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SIMULATION OF THE MAINTENANCE ANALYSIS FOR VIRTUAL STEERING TRAINING IN AUTOMOTIVE INDUSTRY

A. Fratu[1]
[1] Transilvania University of Brasov, Brasov, ROMANIA, fratu@unitbv.ro

Abstract: *In the present paper, we will explore the problem requirements of the virtual training maintenance analysis applications. We present a virtual prototype made on Delphi platform and describe its integration into the applications that include a simulator for the maintenance analysis used in automotive industry for steering system. We will present also the virtual prototypes in the virtual steering training, as the first potential application area of the maintenance analysis, using visual and physical feedback.*
In this paper we explore virtual steering system example of how digital modeling has been implemented in different fields of the automotive industry. Therefore, it should be evaluated carefully and applied fruitfully to integrating this new technology into the design process.
Keywords: *virtual prototyping, maintenance analysis, training steering system*

1. INTRODUCTION

Automotive industry makes every effort to make product development more efficient. Saving on expensive physical prototypes in all development steps is one important area with cost saving potential. In the age focused on getting better, faster, and cheaper results through computer technology, the development of effective virtual training capabilities seems to be a logical next step for spectacularly improving the cycle time, quality, and cost of producing efficient designs.
Particularly computer-intensive software was used more than all by specialists in the area of research. More and more engineers use software intensively and they have to perform other tasks in parallel. Software development had to be considerably simplified and formalized with a view to reliability, making it recordable, repeatable and understandable. The technologies that make this possible originally come from the development of embedded software and are also used today in the process of developing offline software. This considerably improves the quality and reliability, but it also means an extremely high increase in development time and cost per unit of software. It is planned that an effective modeling and simulation capability will be achieved by improvements to existing models, as well as development of extensive new modeling capabilities.
The initial effort concentrates on the development and validation of a toolbox of compatible models that can be configured to address many different concepts and evaluation criteria. This modeling strategy is supported by the emergence of distributed simulation capabilities together with the availability of a suite of models that represent key of the vehicles components.

2. VIRTUAL PROTOTYPING AND HUMANS INTERACTING

Desktop virtual prototyping covers a wide range of activities, from product visualization to vigorous analysis, dynamic simulation and maintenance analysis. Digital modeling and simulation techniques have already proven their ability to significantly reduce the cycle time and cost of designing new products, and have generally improved the quality of products and made them faster, easier and cheaper to produce, operate and maintain.
Desktop virtual prototyping refers to the process by which a new design can be evaluated on a computer without the need to create a physical prototype. Desktop virtual prototyping provides detailed evaluations from many viewpoints of changes to the system prior to their implementation. The benefits are many and profound: reduced

cycle time, reduced cost and increased flexibility facilitate a much more interactive, concurrent and efficient engineering process.
The ability to digitally simulate how humans interact with a product has the potential to revolutionize the way companies design, build, operate, and maintain new products. But many products present additional design challenges in human factors. To get the greatest performance, comfort, and safety from these products, engineers need to know early in the design process how effectively and efficiently humans will be able to interact with them. These challenges become increasingly important as businesses expand into global markets, where the success of new products depends on accommodating a greater diversity of human physical characteristics.
Through accurate digital modeling and simulation of human interactions with a product the engineers can visualize the design and share their concerns about it and make suggestions for improvement. Such evaluations will allow design decisions to be based on a broader understanding of the user before development resources are committed, and will eliminate many additional steps that often occur later in the development and support processes.
A simple evaluation of manual and visual access for adequately installing and inspecting components in a training process, for example, can save many unnecessary steps and thousands of labor hours later on, during the maintenance of the product over its lifetime, who is the case of the automotive steering system.

3. CONCEPT OF MAINTAINABILITY

Maintenance analysis is concerned with the investigation of whether or not a component can be inserted into and extracted from its target environment. This activity is particularly significant in automotive engineering, where components must be accessible for speedy repair.
In engineering, the term maintainability has the following meanings: A characteristic of design and installation, expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when the maintenance is performed in accordance with prescribed procedures and resources.
Maintenance includes tests, measurements, adjustments, and parts replacement, performed specifically to prevent faults from occurring. Doing this analysis in the real world is easy, because the operator can feel surface constraints and contact forces as he or she rotates and manipulates a part into place.
Replicating the same task in an interactive virtual prototyping application is much more difficult. The software is required to perform collision detection and compute a response in a complicated environment, which is a very challenging problem to solve.
In some cases, maintainability involves a system of continuous improvement - learning from the past in order to improve the ability to maintain systems, or improve reliability of systems based on maintenance experience.

4. VIRTUAL MAINTENANCE TRAINING

The major goal of virtual environment simulation is to provide realistic methods to allow us easy creation of digital equivalents for natural phenomena dynamic behavior and its interactions. The results of these simulations and corresponding vehicle tests help to find appropriate specifications for safety measures in the steering assistance as different intermediary actuators and to design stabilizing functions on a central vehicle control level. The effectiveness of these measures will first be tested in simulations of the same kind, which reduce the effort of subsequent vehicle tests.
In recent years, virtual maintenance trainers and innovative training technologies are becoming increasingly vital to adequately meet the nature of trainees. The idea to keep 3D (three-dimensional computer generated environments) interactive trainers prevalent is especially true within the automotive industry, in which virtual training technology - sometimes called “soft trainers” - are implemented together with training on an real vehicle. For the training process, investments in hardware and software for digital modeling and simulation of the human interactions with a product will be an enormous gain.
Virtual Maintenance Training (VMT) is a type of training method that includes computer-based interactive 3D simulations of virtual equipment that replicates the actual real life vehicle or device. VMT safely teaches vehicle and device team members the procedures to properly service, repair, and maintain equipment. VMT is the learning method commonly used by training schools and research centers for the maintenance activities. Its integration into current training courses has continued to increase in popularity. VMT results from a require to practice maintenance and repair procedures to hazardous or unavailable equipment. Virtual maintenance provides visualization, tolerance analysis, dynamics simulation and other functions. Maintenance activity, with a virtual aspect, uses virtual environment technology to construct a model of the vehicle and its components that were replaced or serviced. One of the virtual maintenance trainers resulted from our work was developed the first full 3D virtual interface maintenance trainer for to train the students. It contains a physical arena simulator

and a virtual touch screens or a PC. With high fidelity 3D interactive graphics, this trainer feels like a video game and engages the student in “natural navigation” by moving in virtual space.

4.1. Virtual Prototype for the training technologies

Virtual reality is known as virtual (or synthetic) environments and is widely used as a training tool in engineering. Virtual environments are three-dimensional computer generated environments that the user is able to experience interactively. The manner humans interact with their physical environments is artificially imitated in virtual environments. The modeling tool provides a modeling environment that automatically generates a simulation script for the dynamic response to user controlled conditions and variable values. The output data can be viewed, exported or graphed with little human effort.
Scenarios can serve as specifications for virtual prototypes. This technique emphasizes narrative, rather than theory, as the primary source for designers. Scenarios describe situations where customers would use new technology in the future. Scenarios go to a high level of detail by creating an illustrated script, thus providing a more detailed specification for prototype software.
In this paper the authors propose the Delphi software environment, for the simulation of the steering system using visual programming. Delphi Simulators are the basic tools for creating the virtual prototypes. They are suited for users who know the visual programming, but visualizing still needs another demand. Delphi Simulators offer a qualitative simulation of the dynamic systems. Qualitative simulation based on the structure of a device or system has been a promising technology for many years [1]. A model of a system can be composed by describing the behavior of individual components, and then describing the structure that links the components together. Such models can be used to simulate the behavior of the complete system.
This paper describes a practical method for using functional knowledge to interpret qualitative simulation of the vehicle components like steering system. Delphi Simulators enable more open and flexible software tools for programming the algorithms for steering system.
The simulator created in the Delphi environment was used to test the performances of the steering system in their integrated environment [2]. The simulation methodology uses a number of possible scenarios and involves the presence of the user to create some scenario in the virtual environment, as one can see in Figure 1.

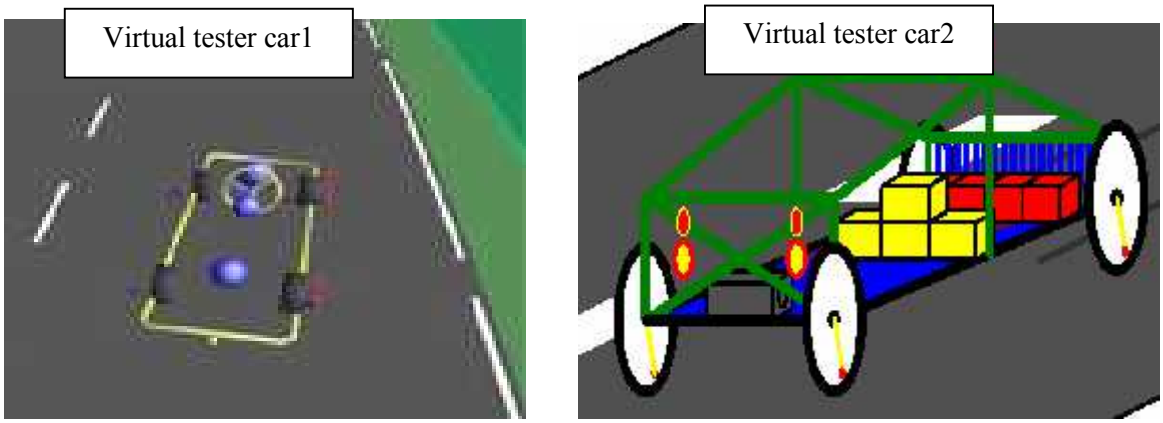

Figure 1: Virtual prototyping of the tester cars for virtual steering training

Having all this in mind and evaluating the possible solutions, the boundaries can be pushed further away, especially when using advanced virtual reality tools. The virtual test stand, help us to save a great deal of time and money.

4.2. Virtual driving test using active steering

One of the important problems in the road traffic is know to control the steering angle and to brake in the manner to assure the minimal distance between vehicles during the displacement.
The huge advantage for virtual vehicle testing is that enables both control devices to be integrated into the hardware; otherwise the control parameters and algorithms of the control devices would have to be entered an additional for each test vehicle model.

Hardware-in-the-loop- test stands for the virtual testing of both subsystems and complete vehicles has become standard tools in automotive development. One uses this test procedure to optimize active steering applications for series production.
Using the virtual system, different setups and designs of the steering system can be naturally tested on the virtual system, and therefore the transmissibility of the system can be easily estimated.
One of many tests carried out on the virtual test stand is driving the "lane change" functional test as a virtual vehicle model in real time simulation. Automotive supplies the software for the simulation system, a comprehensive driving dynamics simulation solution for real time applications. All vehicle and system components which are not actually integrated into the test stand have been simulated as software modules.

4.3. Testing as if the vehicle was real

Due to the complexity of the active steering, there was no guarantee that all of the specifications could be met on the real vehicle [3].
In a real vehicle, the active steering control device communicates with the control device for the electronic stability programmed. The active steering systems are presented in Figure 2.

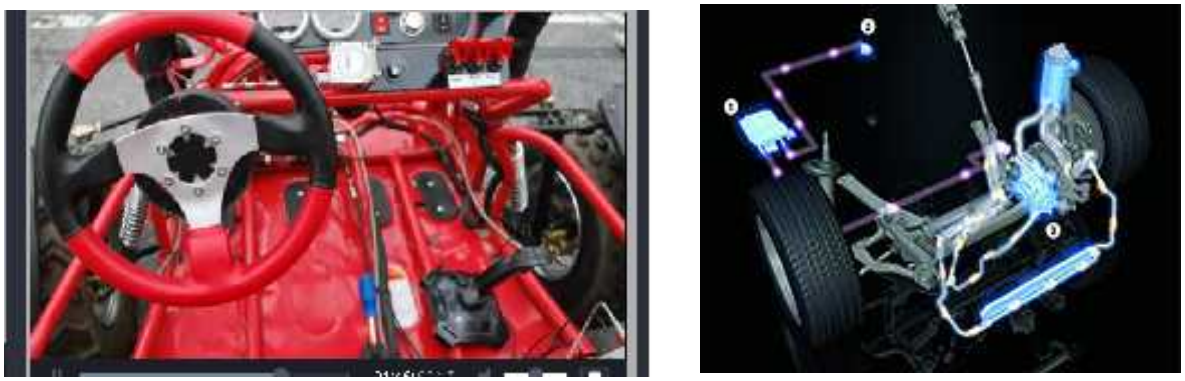

Figure 2: Real models for steering system

The main task of the real vehicle testing stand is to ensure that the software and electronics control for the active steering and its feedback during driving operations harmonize with the overall vehicle. A multitude of possible driving errors and functional tests - from ramp steer input to lane change tests and braking test - are simulated before an active steering application completes these requirements.

5. CONCLUSION

The intelligent use of the virtual test stand can certainly help to save on prototypes. Virtual test stand allows a qualitative simulation. But qualitative simulation from structure can be used to answer questions about the behavior of a whole system. Practical applications of this technology have been limited because of the problem of significant details from the results of a good qualitative simulator. Functional tests give a simple and effective way of interpreting the results of the simulation. The simulations discussed above are currently continued to cover an extensive catalogue of driving situations.

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