Injecting model-based diagnosis thinking into the design process

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Abstract

Widespread adoption of model-based diagnosis has been hampered by a number of challenges. First, model-based diagnosis requires behavioral fault models, which often do not exist or are too expensive to create just for diagnosis applications. Second, often the nominal models do not exist. Third, there is no common language for describing behavior models. Fourth, lack of standard reusable model libraries. Five, ambiguity about the definition of a ‘model.’ Finally, a challenge faced by most diagnosis approaches: by the time diagnostics are considered almost all of the critical design decisions which affect diagnosis have been made.

Fortunately, this landscape is rapidly shifting. Modelica has arisen as the primary declarative modeling language, many open source and commercial implementations of Modelica solvers are available, and many open source and commercial component model libraries can be easily obtained. This talk focuses on exploiting these changes to inject diagnostic thinking into the design process and addressing some of still open issues for model-based diagnosis.

We introduce a novel model-based reliability analysis methodology to guide the best maintenance practices for the components in complex engineered systems. We have developed a tool that allows the system designer to explore the consequences of different design choices, and to assess the effects of faults and wear on critical components as a result of usage or age. This allows the designer to determine the components and their respective fault modes that are critical w.r.t. the performance requirements of the design. Given a design configuration, the tool is capable of providing a ranked list of critical fault modes and their individual contributions to the likelihood of failing the different performance requirements. From this initial analysis it is possible to compute the Mean Time Between Failure (MTBF) for each of those fault modes. These time intervals, grouped by component or Line Replaceable Units (LRUs), are aggregated to develop a preventive maintenance schedule. The most critical faults are candidates for incorporation in the model-based diagnosis approach for the maintenance in the field.

This approach raises questions about what the ‘gold standard’ model of a component or system actually means. This talk will present some initial thoughts on what constitutes a good model.

(collaboration with Bhaskar Saha, Tomonori Honda, Ion Matei, Eric Saund, Tolga Kurtoglu, and Zsolt Lattmann)