

Review of Wijaya Kurniawan's PhD thesis

"Model-based fault diagnosis in networked linear time invariant systems"

The thesis proposes algorithms for detecting and estimating faults in networked, linear time invariant dynamical systems. The targeted application fields are platoons of autonomous ground vehicles and heat exchange networks. The theses address specific, sometimes simplified problems, but the possible extension of the results to a broader class of problems are also investigated, which places the results in a more general perspective. Comparing to the previous version of the manuscript, that has been submitted to the preliminary defense, this is an important improvement. In general, the manuscript has been thoroughly revised after the preliminary defense and has been significantly improved.

The manuscript is well structured, the three theses are organized in different chapters that is preceded by the introduction and the collection of basic notions and followed by the conclusion. The core of the thesis is 93 pages, supplemented by an appendix of no more than 30 pages. At this length, the manuscript meets the formal requirements for a doctoral dissertation.

The first and the second chapters are the "Introduction" and "Basic Notions". Both are well structured, the introduction correctly positions the research and cites the relevant existing results. The chapter of basic notions has been revised after the preliminary defense, it is definitely better.

The first thesis is presented in chapter 3. This thesis focuses on fault diagnosis problems related to a platoon of ground vehicles. The vehicles are modeled by LTI systems and the platoon is assumed to move in one dimension (along a coordinate axis). In the first part of the chapter the problem of isolating sensor faults is addressed. As a solution an Unknown Input Observer (UIO) design method is adapted to this specific model, because the propagation of the sensor fault along the vehicle string induces an additive unknown input signal d . The methodology and algorithms are clearly presented, the chapter is well written, the derivations are easy to follow. Although the problem actually solved is a simplified problem, in section 3.3 the author analyses in detail how the proposed method can be extended to the network of general LTI systems. It is important to stress that this is a very useful part of the chapter.

The second part of the chapter focuses on the actuator faults. This is a simpler problem, as the fault appears as an additive signal in the model of the interconnected systems (i.e. it is not propagated along the string) so a simple state estimator (Luenberger observer with integrator) can be used. The application of the method to the current problem is fairly straightforward, but it is certainly useful that the author addresses this problem and thus complements the fault diagnosis.

Question: If both the sensor fault isolation filter and actuator fault estimator are applied on the same vehicle platoon, is it possible to detect one actuator and one sensor fault simultaneously or do we still have to assume that only one fault can occur at a time?

The 2nd thesis is presented in chapter 4. The estimation of a parametric fault in a heat exchange network is addressed. To solve this problem an existing method (published in [141]) is adapted and applied. Before designing the estimation filter the observability of the interconnected system is analyzed by SDG method and based on the result of the analysis, an appropriate sensor placement is proposed. The chapter is easy to understand.

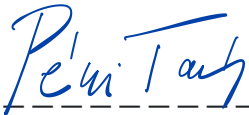
Finally, the 3rd thesis is described in chapter 5. This thesis addresses the problem of detecting additive faults on the heat exchange network. This is a simpler problem compared to the case of parametric faults. By assuming constant fault signals and if a set of further assumptions hold the faults can be isolated by analyzing only the steady state values of the outputs. When the faults are located the same observer based method is applied as in thesis 1 to estimate the fault magnitude. The concept is clear.

Question: How restrictive are assumptions A1-A4 in a real system? If they do not (or not all of them hold), can we simply skip the isolation part and run as many fault estimator filters (sec 5.5) in parallel as many fault locations are possible?

It is important to emphasize that the filter design procedures presented in the theses does not stop at the construction of the fault diagnosis algorithm. The author spends time analyzing the properties and performance of the filters. For example, in section 4.5 a sensitivity analysis is presented and in section 5.6.2 a robustness analysis is carried out. These are important part of the design process and therefore they are certainly appreciated.

Conclusion: the theses can be accepted as novel scientific contributions, I strongly recommend that these results be presented in a public defense.

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Tamas Peni

senior research fellow

SZTAKI