Fault Diagnosis for Electrical Distribution Systems using Structural Analysis - DTU Orbit (08/08/2016)

Fault Diagnosis for Electrical Distribution Systems using Structural Analysis

Fault-tolerance in electrical distribution relies on the ability to diagnose possible faults and determine which components or units cause a problem or are close to doing so. Faults include defects in instrumentation, power generation, transformation and transmission. The focus of this paper is the design of efficient diagnostic algorithms, which is a prerequisite for fault-tolerant control of power distribution. Diagnosis in a grid depend on available analytic redundancies, and hence on network topology. When topology changes, due to earlier fault(s) or caused by maintenance, analytic redundancy relations (ARR) are likely to change. The algorithms used for diagnosis may need to change accordingly, and finding efficient methods to ARR generation is essential to employ fault-tolerant methods in the grid. Structural analysis (SA) is based on graph-theoretical results, that offer to find analytic redundancies in large sets of equations only from the structure (topology) of the equations. A salient feature is automated generation of redundancy relations. The method is indeed feasible in electrical networks where circuit theory and network topology together formulate the constraints that define a structure graph. This paper shows how three-phase networks are modelled and analysed using structural methods, and it extends earlier results by showing how physical faults can be identified such that adequate remedial actions can be taken. The paper illustrates a feasible modelling technique for structural analysis of power systems, it demonstrates detection and isolation of failures in a network, and shows how typical faults are diagnosed. Nonlinear fault simulations illustrate the results.

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