a general notion it could be stated that e-learning applications potentially could have good chances of reaching these drivers as use of e-learning does not require physical presence of a driving instructor. On the other hand it could be argued that many of these groups are not familiar with these types of training tools meaning they would not necessarily be interested in this form of training. However, it is likely that as the extent of the media of e-learning becomes more and more widespread so will the e-learning applications within the areas of driver training.