Reliability Evaluation Using Triangular Intuitionistic Fuzzy Numbers
Arithmetic Operations for Astra Missile System

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Abstract: Achieve a high level of reliability is extremely important in military applications. Part of military grade data is expensive than its commercial parts. This large price difference is mainly due to differences in the quality, manufacture and design of parts used in commercial products for military report. In general, the fuzzy sets are used to determine the reliability of the fuzzy system established under the condition that the failure data not available. By considering the triangular intuitionistic fuzzy number the reliability of each part of a system is determined. Digital and fuzzy arithmetic operations triangular intuitionistic are introduced. Expressions for determining the fuzzy reliability of a following series of triangular fuzzy numbers intuitionistic system have been described. ASTRA missile system is taken as a case study and using the MATLAB programming, the reliability of the missile system is determined. The calculation of failure / MTBF rate calculations are performed using the software package reliability Relex Studio 2008.

Keywords: Intuitionistic fuzzy number, Fuzzy set, Triangular intuitionistic fuzzy number, OBC command generator, System reliability.

I. INTRODUCTION

It is known that conventional reliability analysis using probability was considered insufficient to handle data uncertainty of default and modeling. To overcome the problem, the fuzzy concept approach [1] was used in determining the reliability of any system. In [2] Kaufmann says the discipline of reliability engineering includes a different activities, including the modeling of reliability is important activity. For a long time efforts were made in the design and development large scale systems. At present much work has been done by the researchers to make a systematic theory of reliability based on probability theory.

There are two fundamental assumptions of the theory of classical reliability, namely

(a) binary assumptions of the state: the system is precisely defined as operation or fault.

(b) probability of assumptions: the behavior of the fuzzy system is characterized as part of the probability measures.

Today Missile launching is main battle weapon of such a plan type battle, defects in any part of it can reduce system capacity and even put in a bad accident. It is therefore very important that the ability of battle of combat aircraft to ensure reliability, safety and the validity of Missile Launcher effectively. Recently, using and generalizing fault diagnosis prediction, cost of use and maintenance of several complicated devices is reduced and the reliability, safety of maintenance is improved. Because defects front sensing and diagnostic capacity actual high capacity in a timely manner, failure prediction technology becomes a hot research directions.

II. RELIABILITY BLOCK DIAGRAMS.

There are mainly four types of Reliability Block Diagrams are presented on their configuration those are, viz., series, parallel, series-parallel and non-series-parallel Configuration [3,4].

Series Networks: This arrangement represents a system where subsystem/components form a series network. If any of component fails, the series system gives an overall system failure. The diagram is shown in Fig. 1.

![Fig. 1 Schematic Diagram of Series System](image)

The fuzzy reliability $R_s = n_1 \bigotimes R_1$ can be determined by using the proposed algorithm.

$R_s = \{(r_{11}, r_{12}, r_{13}) \bigotimes (r_{21}, r_{22}, r_{23}) \bigotimes (r_{31}, r_{32}, r_{33})\}$

It can be approximated to a TIFN as

$$R_s = \left( \prod_{j=1}^{n} \left( \prod_{i=1}^{n_j} r_{ij} \right) \right)^{-1}$$

where,

$R_{ij} = (r_{1j}, r_{2j}, r_{3j})$ is the intuitionistic fuzzy reliability of the $j$-th component for $j = 1, 2, 3, 4 \ldots n$. The intuitionistic fuzzy reliability $R_s$ of the series shown below can be determined by using the expression as follows:

$R_s = R_1 \bigotimes R_2 \bigotimes \ldots \bigotimes R_n$

Parallel Networks: The fuzzy reliability $R_p = 1 \bigodot n_1 \bigotimes (1 \bigotimes R_1)$ of the parallel system shown in figure can be determined by using the proposed algorithm. The block diagram is shown in Fig. 2.

$R_p = 1 \bigotimes \{ (1 \bigotimes (r_{11}, r_{12}, r_{13})) \bigotimes \ldots \ldots \ldots (1 \bigotimes (r_{n1}, r_{n2}, r_{n3})) \}$
It can be approximated to a TIFN as

\[ R_1 = \bigoplus_{j=1}^{n} \left( 1 - r_{j1} \right) \cdot \bigoplus_{j=1}^{n} \left( 1 - r_{j2} \right) \cdot \bigoplus_{j=1}^{n} \left( 1 - r_{j3} \right) \]

where,

\[ R_j = (r_{j1}, r_{j2}, r_{j3}) \text{ is the intuitionistic fuzzy reliability of the } j^{th} \text{ component for } j = 1, 2, 3, 4 \ldots \]

\[ R_7 \] represents reliability of crystal oscillator not failure in OBC command generator connecting parallel

\[ R_8 \] represents reliability of desired event in OBC command generator

All imprecise components reliability \( R_j \) are represented by TIFN \((r_{j1}, r_{j2}, r_{j3})\) for \( j = 1, 2, \ldots, 5 \)

Calculate the reliability of occurrence of the desired event (OBC generating command).

The reliability value, for occurrence of event \( R_6 \):

\[ R_6 = R_1 \otimes R_2 = (r_{11} r_{21}, r_{12} r_{22}, r_{13} r_{23}) \]

It is an approximated TIFN.

Similarly, the reliability value, for occurrence of event \( R_7 \):

\[ R_7 = 1 \bigoplus \left( 1 \bigoplus R_4 \right) \left( 1 - R_5 \right) \]

It is approximated to TIFN as follows:

\[ R_7 = \left[ 1 - \bigoplus_{j=4}^{5} (1 - r_{j1}) \right] \cdot \bigoplus_{j=4}^{5} (1 - r_{j2}) \cdot \bigoplus_{j=4}^{5} (1 - r_{j3}) \]

By substituting above two values and the given data value, the reliability value for occurrence of the top event, OBC generating command, \( R_8 \):\n
\[ R_8 = R_1 \otimes R_2 \otimes R_3 \otimes \left( 1 \bigoplus \left( 1 \bigoplus R_4 \right) \left( 1 - R_5 \right) \right) \]

It is approximated to a TIFN as follows:

\[ R_8 = \left[ r_{11} r_{21} r_{31} (1 - R_7) \right] \cdot \bigoplus_{j=4}^{5} \left[ (1 - r_{j1}) \right] \cdot \bigoplus_{j=4}^{5} \left[ (1 - r_{j2}) \right] \cdot \bigoplus_{j=4}^{5} \left[ (1 - r_{j3}) \right] \]

Reliability of events are

\[ R_1 = (0.9987, 0.999, 0.9995), \]
\[ R_2 = (0.999, 0.9993, 0.9998), \]
\[ R_3 = (0.9, 0.938, 0.97), \]
\[ R_4 = (0.78, 0.9, 0.95), \]
\[ R_5 = (0.997, 0.998, 0.999), \]
\[ R_6 = (0.999, 0.999, 0.9995), \]
\[ R_7 = (0.999, 0.9993, 0.9998), \]
\[ R_8 = (0.9, 0.938, 0.97), \]
\[ R_9 = (0.78, 0.9, 0.95), \]
\[ R_5 = (0.69, 0.75, 0.85). \]

So results of \( R_6, R_7 \) are as follows

\[ R_6 = (0.9977013, 0.9983007, 0.9993001), \]
\[ R_7 = (0.9318, 0.975, 0.9925). \]

By substituting above two values and the given data value \( R_3 \) the reliability value for occurrence of the top event, OBC command generator, \( R_8 \) is

\[ R_8 = (0.8366922642, 0.9129959051, 0.9620511887). \]

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IV. PERFORMANCE ANALYSIS

System reliability graph of OBC for the membership function with system reliability as shown in Fig. 4.

Fig. 3 Success Tree for the Top or Desired Event

By substituting above two values and the given data value \( R_3 \) the reliability value for occurrence of the top event, OBC command generator, \( R_8 \) is

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V. CONCLUSION

In this article, reliability of an onboard computer, its terms and formulas, and how to predict reliability and demonstrate through testing and field data is presented. From this data field reliability of an onboard computer must be improved.

<table>
<thead>
<tr>
<th>RELIABILITY OF MISSILE SYSTEM</th>
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<tr>
<td>By Using Exponential Distribution</td>
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<tr>
<td>Reliability of system=0.999997895</td>
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</table>
(a) Reliability of an on-board computer is also calculated using exponential distribution.

(b) Reliability of an onboard computer graphics is observed using fuzzy numbers intuitionistic arithmetic operations.

In fuzzy logic nano components are considered to determine the reliability of the OBC, but in exponential distribution nano components are not considered. Therefore, fuzzy logic is used to determine the reliability of nano- where established data not available failure.

REFERENCES:


