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RELIABILITY OPTIMIZATION OF A SERIES-PARALLEL SYSTEM WITH FUZZY RANDOM LIFETIMES

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Abstract. *This paper studies reliability optimization of a series-parallel system with fuzzy random lifetimes. A fuzzy random reliability model is developed to maximize the system reliability. Since the reliability function consists of fuzzy random parameters, classical mathematical programming methods is not applicable to the reliability model. Therefore, in order to solve the model, a fuzzy random simulation method is first proposed to compute the system reliability, and a theorem is proved which ensures the convergence of the fuzzy random simulation. Furthermore, a hybrid binary particle swarm optimization (BPSO) algorithm incorporating the fuzzy random simulation is proposed. Finally, a numerical example is provided to illustrate the proposed hybrid algorithm.*
Keywords: Reliability, Series-parallel system, Fuzzy random variable, Convergence, Binary particle swarm optimization (BPSO)

1. **Introduction.** Reliability optimization plays a key role in engineering design and has been effectively applied to enhance system performance. In classical reliability models, an underlying assumption is that all the lifetimes of the components are characterized by random variables. Based on probability theory, the classical reliability theory has been well developed. On the other hand, just like many fuzzy decision making models (see [17, 44]), a number of fuzzy reliability optimization problems are modeled through fuzzy set theory [42, 43], for the situation that the crisp data are unavailable, in other words, the lifetime data of the system are imprecise or vague.

In the real-world applications, randomness and fuzziness are often mixed up in the lifetimes of systems. As an example, due to the imprecision in the measurement, some history data of lifetime may be provided by experts who prefer to express them as fuzzy numbers, in a way to incorporate their vague perceptions into hard statistic data. In this case, the statistic data own fuzzy values. As a consequence, it is impossible to use only one of random and fuzzy variables to deal with such two-fold uncertain lifetime data in the reliability system. The concept of a fuzzy random variable was introduced by Kwakernaak [14, 15] to depict such phenomena in which vagueness and randomness appear at the same time. Inspired by the pioneering work of Kwakernaak, several variants as well as extensions of fuzzy random variable were presented by other researchers such as Kruse and Meyer [11], Liu and Liu [20], López-Diaz and Gil [25]. In this paper, making use of fuzzy random variables, we aim to study reliability optimization problems of a series-parallel system under fuzzy random uncertainty. A fuzzy random reliability optimization model is developed. Since the system reliability is made up of fuzzy random parameters, the classical mathematical programming methods cannot be applied to the model. Therefore, a fuzzy random simulation approach is proposed to compute the reliability function, and