RELIABILITY METHODS FOR SOLVING COMPLEX SYSTEMS

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Abstract

In this paper some approximation techniques were used to find the reliability of complex systems such as the Min.cut , path tracing and reduction to the system to series elements, then some comparisons have been made.

1. Introduction

several authors are interested in studying the various method to find the reliability of complex system such as path set method , matrices method , for example Govil [1983] , Srinath [1985], Abdul Ameer [1998].

2.Some Definition and Concepts

2.1 Complex System: is a collection of devices or subsystem interconnected to fulfill complex operation .

2.2 The reliability of a system : it is probability that the system will adequately performed its intended function under started environmental for a specified interval of a time.

3.Solving methods:-

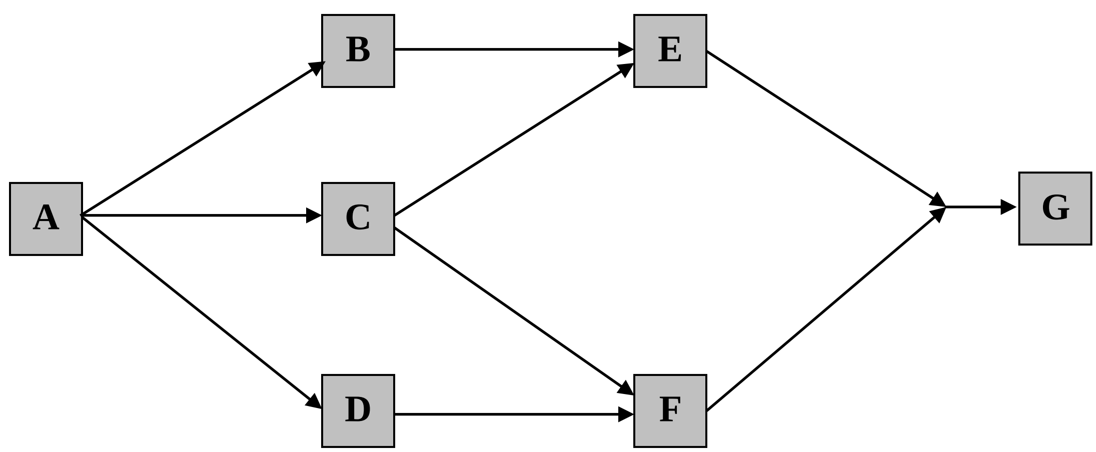

Figure 1: complex system

The system in fig (1) cannot be broken down into a group of series and parallel systems . this is primarily due to the fact that component C has two paths leading among from it . whereas B and D have only one.

Several methods exist for obtaining the reliability of a complex system including :-

3.1 path tracing – method

in this technique we identify all possible paths from the input end to the output have the following paths of a fig .(1):-

$R_{S1} = R_A . R_B . R_E . R_G$
$R_{S2} = R_A . R_C . R_E . R_G$
$R_{S3} = R_A . R_C . R_F . R_G$
$R_{S4} = R_A . R_D . R_F . R_G$

$$R_S = 1 - \prod_{i=1}^{4} (1 - R_{Si})$$

$= 1- [(1-R_{S1}) (1-R_{S2}) (1-R_{S3}) (1-R_{S4})]$

we obtain

$R_{S1} = R_A . R_B . R_E . R_G + R_A . R_E . R_B . R_G + R_A . R_E . R_C . R_G - R_A . R_C . R_B . R_D . R_G - R_A . R_C . R_E . R_D . R_G + R_A . R_E . R_B .R_C. R_G + R_A . R_B .R_C . R_D .R_E. R_G + R_A . R_F . R_D . R_G + R_A . R_F . R_E . R_G + R_A . R_F . R_C . R_G - R_A . R_F . R_B . R_D .R_G - R_A . R_F . R_C .R_D . R_G \underline{+} R_A . R_F . R_B .R_C . R_G + R_A . R_F . R_C . R_D. R_G - R_A . R_E . R_F . R_D . R_G - R_A . R_E . R_F . R_B . R_G - R_A . R_E . R_F . R_C . R_G + R_A . R_E . R_F . R_B .R_D . R_G + R_A . R_E . R_F . R_C .R_D . R_G + R_A . R_E . R_F . R_B .R_C . R_G - R_A . R_E . R_F . R_B .R_C . R_D .R_G$ …(1)

Let $R_A = R_B = \ldots = R_G = 0.9$, with independent identical unit we get

$R_S = R^4 + R^4 + R^4 – R^5 - R^5 - R^5 + R^6 + R^4 + R^4 + R^4 – R^5 - R^5 - R^5 + – R^5 - R^5 - R^5 + R^6 + R^6 + R^6 – R^7$

$= 6 R^4 – 8 R^5 + 4 R^6 - R^7$ …(2)

and we substitute (0.9) in eq.(2)

we get $R_S = 0.86$

3.2 Reduction to series element

in this method we systematically replace each parallel path by an equivalent single path and ultimately reduce the given system to one system consisting of series elements.

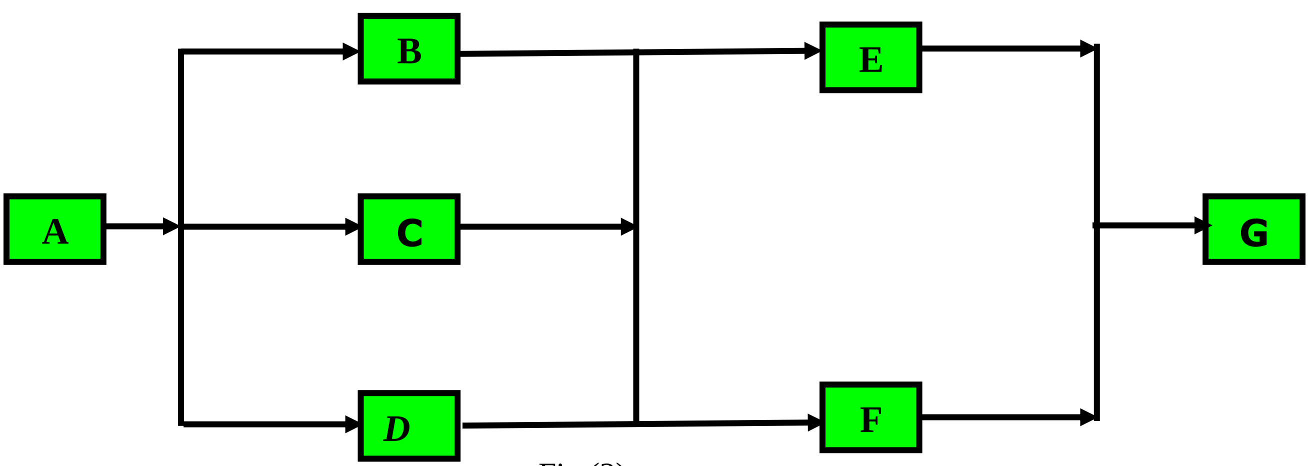

Fig (2)

We can explain the solving of this method by the following steps.

Step 1: The parallel elements E, F will be first replaced by an equivalent series element. ***Say P1***

$R_{P1} (t) = 1- [(1-R_E) (1-R_F)]$
$= R_E+R_F - R_E.R_F$ …(3)

The system has now been modified to another system is shown in fig. (3). Blew

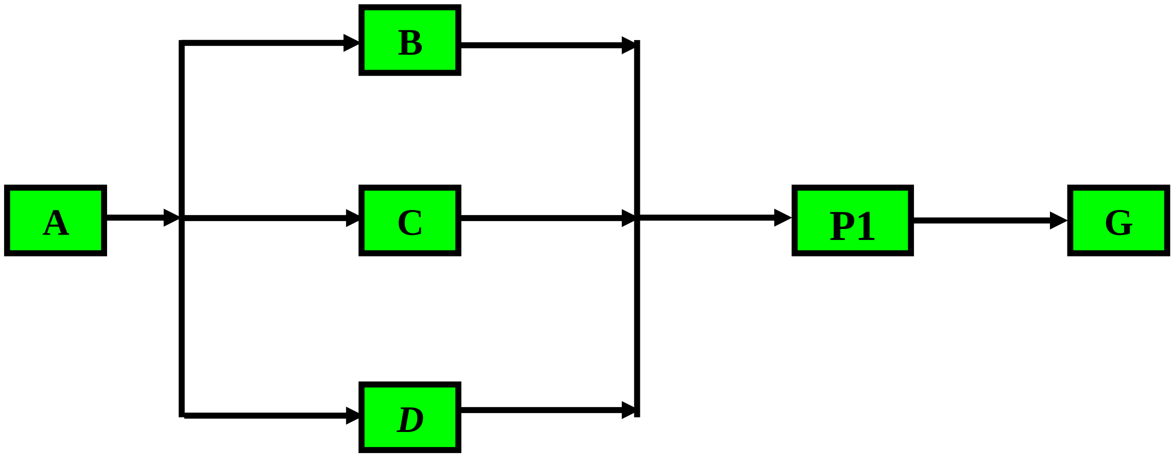

Fig.(3)

Step (2): parallel elements B, C, D can be replaced by an equivalent element whose reliability is obtained from the rule that. **Say P2**

$$R_{P2}(t) = 1 - [(1-R_B)(1-R_C)(1-R_D)]$$
$$= R_D + R_B + R_C - R_B.R_D - R_C.R_D - R_B.R_C + R_B.R_C.R_D \qquad \ldots(4)$$

Step 3: The system has now been reduced to a system contains series elements as:

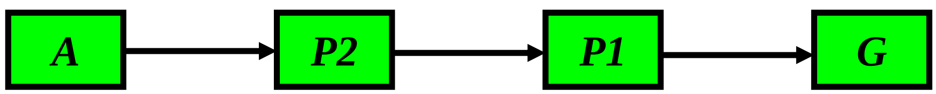

Fig. (4)

The system reliability of Fig. (4) is

$$R_S = R_A.R_B.R_E.R_G + R_A.R_C.R_E.R_G + R_A.R_D.R_F.R_G$$
$$+ R_A.R_C.R_F.R_G - R_A.R_C.R_D.R_F.R_G - R_A.R_C.R_E.R_F.R_G$$
$$- R_A.R_B.R_D.R_E.R_F.R_G - R_A.R_B.R_C.R_D.R_E.R_G$$
$$+ R_A.R_B.R_C.R_D.R_E.R_F.R_G \qquad \ldots(5)$$

If we take $R_A = R_B = \ldots = R_G = 0.9$, with independent identical units we get

$$R_S(t) = R^4 + R^4 + R^4 + R^4 - R^5 - R^5 - R^6 - R^6 + R^7$$
$$= 4R^4 - 2R^5 - 2R^6 + R^7 \qquad \ldots(6)$$
$$= 0.85$$

3.3 Minimal Cut Method

3.3.1 A cut is : a set of component such that when the component in the cut is removed from the system, i.e. there is no path from one terminal to other,. When we apply this method to fig. (1), we get.

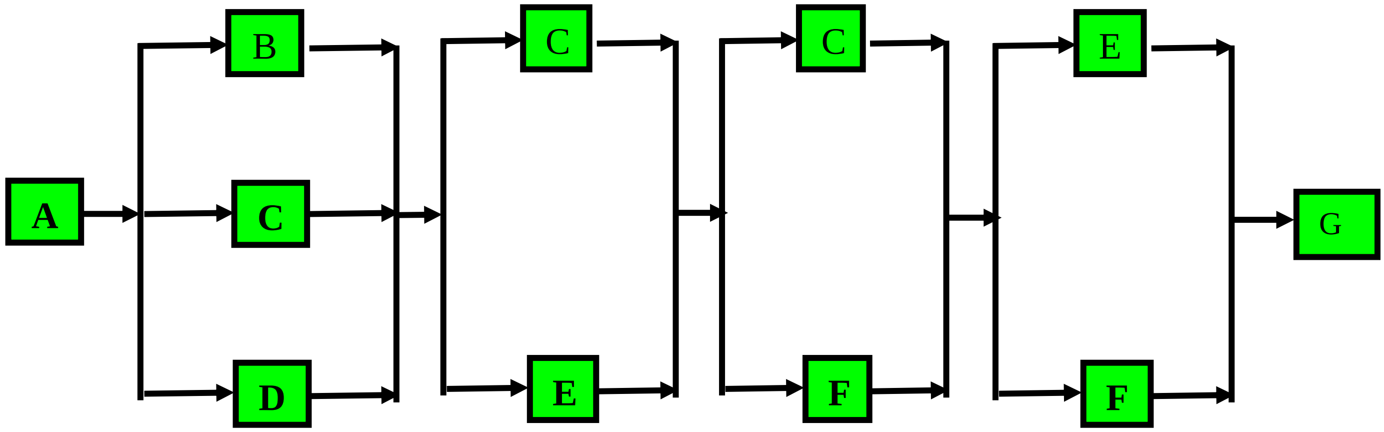

Fig. (2.11)

$R_{P1}(t) = 1- [(1-R_B)(1-R_C)(1-R_D)]$

$R_{P2}(t) = 1- [(1-R_C)(1-R_E)]$

$R_{P3}(t) = 1- [(1-R_C)(1-R_F)]$

$R_{P4}(t) = 1- [(1-R_E)(1-R_F)]$

$$R_S(t) = R_A.R_C.R_E.R_G + R_A.R_C.R_F.R_G - R_A.R_C.R_E.R_F.R_G + R_A.R_B.R_E.R_F.R_G - R_A.R_B.R_C.R_E.R_F.R_G + R_A.R_D.R_E.R_F.R_G - R_A.R_D.R_C.R_E.R_F.R_G - R_A.R_B.R_D.R_E.R_F.R_G + R_A.R_B.R_C.R_D.R_E.R_F.R_G \quad \ldots(7)$$

If we take $R_A=R_B=\ldots=R_G=0.9$, with independent identical units we get

$$R_S(t) = 2R^4 + R^5 - 3R^6 + R^7 \quad \ldots(8)$$
$$= 0.78$$

4.Conclusion

in this work , we study three –method to find the reliability of complex system , path tracing method , reduction to series element method and the minimal cut method.

We concluded

1- the system reliability in the first method as in iq.(2) is largest than the reliability of the second and third method as an eq.(6) and (8) respectively .
2- the system reliability is bounded between the upper as in eq.(2) and lower bound as in eq.(8).
3- The system reliability depending on the connected method the element of the system.

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