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NONLINEAR MODEL DECOMPOSITION FOR ROBUST FAULT DETECTION AND ISOLATION USING ALGEBRAIC TOOLS

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Abstract. *Model-based Fault Detection and Isolation (FDI) approaches are based on fault indicators, namely residuals. Each residual is robust to unknown signals and sensitive to a subset of faults. A bank of residual generators (RG), each of them having different robustness/sensitivity properties, are used to isolate the faulty component. Designing a RG is not trivial especially for nonlinear models. Generally speaking, the Fundamental Problem of Residual Generation (FPRG), may be decomposed in two steps: a model decomposition problem and a stability problem. This paper addresses the first problem using algebra of functions. Existing works using this approach are discussed and improvements on several aspects are proposed. An academic nonlinear example is provided to illustrate step by step the methodology and to the show the relevance of the proposed improvements.*

Keywords: System decomposition, Residual generation, Decoupling, Nonlinear systems, Algebra of functions

1. **Introduction.** Process monitoring is a major concern for the industrial world. The early detection and localization of faulty elements can help preventing larger failures or even the destruction of the monitored plant, by stopping the process or by using fault tolerant control. This is the main purpose of fault detection and isolation (FDI) methods.

Model-based FDI methods rely on analytical redundancy that exists thanks to the use of a mathematical model of the considered system. This redundancy is used to generate fault indicators named residuals. These signals allow to check discrepancies between the behavior of the system and its mathematical model. Several approaches exist to generate residuals: parameter estimation approach [1, 2], parity space approach [3, 4] and observer-based approach [5, 6, 7]. All of these approaches are well formalized in the linear case. However, no general theory exists for the nonlinear case. The main reason of that issue is the difficulties encountered when dealing with nonlinear equations. In the last decade, two major directions were investigated: The most common are geometric