SOUTENANCE DE THESE

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Unité de recherche : UMR 7253 - Heudiasyc

soutiendra sa thèse de doctorat

sur le sujet :

A contribution to the optimal design of systems with imprecise components reliabilities

A l'université de technologie de Compiègne
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Amphi L.103 – Centre Pierre Guillaumat

Devant le jury composé de :

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Résumé de thèse:

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System reliability optimization is described as the selection of components and a system architecture to maximize the reliability. In this work, safe design of systems can be considered as the selection, from several system architectures, the one that presents the higher reliability value. We should note that safety is not reliability because safety is freedom from accidents or losses whereas reliability represents the ability of the system to perform its required functions under stated conditions for a specified time. Thus, a system may be reliable but unsafe, and conversely, a system may be safe but not reliable. However, in this thesis, we use the term safe design when the decision maker has to choose the best design of system regarding reliability attributes. The reliability of the components considered for the system is generally not known in practice and must be estimated from data. Therefore, there is an uncertainty associated with the reliability estimate of the component. Decision makers and designers prefer solutions with a higher reliability estimate, but also lower uncertainty. However, most existing studies assume that the reliability values of the components are precise, and known with certainty, and there are very few studies where estimation uncertainty is explicitly considered within a system reliability optimization model.

For this we will use the notion of imprecise reliability. Indeed, most methods in reliability assessment assume that uncertainty related to reliability data of components is quantified via precise failure probabilities. These precise values is often not available, due to the use of new components or limited knowledge about them or when they only presents rare events failure. In recent decades, several alternative methods for uncertainty quantification have been proposed in the reliability field: fuzzy set theory, possibility theory, random set theory... In this thesis, we do not use such theories, but focus on uncertainty quantification based on upper and lower probabilities, also known as imprecise probability or interval probability and we call this frame imprecise reliability. We are convinced that using imprecise probabilities with clear explanations and interpretations, this the- ory presents a rich and robust approach than the classical precise ones. Note that the possible large imprecision of resulting system reliability measures reflects the available incompleteness of initial information and stimulates to collecting more reliability data or using more information sources.

The main contribution of this thesis lies in two aspects. First, when we have different designs of system, the next step is to compare them and choose the optimal one (in term of reliability attributes) as a decision maker. Thus, comparing system reliabilities is essential and helps people to make a decision. When the structure function, which maps single component reliabilities to the overall system reliability, is known, and the components reliabilities are precisely known, this step poses no particular problem. How- ever, in practice, it may be difficult to provide precise assessments of such reliabilities, for example because little data exist for some components (they may be issued from new technologies), or because they are given by expert opinions. This typically happens in early-stage phase design of new systems. In such cases, the problem of comparing systems reliabilities becomes more difficult, both conceptually and computationally speaking. We explore what happens when the components probabilities of functioning are ill-known, that is are only known to lie in an interval. In brief, the first objective of this thesis is to propose different comparison methods and dominance criteria for system reliability under uncertainty or when using imprecise reliabilities. The second contribution of the thesis is to propose a methodology based on the use of a genetic algorithm (GA) and interval dominance criteria to find solutions to the redundancy allocation problem for a series-parallel k-out-of-n systems. More specifically, there is a specified number of subsystems and, for each subsystem, there are multiple component choices which can be selected and used in parallel. Note that the considered components are characterized by imprecise reliabilities. The problem is then to select the number and the types of components in order to maximize the overall system reliability.