

Component Reliability- A New Approach



Engineering

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ABSTRACT

Reliability of a component is finding out the probability that the component will perform under its normal operating conditions for a set period of time. The reliability of the whole of the system not only depends upon the collective reliability of all the components of the system but also how these components are arranged. Here accent is given to elaborate the serial and parallel arrangement of the component which evolve into better reliability of the components and the same the system as well.

Introduction

The reliability is the probability of the system to perform their function at the prescribed time. But if all the components of a system have 97% reliability, collectively they are producing the same effects of the reliability. That lies the crux of the problem. The reliability of system also depends upon the arrangement of their components that means if we arranged the components in such a way that the probability of failure of their components is negligible then the reliability is up to mark. In this paper accent is given to use the components so as to enhance the reliability of the system. I purpose a new approach of the algorithm of the component so as to improve the reliability of the whole system. The approach is entirely based upon the algorithm and mathematical formulation. Component of the system either perform their operation with negligible mean time of failure and the probability of repair is accurate then the effect on the reliability of the whole system i.e. collective effect of the reliability of components are reliable in nature only in the accordance with the arrangement of the components. There are several ways to arrange the components of the system. The impact of the reliability of the whole of the system is also very much depends upon the arrangement. There are typically three arrangements of components in a system. Serial-Serial combination of the components, parallel- parallel combination of the components and the Serial- Parallel combination of the components. The studies show that Serial- Parallel combination of the components in the system produces the better reliability than all the combinations of the components. My assumption is based upon the design, testing and arrangement of the components of the system. By combining both of the algorithm which is based upon the test model and the arrangement of the components in the system during the design and test phase of software life cycle, we remove the possibility of mean time of failure and enhance the mean time to repair which outcomes the reliability.

2. Reliability Estimation

Reliability estimates are subject to vagueness and this vagueness must be understood and modeled appropriately. The system reliability is often predictable based on component reliability values. When components are tested in a short time or with limited samples, the estimated component reliability involves estimation doubts. If these values are used to estimate the system reliability, the uncertainties will be propagated to the system-level and result in system reliability uncertainty. But I provide a method for the reliability certainty such that the reliability is deterministic in the component level as modularization is effected and these components collaborate together to ensure the predictability of the reliability of the software.

3. Notation¹

R reliability constraint

C cost constraint

W weight constraint

S number of subsystem

m_i number of available component choices for subsystem

$i(i=1, \dots, s)$

r_{ij} reliability of component j available for subsystem i

c_{ij} cost of component j available for subsystem i

w_{ij} weight of component j available for subsystem i

x_{ij} number of the j^{th} component used in subsystem i

$x_i(x_{i1}, x_{i2}, \dots, x_{im_i})$

t_j number of good(not failed) of j^{th} component

$t(t_1, t_2, \dots, t_{m_i})$

n_i total number of components used in subsystem $i = x_{i1} + x_{i2} + \dots + x_{im_i}$

n_{max} maximum number of components in parallel(user specified)

k_i minimum number of components in parallel required for subsystem i

$k(k_1, k_2, \dots, k_i)$

$R_i(x_i/k_i)$ reliability of subsystem i , given k_i

$C_i(x_i)$ total cost of subsystem i

4. Problem Formulation¹

Since we can assume that

- The component reliability is known as deterministic
- Failure of the individual components is independent
- All redundancy is active redundancy without repair.

Given the redundancy allocation problem for the serial parallel system, the problem is to maximize reliability (problem P1) and to minimize the cost (Problem P2) of the given constraints and K_i is specified for each subsystem. Expansion of the can be easily shown:-

$$\text{Problem P1: } \max \prod_{i=1}^s R_i(x_i/k_i)$$

$$\text{subject to } \sum_{i=1}^s C_i(x_i) \leq C$$

$$\sum_{i=1}^s W_i(x_i) \leq W$$

$$R_s(x_1, x_2, \dots, x_s | k) = \prod_{i=1}^s R_i(x_i | k_i)$$

$$= \prod_{i=1}^s \left(1 - \sum_{l=0}^{k_i-1} \sum_{\substack{t_j=l \\ j=1 \\ t_j=1}}^m \prod_{j=1}^{m_i} \binom{x_{ij}}{t_j} r_{ij}^{t_j} (1 - r_{ij})^{x_{ij}-t_j} \right)$$

4. Algorithm for improving the Component Reliability

Algorithm A

- 1) Take a problem of the single component of the system.
- 2) Analyze the problem and select an appropriate test model.
- 3) If the model is optimum generate the result
- 4) If the result meets the reliability matrix implement it.
- 5) Generate the result and if the result meets reliability matrix implement it. as shown in figure 1.



Fig.1 An Improvised Algorithm

Algorithm B

- 1) Repeat the first step definitely within a specific period of time for all the components of the system.
- 2) If the reliabilities of all the components is appr. 98%
- 3) Arrange components of the system in Serial - Parallel manner i.e. some components are arranged in serial manner and some components are in parallel.
- 4) The resultant reliability of all the components of the system i.e. whole system is high.

The two algorithms when combined together will work in individual component to maximize the reliability and similarly the cost also. When all the components reliability are checked after assembling a system it will ensure the reliability of the system at minimum cost. The Research paper further explores the problem domain to emphasize it in all practicable system.

Conclusion In this Research paper I intend to improve the component reliability since the problem formulation is elaborated to maximize the reliability and to minimize the cost of one component which thereafter combine to form a system in serial- parallel technique, but the reliability of the component is deterministic. This technique convenient for improving the reliability of the system.

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