

Novel Model-Based Diagnosis Approaches for Advanced IVHM Systems

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Abstract

Although diagnosis is needed for any IVHM system, current approaches are almost uniformly “ad-hoc,” inefficient, and incomplete. Powerful methods of general Model-Based Diagnosis exist in literature, but all suffer from exponential complexity and are therefore impossible to implement on a meaningful scale.

In this paper, we first present an overview of the current state-of-the-art of Model-Based Diagnosis approaches to highlight the main computational bottleneck in their practical and large-scale applications. We then present new algorithmic approaches to model-based diagnosis based on two new techniques for mapping the diagnosis problem onto the more well-know and established Boolean Satisfiability and Linear Integer Programming. Although the diagnosis problem is widely believed to be very hard requiring an exhaustive exponential search, we provide, for the first time, an analytical proof. The discovery of the connection between the diagnosis and the Boolean functions enables the use of a new set of efficient tools to tackle the problem. On a separate approach, we also present a clear formalism for mapping the diagnosis problem into Linear Integer Programming Problem. This mapping provides us with the large and versatile machinery of Linear Integer Programming to tackle the diagnosis problem with a more practical approach.

These new representations of the problem allow us to explore techniques that are not directly available for the original setting of the Model-Based Diagnosis problem. For example there are superpolynomial algorithms for solving Boolean Satisfiability Problem, and it is possible to solve Integer Programming Problem with several thousands variables. Our new techniques allow us to expand the range of the size of the problems solvable by these algorithms even more and thus make Model-Based Diagnosis technique applicable to practical problems of interest.