Truck Simulator an Instrument for Research and Training

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Abstract – *This paper describes the real-time distributed truck simulator developed by University of Cagliari and Genoa. The simulator has been designed and constructed for realizing research about active safety in driving using a physical simulation model. The different situations which involve during driving want to be necessary reproduced with use of simulator. This work describes the main features and components of the simulator, a transportable containerized facility provided with a 6 degrees-of-freedom motion platform. The simulator has been designed to provide a full immersion environment for high performance training, but also and above all for basic and applied research, monitoring and analyzing operator performance by means of electromedical instruments. The specific activities conducted with the truck simulator (training, research, technological advance) aim to reduce the possibility of accident occurrence, which are largely caused by the onset of fatigue. A research simulator as driving simulation to develop many protocols in active safety for sizing fatigue in different context. One of the main objectives of the research in interaction between man-machine is about conditions that caused in man an overload or under-load of work that must produce a reduction quality of the performance. In European and international sphere many researchers have regarded fatigue and influence in quality of driving, many of these are based on using of driving simulator, other studies "naturalistic" contemplate the use of many equipments inside the same vehicle.*

Introduction

One of the main objectives of the research in man-machine interaction is about conditions that caused an overload or under load of work that must produce a reduction of the performance quality.

The causal factors of accidents in transportation systems can be commonly divided into human, technical and environmental. Human error can be the result of improper task and/or equipment design and ineffective training.

The major contributory factors for reducing accident occurrence are enhanced operator skill development, including periodic refresher training to maintain high truck operators' efficiency, and also performance studies and assessment.

However, actual task performance and fatigue analysis implies some difficulties, that combined with the challenges of virtual reality training, prompted the idea to set up a simulator that was able to record and to analyse performance curves in a virtual environment.

This simulator is also studied to work “on-line” with the “ship to shore gantry crane simulator” of the University of Cagliari (Bruzzone *et al*., 2008), in the harbour context.

Background and State of Art

Fatigue and in general impaired performance, is as a significant factor in occurring of accidents in transport systems (Fadda 1984a).

Past research conducted on human fatigue prevention has focused on physiological mechanism and methods for measuring fatigue levels (Sherry 2000; Czeisler 1995; Ji, Lan, and Looney 2002). The most common physiological measurements for determining the extent and length of reduced alertness, that are considered as an indicator of increased fatigue and/or drowsiness, make use of the electroencephalogram (EEG) (Lal and Criag 2002). A training manual prepared by the Transportation Development Centre of Canada in November 2002, provides guidelines for analysing fatigue, drowsiness and the resulting performance deterioration of Canadian navy personnel, combining EEG, EOG (eye movement), ECG (heartbeat) and EMG (muscle tone). Behavioural measurements are used for gauging fatigue and are based on frequency of the body movements: the number of movements recorded during task performance over a specific time interval is significantly correlated with the EEG (Bruzzone 1996b).

Fatigue can also be detected observing facial behaviour: changes of facial expression, eye and head movements and gaze are all indicators of fatigue.

As can be observed from the scientific literature no significant in-depth studies have been conducted concerning port operations, specifically truck trailer drivers.

Philip *et al*. (2007) have studied effects on fatigue drivers using driver simulator, the aim of this study was to identify risk factors for performance decadence. Drivers' accidents were the principal cause of death in the modern society and fatigue condition is indicated as the most critical factors.

Test realized with computerized analysis were directed to verify the deviation trajectory from ideal during driving. The software calculates the mean deviation from the centre of the road and the standard deviation of this difference. This standard deviation from the centre of the road (SDS) is one of the studied variables.

Standard deviation of the car steering error from the ideal curve (SDC) is another measure, which represents the ability of the driver in following perfectly the curve with the car. The time taken to identify and respond to the digits, called ‘‘reaction time’’ is measured from the presentation of the digit to the driver's screen display after the signal received from the button. Drivers performed significantly worse than controls on the driving simulator. The main factor affected was the standard deviation steering error from the ideal curve. Many of our vacation drivers had driven for long times with acute sleep loss. The differences observed between drivers and matched controls confirm that fatigue affects long-distance drivers. Sleep debt and none of the variables related to sleep duration influence the regression confirms findings obtained using reaction time tests. There again, duration of driving was the major determinant for performance decrement. Finally, long duration of driving was associated with sleep restriction and cumulative factors may play a role in covering the effects of sleep deprivation, as this factor was almost never observed ‘‘alone’’ in our drivers.

Hanowski *et al*. (2007) have underlined that drivers of commercial vehicles get an average of 5.18 sleep hours per night. The revised hours-of-service (HOS) regulations (in the United States) will provide drivers more opportunities to get sleep. Driver's impairment due to drowsiness is known to be a major contributing factor in many crashes involving commercial-vehicle drivers. Another goal of this research was to assess the association of sleep duration and involvement in critical incidents, including crashes, near-crashes, and crash-relevant conflicts.

Fatigue and sleep deprivation are important factors in the transport industry, fatigue involves loss of attention and decreases individual ability of driving in safety and upgrades risks of human error that can take to fatalities and accidents. Sleepiness delays time of reaction decreases awareness of the judgment. Weakening dues by somnolence is a relevant factor of the involvement in accident with truck vehicles. Trucks drivers' average sleep is good described in literature. Mitler *et al*. (1997) have assessed for commercial driver an average of 5.18 h/day of sleep (during 24 hours) and 4.78 h of sleep electrophysiological verified. The study was conducted during a period of 5 days and has included 4 different scales of driving. To define total amount of sleep it was used an instruments called “actigraph”. On sixty-two drivers they have less than seven consecutive days of data (Monday-Sunday), average amount of sleep per day was 6.28 h. They have registered fifty-eight serious accident in the tenth and eleventh hour of driving and analysis results have indicated, besides, as before a serious accident, have a significantly rest less than usually.

In the April 2003 the Federal Motor Carrier Safety Administration (FMCSA) published a revised set of regulations concerning the HOS of commercial-vehicle drivers. These regulations were amended on 30 September 2003 and implemented on 4 January 2004. One central component to the revision was a two hours extension of off-duty time from 8 to 10 h. In this regulation were defined additional 2 h off-duty time which would provide drivers more opportunity to obtain restorative sleep. An additional two off-duty hours were included in the 2003 HOS regulations, but there has been no research conducted to determine if drivers would use those extra hours to sleep. Determining the quantity of sleep that drivers are receiving under the revised regulations was one goal of this study.

A second goal of this research was to assess the association of sleep quantity and involvement in critical incidents, including crashes, near-crashes, and crash-relevant conflicts. This study resulted in an important finding with regard to the revised 2003 HOS regulations. In comparing the mean sleep quantity of drivers in the current study to previously collected data, it appears that drivers may be getting more sleep under the revised HOS regulations.

Long distance driving can be very fatiguing, the task requires long periods of alertness and attention which make considerable demands of the worker. Ample evidence exists to demonstrate that performance deteriorates over time, particularly when the task is monotonous as is the case with driving. Driver errors increase with driving time and performance worsening can be evident after 3 hours of the beginning of the trip. Furthermore, accident risk also increases with driving time.

One of the major obstacles to the better management of driver fatigue during long distance in road transport industry can be a lack of practical assessment of the problem which occurs in the industry. The purpose of the present project is to identify possible strategies to manage driver fatigue in the long distance road transport industry in Australia. In the first part of the project, 960 truck drivers were surveyed (Williamson *et al*., 1992). The results suggested that shorter trips and greater flexibility in arranging the timing and scheduling of trips were related to lower levels of reported fatigue (Feyer and Williamson, 1992; Williamson *et al*., 1992). When drivers had more flexibility they were more likely to take their rest breaks to coincide with periods of fatigue, and to avoid starting their trips in the early hours of the morning. Drivers who did not have such flexibility but have familiarity with shorter trips also appeared to fare better than drivers who had neither flexibility nor shorter working hours. These findings underscored that operational factors other than working hours are also important in determining the experience of fatigue among truck drivers.

This study was directed towards collecting in information about the experience of driver fatigue in the passenger sector. In particular, the relationship between aspects of operational practice and driver fatigue in the long distance coach industry was investigated. Most express drivers (82.5%) were employees of large companies with more than 50 buses. Overall, details of the last long distance trip revealed that express bus drivers covered an average of 1479.5 kilometres (SD = 1576.8) with a mean trip duration of 28.4 hours (SD = 32.6). Virtually all drivers had their trips scheduled for them. Close to one third of the drivers (29%) started their trips in the night hours, between 6.00 p.m. and 6.00 a.m. More than three quarters of the drivers reported that the last trip was typical of trips that they do. Overall, the majority of express drivers did not report fatigue as a major problem for them (20.6%), although 53% reported experiencing fatigue at least occasionally. By far the most common time of day drivers reported experiencing fatigue was between midnight and 6.00 a.m., with approximately half of drivers (50.6%) reporting fatigue as typically occurring at this time. There was consistency, too, in the effects of fatigue: the majority of drivers reported that their driving was adversely affected by fatigue (71.7%), with slowed reactions (78.2%) being the most common outcome reported.

Simulation can play a key role in vehicle design and training, and is more likely to be applied as fidelity increases and cost decreases (Bruzzone *et al*.1997).

A study of Systems Technology, Inc, California investigates in using of “low cost simulation” for research in safety, prototyping and training. Improvements in crash avoidance through vehicle design require methods for prototyping new equipment and exposing drivers to new designs. The central thesis of this study is that low cost PC and related technology can be used to reproduce realistic sensory feedback to the human operator in safety critical driving simulations (Bruzzone *et al*.1997). Processors, display accelerator chips and cards and operating system software advancements over the last few years permit the presentation of virtual environments that can quite adequately simulate visual, auditory and proprioceptive cueing involved in vehicle operation tasks. Furthermore, the feedback can be provided with adequate update rates and minimal transport delays required for simulating the psychomotor and cognitive tasks typically involved in driving in complex environments (Fig. 1).

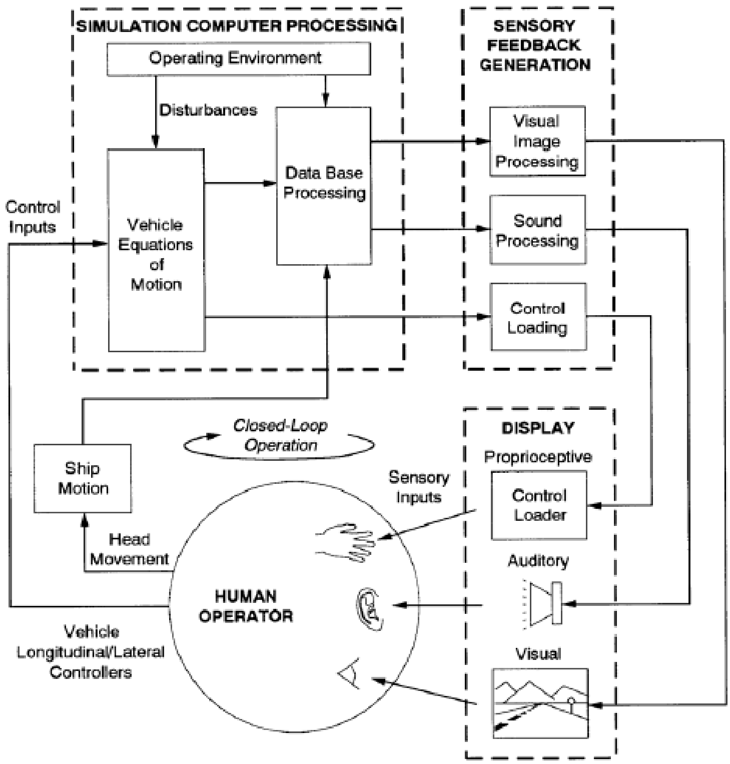

Figure 1. Basic Processing Requirements for vehicle operation Simulation

The visual modality is the most important since it allows the operator to compare the vehicle’s path with a desired path in the environment and make appropriate corrections. Proprioceptive feedback can provide added information about the magnitude of control inputs. Auditory feedback can provide some additional information about the aggressiveness of vehicle maneuvering and possible situation awareness.

The sensory feedbacks must reach the operator in a timely fashion, after allowing for delay by the simulation computer processing and sensory feedback generation.

Issues associated with the primary cueing modalities are as follows:

- Proprioceptive (control loading) information must be returned to the human operator at the highest rate and lowest time delay of any sensory feedback in order to give realistic feel characteristics (e.g. Young, 1982). If proprioceptive cueing is dependent on simulation computer processing, update rates of hundreds of times a second with transport delays on the order of a few milliseconds are important here in order to give realistic feel.
- Visual information must be returned to the human operator in less than 100 milliseconds with update motions on the order of 30 Hz or greater to give the appearance of smooth motion (e.g. movie frame rates are 24 Hz). Input sampling and processing can give delays on the order of 2 ½ frames, which result in transport delays of less than 100 milliseconds. Transport delay compensation can also be used to offset the effects of computation delay (Hogema, 1997). Resolution and quality of the visual display must be adequate for the required visual discrimination tasks. It is difficult to achieve resolutions below a few minutes of visual arc with low cost image generators and displays, so high acuity real-world tasks such as highway sign reading are difficult to simulate.
- Motion feedback must correlate closely with visual simulation, so must be returned with a similar time delay (e.g., Allen, Hogue, *et al*, 1991 App. E). Practical, low cost platforms severely restrict motion, and so cueing algorithms have been developed to approximate the cues sensed by the human operator in the real world (e.g., Allen, Hogue, *et al*, 1991 App. F).
- Auditory feedback has the least severe requirement for transport delay, with hundreds of milliseconds probably being acceptable. The frequency content or bandwidth of the auditory stimulus must match the human ear (on the order of 15 KHz), however, in order to produce sounds that are natural and recognizable. Doppler and stereo effects may be of importance in various driving scenarios.

Successful simulation development should include some validation procedures to verify the above response requirements and to ensure correct software implementation (Bruzzone, Kerchoffs 1996a). Validation can include engineering methods applied to various simulator response characteristics (e.g., Allen, Mitchell, *et al*., 1991; Allen, Rosenthal, *et al*., 1992; Heydinger, Garrott, *et al*., 1990). The validation procedures should be designed to verify software coding and the adequate responsiveness of the various cueing dimensions.

Fatigue and impaired performance in general, is regarded as a significant factor in the majority of accidents occurring in transport systems (Fadda 1984).

Past research conducted on human fatigue prevention has focused on both the physiological mechanism and on methods for measuring fatigue levels (Sherry 2000; Czeisler 1995; Ji *et al*. 2002). The most common physiological measurements for determining the extent and length of reduced alertness, considered as an indicator of increased fatigue and/or drowsiness, employ the electroencephalogram (EEG) (Lal and Criag 2002). A training manual prepared by the Transportation Development Centre of Canada in November 2002, provides guidelines for analyzing fatigue, drowsiness and the resulting performance deterioration of Canadian navy personnel, combining EEG, EOG (eye movement), ECG (heartbeat) and EMG (muscle tone). Behavioral measurements, that have gained credibility recently, are used to gauge fatigue and are based on the frequency of body movements: the number of movements recorded during task performance over a specific time interval is significantly correlated with the EEG (Bruzzone 1996b).

Fatigue can also be readily detected by observing facial behavior: changes of facial expression, eye and head movements, and gaze are all indicators of fatigue.

As can be observed from the state of the art review no significant in-depth studies have been conducted concerning port operations, specifically truck trailer drivers.

General description and universal features of simulator

Like existing training simulators, the truck simulator comprises five main components:

1. Driver cab interface (cockpit): a faithful replica of the truck operator workstation. It is generally fixed to a motion platform, with 2, 3, 4 or 6 degrees of freedom (DOF) depending on load capacity that not only imparts visual and sound stimuli to the operator, but also stimulates sensations of movement. The platform is supported by actuators placed underneath the cab that move the cab in response both to user input and to the tasks performed. The motion system simulates the vibrations and collisions that occur in real operating conditions;
2. Instructor workstation interface: outside the operator cab, it is equipped with special monitors for following the exercise in real time. The instructor can:
   - create innumerable simulation scenarios, in all climatic conditions (wind, rain, sun etc.) and at all times of day (daytime with natural light, night-time with artificial lighting) and for any boundary condition;
   - make trainees repeat a test in the same conditions, in the event he has not performed well in a particular scenario, and can analyze a posteriori any errors made;
   - move on to higher level training, gradually introducing more demanding scenarios as the trainees gradually enhance their skills.
3. Visual display system: recreates through a projection screen the same environment that the operator would actually experience;

4. Audio System: recreates the sound effects generated by vibrations (cab moving during gantry travel), collisions, wind noise;

5. Central operating system: the simulator "brain", controls operations and executes different simulation scenarios (Fig.2).

The innovative conception of this simulator is the portability of the instrument, the simulator inside a container 40' High Cube is easily to transport and to move for training or research scope.

Figure 2. Simulation Graphic Interface and interactive Board integrated during debriefing activities

Operator fatigue and performance measurements in physical task simulators

Simulators are increasingly used for researching human factors in transport as these devices allow reproducing and evaluating, also singly, all those factors contributing to fatigue. In a study conducted at the Northeastern University of Boston (Yang, Jaeger, and Mourant 2006) the behavior of 12 novice and 12 experienced drivers, recorded during three right-to-left lane change scenarios was investigated. Each lane change involved:

1. A preparatory period;

2. The actual steering maneuvers from right to left;

3. A post lane change period, accomplished maintaining a specific speed.

Novice drivers were found to be less secure than experienced drivers, showing significantly more variance in lane position during the preparatory and post-lane change phases. They also spent less time looking at the speedometer and mirrors.

The findings of this study suggest that virtual reality driving simulators may be a useful aid for improving novice driver skills in maneuvers such as lane changes.

One particularly interesting area of human factors is the determination of the visual field using specific devices that identify and record operator gaze points during a work cycle. These applications aim to study the field of vision and the information required by the operator to cope with changing conditions, to determine whether any distracter signals exist that alter perception time and consequently the ability to make the right decision.

The majority of driving simulators (for example the Drive Safety Simulator at the North Dakota State University) are equipped with an oculometer, a gaze tracker that records fixations points and saccades - from the pupil. In addition, with this device it is possible to evaluate, for example, whether any objects outside the field of vision create sources of distraction, thus impairing performance.

Recent studies conducted by the Universities of Taiwan and San Diego on the assessment of driver performance interpreting EEGs using fuzzy neural networks (Wu, Lin, Liang, and Huang 2004), have shown that accidents caused by sleepy drivers involve a high percentage of fatalities due to a marked impairment in driver ability to control the vehicle; this techniques provide interesting opportunities for being integrated with simulation as already experience by the authors (Giribone, Bruzzone 1995)

Simulation architecture

The development of a truck simulator requires considering all the internal (i.e. engine, suspensions, controls, trailer) and external components (i.e. traffic, environment, road infrastructure) (Bruzzone *et al*., 2007); the authors are very interested in creating even scenarios that involve multiple vehicle interactions (Bruzzone *et al*., 2004b). A classical example is provided by in-land or port terminals where the trucks have to interact with cranes and other devices (Bruzzone *et al*., 1998c). It is evident that the ability to work by this approach strongly enhance the capabilities of the simulator (Bruzzone *et al*., 1998b); due to these reason the authors decided to adopt an architecture capable to support extensively the interoperability concept (Bruzzone, Giribone 1998); by this approach it is possible to integrate different simulators and to let them to interact dynamically (Bruzzone *et al*., 2003b); in this case the proposed architecture is presented in the scheme (Fig. 3).

The conceptual model include several objects in addition to trucks and trailers in harbor context, such as bridge cranes, transtainers, reachstakers, People, Cars; several objects are driven by intelligent agents similar to Computer Generated Forces (CGF) and in particular the people and the other cars.

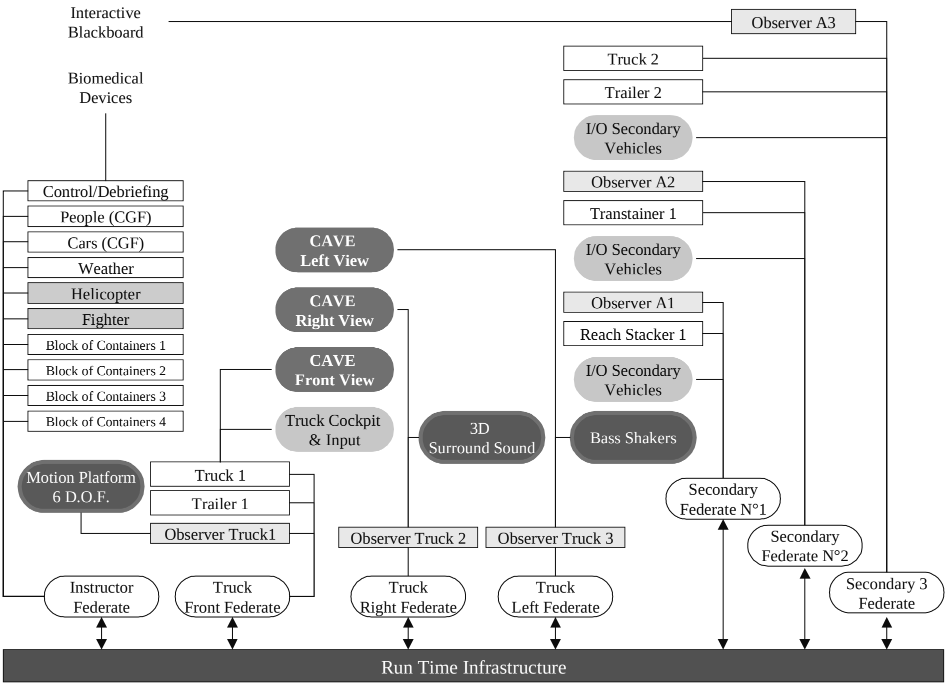

Figure 3. Example of Simulator Architecture

The hierarchical structure of the objects integrated in the truck federation is complaint with HLA (1516 IEEE Standard) so the system developed, defined ST_RT_1 (Simulation Team, Riding Truck One), resulted as an interoperable real time simulator (Bruzzone *et al*., 2003a); ST_RT_1 operates over a WAN and integrates the different simulators (federates), while object ownership is attributed to the different federates based on the desired configuration and operations dynamics. In fact based on this architecture, ST_RT_1 allows a wide range of configurations and operative applications; however it is possible to operate in standing alone mode, obviously with limitation on the I/O (input Output), while the federation allows to control all the different dedicated hardware solution.

The simulator is implemented in C++ for Windows XP^{TM} operating systems; the hardware is based on a set of last generation workstation, while the I/O includes CAVE, motion platform six degree of freedom, truck cockpit, truck driving wheels, etc.

The ST_RT_1 support a quick dynamic reconfiguration of each workstation in order to reallocate the equipment and to create different scenarios; obviously this is in some way limited by the availability of proper hardware device on a PC Workstation for driving/operating a specific vehicle.

The key concept for the implementation solution was to fix a full scope simulator (Cave Motion Platform Cockpit, realistic devices) and to set up an instructor position as well as secondary federates devoted to direct other vehicles interacting with the main simulator; in fact the proposed approach allows to install the secondary federate on simple PC/Laptop and to operate in driving other vehicles or handling device even by using just simple game devices (joysticks, driving wheels) (Bruzzone *et al*., 2006b).

This approach enables the possibility to create large federation with many secondary operators for analysis or training in complex cooperative scenarios (Bruzzone *et al*. 2004a); in addition it is even possible to activate competitive scenarios where different teams are working concurrently. The architecture was developed in order to support several operative modes such as:

- ST_RT_1 supports practice in different scenarios. The operators can virtually works in the same virtual world where different activities and tasks are carried out simultaneously. Several objects can be driven by the intelligent agents directed by the computer
- Control/Debriefing object allows the instructor to control all the boundary conditions during exercises so obviously the trainer control environmental conditions such as rain, fog, wind etc. In addition it is possible to analyze and proceed in debriefing of past operation on-line, while the main simulation is still running, and to jump back to the real-time operation based on instructor control. This represents a pretty innovative approach moving from traditional AAR (After Action Review) to OLR (On-Line Review).

Simulator infrastructure for ST_RT_1 simulator

The first implementation of ST_RT_1 was installed on a shelter based on a 40 feet high cube container to guarantee maximum mobility to this infrastructure; this solution, tailored for Cagliari needs, include the configuration of the simulation architecture presented in Figure 2 and the following layout of the shelter:

Full Scope Simulator

- Cockpit and Truck Controls
- Driver Seat
- Motion Platform
- Bass Shakers
- 3D Surroundings Sound
- Cave (horizontal amplitude 270° Degrees)
- Camera and intercom for controlling the activities
- Biomedical devices
- Workstation Rack
- UPS
- Transformers

Instructor Module

- Instructor Workstation
- Driving Devices to take control of vehicles, aircrafts or cranes (joysticks, driving wheels, etc.)
- Direct View of Full Scope Truck Front Federate
- Intercom

Didactic Area

- 3 Secondary Federates running on laptops
- Driving Devices to take control of vehicles, aircrafts or cranes (joysticks, driving wheels, etc.)
- Interactive blackboard directed connect to Control/Debriefing Unit or to secondary federates
- Camera for controlling the activities
- Intercom

External Connections

- VGA Connection to Control/Debriefing Unit
- External WAN Connection (Ethernet for Internet activities)
- External LAN Connection for sub-net management

The motion platform as well as the cockpit was prototyped in order to match with the shelter space constraints (Bruzzone *et al*., 2006a).

The solution proposed is open to both local connection with other simulators such ST_PT_1 or with external additional secondary federates (Bruzzone *et al*., 2008); in addition the ST_RT_1 is enable to connect trough the web with other position for blended education and wide area distributed simulation (Bruzzone *et al*., 1999).

The shelter is equipped with UPS and Transformers in order to be able to operate worldwide with different power supplies.

Electromedical instruments and analysis strategies for basic and applied research

The medical instruments provided for research activities comprise:

- Eye tracker (oculometer), as repeatedly mentioned visibility is a human factor of key importance in driving tasks;
- Integrated polygraph, that allows to record simultaneously EEG, ECG, EMG as well as other parameters specific of drivers tasks;
- Flicker Fusion Unit: for conducting the FLIM test for performance assessment (memory, alertness, speed of reaction).

The research strategy for analyzing visual activities of operators undergoing simulator training will consist in analyzing visual behavior, measuring, using specific analytic tools (Camilli *et al*., 2007) or trial analysis, “look zones”, fixation points and saccades, in other words the movement between consecutive fixation points (once fixation times/points are known the saccades can be easily detected).

A device for determining muscle tone (EMG test) will also be installed. The system comprises electrodes attached to the body parts to be monitored (neck and back). The electrodes record, display and amplify local nerve response to electrical stimulation and detect muscle anomalies and disorders in particular work postures, providing a measure of operator physical performance (Fig. 4).

Figure 4. Eye Tracker instrument and some results and ME6000 Polygraph and some applications

Another electromedical instrument is the FLIM unit that provides a measure of central-nervous system activation (arousal) and of the level of performance (memory, attention, reaction time).

The particular simulation architecture of ST_RT_1 truck simulator (HLA federation), allows for the inclusion of electromedical equipment as federates. The simulation system provides advanced synchronization functionality ensuring that the psychophysical fatigue measurement systems can be combined with simulated time evolution. The debriefing system matches the operating phases with those portions of the electromedical plots whose spectra coincide with fatigue phases. A model such as a neural network (NN) model will be used for reading and interpreting the complex data based on previous researches (Mosca *et al*., 1996, Giribone *et al*., 1998).

In this sense it will be possible to construct performance curves on the simulator along the same lines as for field measurements.

Conclusions

This paper wants to present the truck simulator created by University of Cagliari and Genoa which will become an instrument for research and training. The purpose of this simulator is to create an instrument set to measure drivers/operator fatigue during his task. The special architecture allows reproducing many particular situations as harbor movements estimated between the most potential dangerous for truck drivers. The versatility of this instrument will allow representing different scenes of driving.

Thus research and training activities conducted with the simulator will be of key importance. Training and refresher courses for drivers that use truck simulator are important for two reasons::in economic terms the proceeds from training package sales to terminal operators will be used to fund research activities. Therefore management strategies need to be created for competitive advantage, offering up-to-date training packages at attractive prices. In this sense one strong point of the truck simulator is its transportability. The infrastructure will make it possible to carry out integrated task training, by means of remote experimentation and tests coordinated by an efficient multimedia network. The integrated training program also envisages the construction of a container trolley simulator. In addition the proposed approach guarantee the possibility reuse and further develop for the simulator new application areas such as operative and safety policy design, re-engineering and validation, terminal analysis and control etc.

Keyword: Truck Simulator, 6 DOF Motion Platforms, Electromedical Instruments for Performance and Fatigue Assessment.

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