240o Automata as Fault-Detection Algorithms

Heinz Preisig

The currently used advanced fault detection algorithms and mechanisms are today mostly based on data filters which compare “normal behaviour” with the observed behaviour. One of these class of methods uses the for example extended Kalman filters for the estimation of parameters and then makes decisions based on changes observed in the behaviour of the parameters as a function of time. These methods are generally based on residuals between observed and expected behaviour.

This group has been working on an approach that attempts to look at the inverse problem, attempting to reconstruct unobserved event inputs, faults, from the observed behaviour of the plant using only events observed in the plant. In terms of a plant, the events are for example crossing of warning and alarm limits but can also be others that are designed specifically to meet a fault observability condition, which is the subject of this paper.

The underlying analysis discretises the state space into subspaces and then constructs the discrete-behaviour from the discrete inputs, some of which are controlled (for example changes in the setpoints or changes in the control parameters) whilst others are suggested faults. The algorithms then compute all possible events and thereby generate an automaton description of this discrete event dynamic behaviour of the plant. The model can then be used in a type of observer, which reconstructs the unobserved, but suggested faults.

This approach has been applied to sample plants at National University of Singapore with some success. Recent further developments now solved the problem of how to design the discrete observer, that is, how to discretise the state space such that the suggested faults are become detectable. Interestingly this can be done quite locally, thus given a continuous model of a large plant, it is local conditions that define the discrete-event observability of the unobserved persistant event, thus the fault. This makes it obviously interesting for the analysis of large-scale plants.

The approach has yet another interesting flavour, as it can also be utilized for safety and hazard analysis, which, if space and time permits will also be addressed.