Fault Detection of Power Electronic Circuit using Wavelet Analysis in Modelica

Jianbo Gao*   Yang Ji**   Johann Bals**   Ralph Kennel*

*Technische Universität München

Arcisstr. 21, 80333 Munich, Germany

{michael.gao, ralph.kennel}@tum.de

** German Aerospace Center

Muenchner Str. 20, 82234 Wessling, Germany

{yang.ji, johann.bals}@dlr.de

In more electric aircrafts (MEA) the electric power network is important for the reliability of the whole system [1]. To prevent the occurrence of severe faults it is the key to identify the faults in the early stage before a complete failure happens. In this study the fault detection of a buck converter for MEA was investigated. Specifically, the capacitance drop failure of the electrolyte capacitor in the input filter of the converter had to be detected.

For designing a feasible fault detection strategy Modelica simulation combined with wavelet transform was used in the reported study. By applying wavelet multi-resolution analysis to the inverter input current signals, which was obtained from the simulation results, clear fault features could be extracted from the noisy sensor signals.

In order to carry out wavelet transform in Modelica, a specific wavelet library is being developed and the preliminary library has been used to design the fault detection method. The structure of the library, which is still under construction, is shown in the figure (left side), whereas the right part of the figure gives the fault features obtained using wavelet analysis, with the comparison to the traditional filter method, as an example.
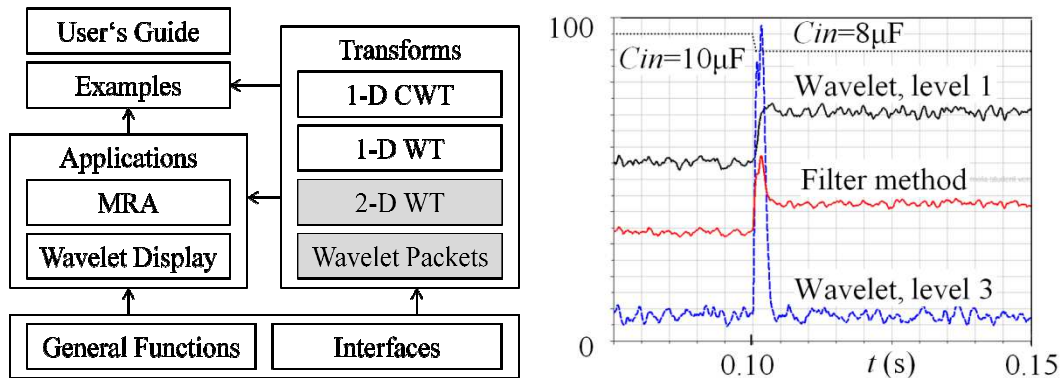
The results showed significant advantages of the wavelet method over filtering. As shown in the figure, the wavelet method obtained a much stronger pulse and a more significant magnitude change related to a fast drop of 20% capacitance.

This work not only proved the feasibility of the wavelet theory in early stage fault detection in MEA power electronics, but also showed the functionality of Modelica as a suitable tool for quick design of fault detection strategy.

References

[1] Y. Ji and J. Bals. Multi-Model Based Fault Detection for the Power System of More Electric Aircraft. Proceedings of the 7th Asian Control Conference, Hong Kong, China, Aug. 27-29, 2009.