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Actions taken to publicise project

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Abstract	Actions taken to publicise the project to potential end users are described.
Keywords	Specification, Software, Simulation, Visualization

This report summarizes the actions taken to publicize the existence of the project VIRTUALFIRES and to identify potential end users. Various activities were carried out to disseminate the project aims and publicize its existence were: A kick-off meeting was organized in a hotel in Graz and the press, TV and local fire brigades and tunnel operators were invited to attend. A half page article appeared in the local press. A web page was established (www.virtualfires.org) which serves for external as well as internal communication. On this web page major milestones will be published. The coordination project also maintains a data base of those who may be interested in the outcomes of the project (Tunnel operators, consultants, manufacturers of safety equipment, the press and television etc.). As soon as the first prototype will be available it is planned to organise a workshop where representatives of the commission and all interested will be invited.

The "Südwestrundfunk (SWR)" arranged an TV interview with Dr.-Ing. Volker Luckas from FIGD on 11.12.2001 about VIRTUALFIRES. It was broadcasted in German TV in the scientific magazine called "Sonde" on the 10.01.2002 from 21:45 to 22:15 which was specialized on fire in tunnels and their prevention /analysis. The video stream of the interview is available for download on the WebPage of IGD for Virtualfires on http://www.igd.fhg.de/igd-a3. Furthermore the project was presented by the project coordinator Gernot Beer at the recent "Tunnel safety and Ventilation" Conference in Graz (a copy of the paper is included) and at a FIT (Fire in Tunnels) network meeting in Malmö.

In addition the coordinator has been invited to present the project at the world congress on virtual reality held in Paris September 12-14, 2002 . It is planned to prepare a poster for this conference. It is also planned to prepare a brochure of the project. Authorities and fire brigades of a community in South Tirol have also invited the coordinator to present the project aims.

Paper presented at the international conference on Safety and Ventilation of Tunnels held at Graz from 8. to 10. April, 2002

VIRTUALFIRES a virtual reality simulator for tunnel fires

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ABSTRACT

The project VIRTUALFIRES, which is being funded by the European Commission and involves eight partners from five European countries, is presented. The aim of the project is to develop a simulator that allows to train fire fighters in the efficient mitigation of fires in a tunnel, using a computer generated virtual environment. This will be a cheap and environmentally friendly alternative to real fire fighting exercises involving burning fuel in a disused tunnel. The simulator can also be used to test the fire safety of a tunnel and the influence of mitigating measures (ventilation, fire suppression etc.) on it's fire safety level.

Key words: Visualisation, Virtual Reality, Tunnels, CFD

1 Introduction

Recent serious fire accidents in tunnels have highlighted the problems that currently exist with respect to the prevention of serious fire incidents and with respect to fire mitigation once the fire has started. There is a need for action on a European scale with respect to

- Ascertaining the safety level of existing tunnels and retrofitted tunnels (i.e. Mont Blanc tunnel).
- The specification of the required safety features and installations for new tunnels.
- Training of rescue personnel in order to increase the efficiency of fire and smoke mitigation procedures.
- Training of drivers with respect to correct behaviour in the case of a fire emergency.

With respect to ascertaining the safety level of existing and retrofitted tunnels much reliance is still placed on real tests using fire/smoke pans or vehicles set on fire. Such tests have been recently performed for example in the refurbished Mont Blanc Tunnel. Fire fighting exercises are usually carried out on a regular basis using burning vehicles or cold smoke generators.

The disadvantages of real tests are that they are expensive, can only be carried out at certain times and are not environmentally friendly since toxic smoke is produced. The main aim of the VIRTUALFIRES project is to develop an alternative to real tests by replacing them with virtual tests. In an virtual test the tunnel and the fire emergency only exists in computer memory. Using computational fluid dynamics (CFD) computations, the spread of fire and smoke in a particular tunnel is calculated.

The tunnel including the safety installations, traffic signs, vehicles etc. is visualised together with the results of the CFD calculations using the method of virtual reality. Under the term virtual reality we mean total immersion in a three-dimensional data set. The effect should be very close to reality. The simulator can be used as a training tool for fire fighters and for assessing the safety level of existing or retrofitted tunnels. It may also be used to check the design of a planned tunnel.

The simulator will be equipped with a user friendly program for the input of data which comprise the shape of the tunnel, ventilation characteristics, safety installations, vehicles, emergency exits etc. Two versions of the simulator will be developed: One where the CFD simulations are carried out prior to the visualisation (pre-calculated scenario) and one where the CFD simulations are carried out concurrent with the visualisation. The advantage of the second type would be that ventilation characteristics may be changed during the visualisation (i.e. one may check the effect of reversing the ventilation on the spread of smoke and fire). The first type of system can be used for the training of fire fighters and drivers and for checking the fire safety of existing tunnels.

2 DESCRIPTION OF SIMULATOR

2.1 Hardware

The simulator will be implemented on two hardware platforms: a portable version consisting of a Laptop PC with a head-mounted display connected to it for off-line simulation and a more powerful and interactive version running in a distributed computing environment and a CAVE as the visualisation front-end.

A headmounted display (HMD), like the one shown in figures 1 & 2, contains 2 liquid-crystal displays and a 3DOF tracking sensor. Due to the possibility of displaying images from different viewpoints to the each eye, the user gets a threedimensional impression of the scene. The tracking sensor, which delivers the rotation-angles around the 3 principal axis in realtime, allows for synchronisation of the users head movement with the viewing direction of the rendered scene.

Figure 1: User wearing a headmounted display

Figure 2: interior view of a HMD

A CAVE is a multi-person, room-sized, high-resolution, 3D video and audio environment. Graphics are backprojected in stereo onto the walls, the floor and the ceiling, and viewed with shutter glasses (see figure 3). As a viewer wearing a position sensor moves within the display boundaries, the correct perspective and stereo projections of the environment are updated in realtime by the rendering system, and the images move with and surround the viewer. Hence stereo projections create 3D images that appear to have a continuous presence both inside and outside the projection room. To the viewer with stereo glasses, the projection screens become transparent and the 3-D image space appears to extend to infinity.

Both display-systems have some advantages and drawbacks.

HMD:

+ portable and lightweight device

+ moderate computing power for image rendering: only 2 different images of the scene need to be generated at the given framerate

- user not fully immersed into the scene due to the limited field of view, impression is more like watching the scene through divers-glasses

- low resolution of the display

CAVE:

+ wide field of view, so the user is fully immersed into scene

+ very high resolution of the rendered scene

- stationary installation

- high computing power needed for rendering: dependent on the number of backprojected walls 10 or 12 images are required at the given framerate

Figure 3: User in a CAVE wearing shutter glasses (courtesy of KTH)

Due to the limited computing power of the mobile version of the system there will probably be no possibility of changing parameters of the simulation in realtime. This system is more thought of an interactive threedimensional movieplayer for the precalculated simulation results. Nevertheless it will be possible to change parameters at any given timestep and to continue the simulation from this point with the new values.

2.2 Software

Since CFD computations of fire and smoke spread are already at a fairly high level of sophistication the emphasis of the project is on the further development of methods of visualisation and virtual reality. New developments are only envisaged in concurrent CFD calculations using massive parallel computers.

There are two aspects that need to be considered in the visualisation:

Size of data: The amount of data produced by a CFD program is quite large. Depending on the length of the tunnel being considered in the simulation and the time span modelled they are in the order of several Gigabytes. Before such a large amount of data can be displayed in real time one must apply data compression/optimisation techniques.

Feeling of reality: The simulator will only find acceptance if the simulation is realistic, i.e. gives a feeling of reality. A realistic display of the tunnel and its safety installations for example is important, as is the use of realistic textures. Questions to be answered are: how does one visualise fire and smoke, temperature and toxicity etc.

2.3 Rendering system and user interface

Not all of the potential users (i.e. fire fighters, rescue personnel, etc.) are familiar with VR-Equipment, so the userinterface must be simple and easy to understand in a straightforward manner. The planned System will be capable of defining missions prior to the simulations as well as interactive interaction during the execution of such a mission, like "freezing" the scenario, changing some parameters, i.e. start the ventilation, or move forward or backward in time.

3 SYSTEM SPECIFICATIONS

The specifications of the system capabilities are still being worked out but can be summarised as follows:

- VR-System
  Tunnel geometry and safety installations will be visualised with realistic textures. Traffic signs, emergency exits, escape tunnels, vehicles must be displayed very realistically for the evaluation of safety features.

- CFD calculation
  Calculation of fire and smoke spread after a vehicle has been set on fire. Level of detail sufficient for realistic visualisation (higher level close to observer, lower further away) and for calculation (using 1D or 3D-Models). Type of output expected: Flame spread, smoke density, temperature and toxicity. Time step may be governed by stability criteria but updating of transient data for visualisation is only required every 4 ms (equal to 25 frames per Second) to ensure smoothness of display.

- Display of CFD data
  The rendering of the simulation results needs to fulfil two different criteria: For those tasks where a visual evaluation of the scene is necessary, like in checking the readability of traffic signs, the display of the smoke distribution data must be as realistic as possible, including changing fog density and turbulent flow (see figure 4). On the other hand the rendering of temperature and toxicity-values needs a meaningful and rapidly interpretable representation like the one shown in figure 6, where colour is used to discriminate the different levels of danger (blue: safe area, red: dangerous). To observe the velocity

and direction of the flow of the smoke the system will allow traces of particles to be shown (see figure 5).

- User navigation
  User moves through virtual space with a three-dimensional input device (space ball or hand held input device). Speed of movement is controlled to simulate walking, running. Head movement is detected by positioning devices. Collision detection is implemented to prevent users from going through tunnel walls. Pull down virtual menus are used to select type of display.

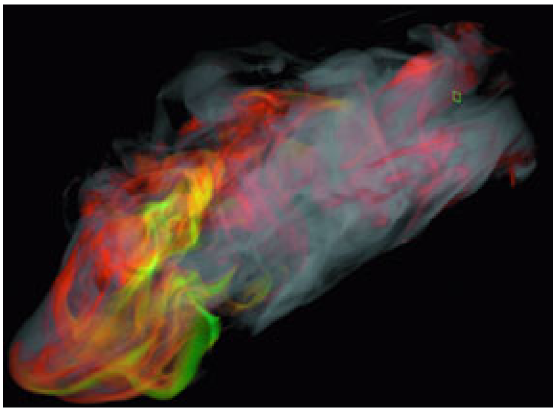

Figure 4: smoke visualisation

(courtesy of UMN)

Figure 5: tracelines of particles

(courtesy of ems-i)

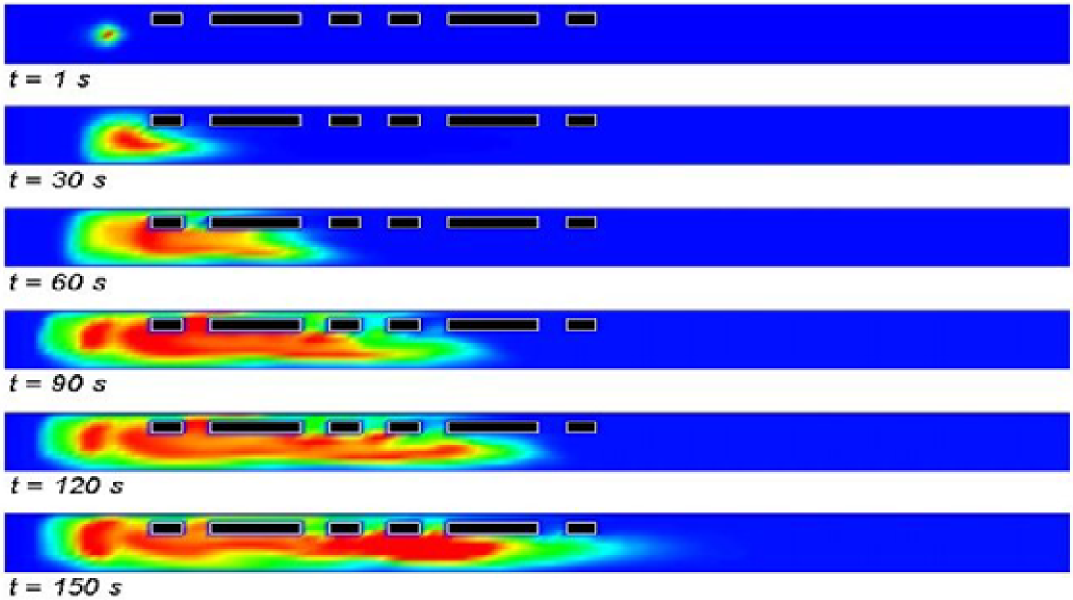

Figure 6: temperature values for different timesteps (courtesy of ACT)

4 EXAMPLES OF APPLICATION

4.1 *Mission planning for firefighters*

In this application is designed to allow a fireman to evaluate the effectiveness of a planned mission in a specific emergency-scenario. After defining the necessary mission-parameters like number of firemen involved, type of equipment and direction of attack, the simulation provides some quantities for ranking the success of the mission like set up time for equipment, time to extinguish, level of impact of the fire or toxic load exposure of the firemen.

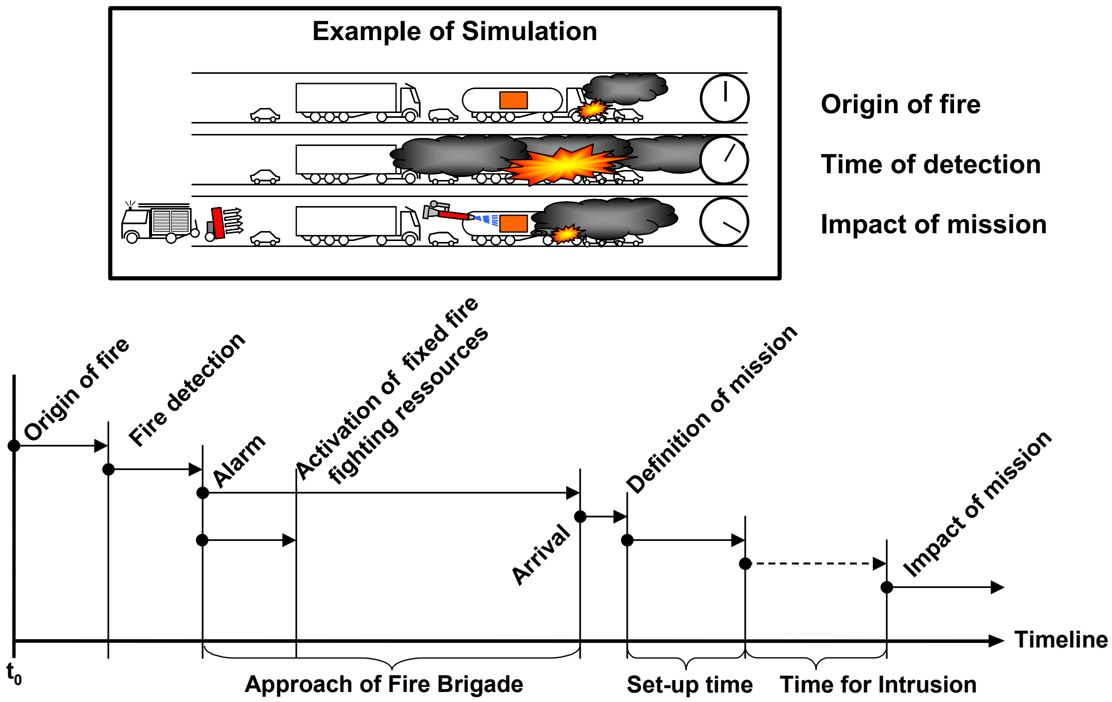

Figure 7: Resulting timeline of a simulated mission

(courtesy of FDDo)

4.2 *Evaluation of tunnel safety equipment*

The authority or planner of the tunnel infrastructure can use this tool to objectively evaluate the functionality and usability of the safety equipment. This task includes checking the visibility of road-signs in a smoke environment, testing the amount of fresh air supplied to the emergency cabins or evaluating the performance of the ventilation system.

4.3 *Evaluation of fire countermeasures performed by tunnel operators*

As the operators sitting in the control-rooms are the first persons to respond to an emergency, these people need to be trained for specific situations. With the help of the simulator an operator can monitor the consequences of his set actions.

4.4 Training of drivers for firesituations in tunnels

Several incidents in road tunnels have shown, that the majority of the drivers reacts totally wrongly due to panic and missing information about the things that can happen. The simulator can give a trainee the experience of an accident of a lorry with flammable goods and he/she can try different strategies of escape from the tunnel to a safe environment without the danger of getting harmed by a wrong reaction.

5 SUMMARY AND CONCLUSIONS

The project aims at the building of an interactive and high-performance simulation environment for fire incidents in tunnels. This development will lead to an objective tool for evaluating the safety infrastructure of a tunnel and provides a cheap alternative for verifying the effectiveness of fire fighting missions and for training of drivers and tunnel-operators in the case of an emergency.

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