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PROFUST AND POSFUST RELIABILITY OF A NETWORK SYSTEM

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ABSTRACT

A Fuzzy process, similar to a stochastic process is carried out for reliability network modeling. It is well known that the classical reliability analysis using probability and binary state assumption has been found to be inadequate to handle uncertainties of failure data and modeling. This present paper attempts to review the fuzzy tools when dealing with reliability of series, parallel, bridge, k-out of-n networks systems. In the present paper to overcome this problem, the concept of "fuzzy probability" has been used in evaluating the fuzzy reliability of network.

Key Words: Reliability, possibility, fuzzy sets, series, parallel, bridge and k-out of n-systems.

INTRODUCTION:

The conventional reliability of a system is defined as the probability that the system performs its assigned function properly during a predefined period under the condition that system behaviour can be fully characterized in the context of probability measure. However, in the real world problems, the system parameters are often fuzzy/ imprecise because of incomplete or non-obtainable information, and the probabilistic approach to the conventional reliability analysis is inadequate to account for such built-in uncertainties in the system. For this purpose, the concept of fuzzy reliability has been introduced and formulated in the context of possibility theory. Processes, components, equipments, systems, and people are not perfect and not free from failures. In a naïve, simplistic, and deterministic view, we can have perfection with perfect reliability. In the real world we fall short of perfection. Everything fails either because of events or from aging deteriorations. Reliability engineering is a strategic task concerned with predicting and avoiding failures. For quantifying reliability issues it is important to know **why, how, how often** the failures occur and what is the cost of failure in terms of money, time and goodwill. Reliability issues are bound to the physics of failure mechanisms so the failure mechanisms can be mitigated. In fact almost all potential failures are seldom well known or well understood, that makes failure prediction a probabilistic issue for reliability analysis. Taking into consideration the role of failure engineering in system reliability estimation, we intend to study in this paper, various network configurations in fuzzy approach. Reliability analysis of a network is known since the early stages of the standard reliability theory based on probabilistic modeling. Pursuing the theme of the work, we shall now replace probabilistic modeling by possibilistic models using the concept of fuzzy probability. This paper deals with probist and profust reliability estimates of various network configurations.

Present paper basically includes explaining how fuzzy set concepts can be applied in system reliability evaluation of a series, parallel, bridge, k-out of -n network and non-series parallel network, particularly in a situation where the data are inadequate or unreliable. Reliability of elements in a network depends on numerous factors. To evaluate reliability associated with considering all such factors would become very difficult. The fuzzy modeling has been applied for subjective evaluation, which replaces the analytic approach. The basic operations on fuzzy sets can be represented by simple networks as in the theory of reliability networks.

OPERATIONS ON FUZZY NUMBERS THROUGH CUTS :-

Generally a fuzzy interval is represented by two end points a_1 and a_3 and a peak point a_2 as $[a_1, a_2, a_3]$.

For $\alpha \in [0,1]$, the α – cut set A_α of fuzzy number A is an interval given by,

$$A_\alpha = \left[a_\ell^{(\alpha)},\ a_r^{(\alpha)}\right] \ ;\ a_\ell^{(\alpha)} \le a_r^{(\alpha)}$$

Let $A_\alpha = \left[a_\ell^{(\alpha)},\ a_r^{(\alpha)}\right]$ and $B_\alpha = \left[b_\ell^{(\alpha)},\ b_r^{(\alpha)}\right]$

operations of addition, subtractions, multiplication and division between the two α -cut sets are defined as following:

(i) Addition:

$$(A+B)_\alpha = \left[a_\ell^{(\alpha)} + b_\ell^{(\alpha)},\ a_r^{(\alpha)} + b_r^{(\alpha)}\right]$$

for every two valued function ϕ, there exists structure function in minimal path sets and cut sets respectively, such that for nay (v_1, v_2, v_3,.............v_n) in $\Im^n$ We have,

$$\phi(v_1, v_2, \ldots\ldots\ldots v_n) = \underset{1\le r\le n_p}{\vee} \ \underset{i\in p_r}{\wedge} v_i = path\ set \text{ and}$$

$$\phi(v_1, v_2, \ldots\ldots\ldots v_n) = \underset{1\le r\le n_p}{\wedge} \ \underset{i\in c}{\vee} v_i = cut\ set$$

Now the structure function for the minimal path set can be written as

$$\phi(v_1, v_2, v_3, v_4, v_5) = (v_1 \wedge v_4) \vee (v_2 \wedge v_5) \vee (v_1 \wedge v_3 \wedge v_5) \vee (v_2 \wedge v_3 \wedge v_4) \quad \ldots\ldots\ldots \quad (16)$$

and the minimal cut set is given by

$$\phi(v_1, v_2, v_3, v_4, v_5) = (v_1 \vee v_2) \wedge (v_4 \vee v_5) \wedge (v_1 \vee v_3 \vee v_5) \wedge (v_2 \vee v_3 \vee v_4) \ \ldots\ldots\ldots \ (17)$$

Now let we consider that r_1 be the possibilistic reliability of component C_1i and by R_s the possibilistic reliability of the system. In case of possibilistic independence we can say that the possibilistic reliability of the system may be given as;

$$R_s = \tilde{\phi}(r_1, r_2, r_3, r_4, r_5)$$

and the possibilistic fuzzy reliability can be obtained by fuzzifying either by the above equations

$$R_s = (r_1 \tilde{\wedge} r_4) \tilde{\vee} (r_2 \tilde{\wedge} r_5) \tilde{\vee} (\tilde{r}_1 \wedge \tilde{r}_3 \wedge \tilde{r}_5) \vee (\tilde{r}_2 \wedge \tilde{r}_3 \wedge \tilde{r}_4) \ \ldots\ldots\ldots \ (18)$$

$$= (r_1 \tilde{\vee} r_2) \tilde{\wedge} (r_4 \tilde{\vee} r_5) \tilde{\wedge} (r_1 \tilde{\vee} r_5 \tilde{\vee} r_3) \tilde{\wedge} (r_2 \tilde{\vee} r_4 \tilde{\vee} r_3) \ \ldots\ldots\ldots\ldots \ (19)$$

For numerical computation, we consider the following trapezoidal fuzzy numbers based on hypothetically selected values:

The possibilistic reliability of the all components in trapezoidal form is given as follows.

Components (*i*)	Possibilitic reliability of each component, *i*
C_1	(.045, .054, .055, .066)
C_2	(.038, .032, .043, .048)
C_3	(.042, .052, .053, .063)
C_4	(.046, .056, .057, .069)
C_5	(.046, .055, .056, .068)

Now applying the methodology described in the equation (18) and (19) the posfust reli ability of the system can be calculated as;

$$R_S = (.043, .052, .058, .064) \ldots\ldots\ldots\ldots\ldots\ldots (20)$$

Conclusion :-

This present paper has attempted to investigate the system reliability in the context of fuzzy set theory and possibility theory. We have discussed the fuzzy reliability of network i.e. series, parallel, k-out of – n, bridge and non- series parallel network. In the latter, the initial input reliability is modeled as fuzzy set on the universe of probability values. This allows us to model situations in which the single probability is supplied in place of a range of values. Expressions for the fuzzy reliabilities of series, parallel and k-out of n configuration networks have been obtained using fuzzy numbers as well as extension principle. These expressions are given in equations (4) to (8). Bridge network has also been studied. Its profust reliability expression, that is, equation (11), has been obtained using fuzzy probabilities. Bridge network has also been discussed for obtaining its profust reliability estimates. For this purpose concept of structure function, minimal path and minimal cuts have been used. The expression for posfust reliability is given in equations (19). Numerical computations for profust and posfust reliabilities have also been performed to examplify the process. Results of profust and posfust reliability estimates are given in (15) and (20) respectively.

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