An advanced modeling and simulation tool for dynamic systems

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ABSTRACT

In this paper, a new modeling and simulation tool, the Virtual Test Bed (VTB), is introduced. The VTB is a software environment that has been developed for design, analysis, and virtual prototyping of large-scale multi-technical systems [1, 2, 3]. The two most important features of the VTB are that [1, 2, 3]: (i) it has the capability of integrating models, that have been created in a variety of languages such as SPICE (Simulation Program with Integrated Circuit Emphasis), ACSL (Advance Continuous Simulation Language ®) and SABER ®, into one simulation environment, and (ii) it provides advanced displays of simulation results including full-motion animation of mechanical components, oscilloscope-like displays of waveform data, and imaginative mappings of computed results onto the system topology.

Consider a multi-technical dynamic system, which consists of mechanical, electronic, and electromechanical components. Simulation of such a system is usually challenging since the existing simulation tools are generally developed for specific applications. For example, ACSL and MATLAB are excellent tools for modeling and simulation of control systems which include mechanical and electromechanical parts for which the differential equations can be easily written. On the other hand, other tools, such as SPICE and SABER, are preferred for the detailed analysis of electric circuits. Especially, SABER is the software of choice in modeling and simulation of power electronic circuits.

One of the main purposes of the VTB is to allow the system designer(s) to model each individual component of a multi-technical system in a language appropriate to that component, and then, to bring those separate models into one common simulation environment [1, 2, 3]. In addition to the external models, which are obtained from their source languages by translation, the VTB has also its own native models created in C++. Currently, the VTB library includes native models of basic circuit components, power electronic devices, power converters, electric motors, and mechanical parts.

In this paper, application of the VTB to a motion control system is introduced. Specifically, vector control of a permanent-magnet synchronous motor (PMSM) is considered. In recent years, the PMSMs tend to replace any other electric motors in many applications due to their higher torque-to-volume ratio, and the current-command rotor-oriented speed controller (vector controller) for PMSMs is the industry standard for precise tracking of predetermined speed/position trajectories [4, 5]. The simulation of this system within the VTB environment is achieved by the use of the VTB native models and/or external models which are translated from their original languages such as ACSL and MATLAB.

In the final version of the paper, the detailed description of the VTB architecture and the simulation results for the above-mentioned system will be presented.

REFERENCES

[1] Charles W. Brice, Levent U. Gökdere, Roger A. Dougal, "The Virtual Test Bed: An Environment for Virtual Prototyping," *Proceedings* of *International Conference on Electric Ship (ElecShip'98)*, pp. 27-31, September 1, 1998, Istanbul, Turkey.

[2] R. A. Dougal, C. W. Brice, R. O. Pettus, G. J. Cokkinides, and A. P. S. Meliopoulos, "Virtual prototyping of PCIM systems - The Virtual Test Bed," *Proceedings of the 37th International PCIM'98 Power Electronics Conference*, pp. 226-234, November 7-13, 1998, Santa Clara, California.

[3] Levent U. Gökdere, Lei Hua, John Mookken, Charles W. Brice, and Roger A. Dougal, "Operation of imported power converter models in the Virtual Test Bed," in *Proceedings of the High Frequency Power Conversion Conference* (*HFPC'99)*, pp. 99-106, November 9-11, 1999, Chicago, Illinois.

[4] P. Vas, *Vector Control of AC Machines*, Oxford, U.K.: Clarendon Press, 1990.

[5] W. Leonhard, *Control of Electric Drives*, Berlin, Germany: Springer-Verlag, 1985.