

Development of an Interface for Design Sensitivity and Optimization of Multibody Models

*Luís Sousa¹,

Jorge Ambrósio²

¹ Instituto Superior Técnico
Avenida Rovisco Pais, 1
1049-001 Lisbon
Portugal
lsousa@dem.ist.utl.pt

² Instituto Superior Técnico
Avenida Rovisco Pais, 1
1049-001 Lisbon
Portugal
jorge@dem.ist.utl.pt

Key Words: *sensitivity analysis, multibody models, graphical interface, crash response.*

ABSTRACT

At present a designer can choose and use a set of computational tools to analyze complex rigid multibody models. However, these powerful codes use different formats for input data and output results, which forces the designer to spend a lot of time to connect the models.

There are in the market some software's that include a set of tools for pre-processing and post-processing, analysis, sensitivity analysis and optimization, but the usability and control of the full process is not yet a simple process. One way to overcome this issue is the development of interfaces applied to specific problems.

This work shows the developments made to build an interface for personal computers that are able to process data and result files of some commercial codes in a best design point of view. The main objective is to obtain the sensitivities of design parameters, defined by the designer, in a systematic and interactive way to be included in an optimization module of rigid multibody models, to be applied in the design of crash impact of automotive vehicles.

The present tool is based on RAD (Rapid Application Development) object oriented programming language. This permits to build an easy, fast and intuitive interface between the intended codes. This tool is to be applied in adapting finite elements models to rigid multibody models using the plastic hinges approach.

Since the responses of a dynamic complex model are difficult to analyze, the influence of the change of several design parameters is even more complex to understand. To simplify this problem, the use of a graphical interface is of great importance. The relevant results from the analysis can be filtered from the output files and showed to the designer in a suitable manner, as tables, 2D or 3D plots and graphs. During the involvement of the authors of this work in the Advanced Protection Systems (APROSYS) European Project, for the improvement of the use of virtual testing's in the design of new vehicles for impact protection of the occupants, it is realized the importance of the use of graphical interfaces [1]. As mentioned above, the actual

commercial codes are not yet enough developed to accomplish the required manipulation of the information. This is particularly true for the design sensitivity analysis of multibody models of the vehicles (in this work modeled in Madymo [2]). During the initial design phase, the designer must perform a large number of simulations and observe the relevant changes in the selected results. The automation of this procedure is an important step to accelerate all the process.

The actual tool is developed using an Object Oriented programming language, using the concept of RAD to accelerate the development process in a personal computer operating system. Among several advantages that can be mentioned, the easy use of graphical objects and connections to other common programs and graphical libraries are relevant ([3], [4]).

Another important aspect is the tuning of the computational models against some existing reference data. This can be performed using optimization techniques which are best used when state variables and their gradients (with respect to the design variables) are given by the user. Again, the importance of the design sensitivity analysis must be reinforced ([5], [6]).

The examples show the application of the interface to the validation of multibody models against reference models, in this cases a finite element model.

REFERENCES

- [1] Sousa, L., P. Veríssimo, and J. Ambrósio, "Development of Generic Multibody Road Vehicle Model for Crashworthiness". *Multibody Systems Dynamics*, Accepted 26 July 07. 2007.
- [2] MADYMO, *Madymo Manuals, version 6.2*. TNO MADYMO BV. 2004.
- [3] Cantù, M., *Mastering Delphi 2005*. Sybex, San Francisco, 2005.
- [4] Hearn, D. and M.P. Baker, *Computer graphics with OpenGL*. Pearson Prentice Hall, Upper Saddle River, NJ, 2004.
- [5] Arora, J.S., *Introduction to Optimum Design*. McGraw-Hill, New York, 1989.
- [6] Arora, J.S. and E.J. Haug, "Methods of Design Sensitivity Analysis in Structural Optimization". *AIAA Journal*, vol. 17(9), 970-974. 1979.