Chapter 76
Binary Decision Diagram Reliability for Multiple Robot Complex System

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ABSTRACT

Assume a production system having multiple robots and work stations leading to a complex system. To evaluate the reliability of this system, a network of components is considered configuring a complex reliability network. A robotic network is considered which has perfect vertices and imperfect links. It means path links may fail with known probability. The authors obtain the reliability of the given network by using an exact method and with binary decision diagram. Binary decision diagram-based reliability evaluation involves three main steps. First, ordering the given path link. Second, generate the reliability function with the help of min-paths from source to sink. At last, apply Shannon's decomposition to compute the reliability of the given network.

INTRODUCTION

Generally, complex systems in reliability are defined as a system having a combination of series, parallel, R out of N and standby components. Each of these models has the corresponding mathematical formulations for reliability computations leading to decompose the original system (or sub-system) into an equivalent one with a known cumulative distribution function (CDF) or reliability function. Continuing the decomposition procedure enables the decision maker to reduce the whole system to a unique component with a known CDF. For better understanding, an illustrative example for a complex system reduction is given in Figure 1. The system is composed of both series and parallel components which are reduced first to a series system and eventually to a one-component system.

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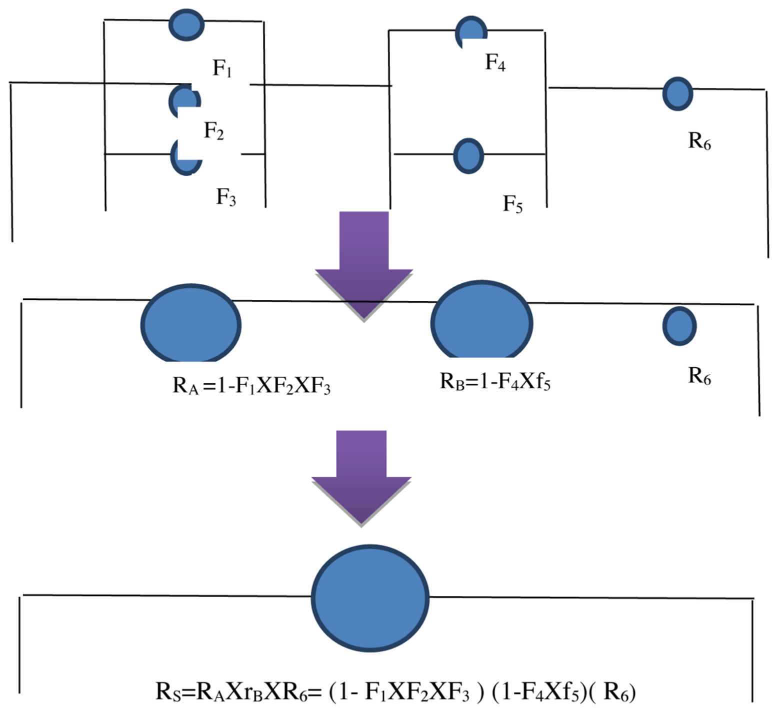
Figure 1. A complex system reliability



It should be noted that the reduction methods explained before are not effective for all systems. In cases with complicated interrelations of components it is required to develop an efficient methodology. This methodology deals with subjects such as event trees, Boolean representations, coherent structures, cut sets and decompositions.

Network reliability analysis receives considerable attention for the design, validation, and maintenance of many real world systems, such as production, computer, communication, or power networks. The components of a network are subject to random failures, as more and more enterprises become dependent upon network or networked computing applications. Failure of a single component may directly affect the functioning of a network. So the failure probability of each component is a crucial consideration while considering the reliability of a network. There are so many exact methods for computation of network reliability (Bobbio et al., 2006). The network model is a directed stochastic graph $G=(V, E)$, where V is the vertex set, and E is the set of directed edges. An incidence relation associates with each edge of G a pair of nodes of G, called its end vertices. The edges represent components that can fail with known probability. In real problems, these probabilities are usually computed from statistical data. The problem related with connection function is NP-hard. The same thing is observed for planar graphs (Provan, 1986).

BACKGROUND

The word *reliability* can be traced back to 1816, by poet Coleridge before World War II the name has been linked mostly to repeatability (Saleh and Marais, 2006). A test (in any type of science) was considered