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Research and Computer Realization of Fault Tree Quantitative Calculation Algorithm

Zhou Xian Lai

GuangzhouNanyangPolytechnicCollege,Guangzhou,510925,277980379@qq.com

Abstract: Through the research and understanding of FTA, analysis of its role in reliability engineering and its working principle, for the application of FTA method in the computer to make a reasonable demonstration. From the overview of FTA and the research status at home and abroad, the working principle of reliability engineering and the importance of an important branch -- FTA are analyzed. From the qualitative analysis and quantitative calculation algorithm of FTA, and its quantitative calculation module, FTA is studied separately. Hope to be able to provide help for this professional researchers.

Keywords: FTA, reliability engineering, quantitative calculation, quantitative calculation module

1.Introduction

The rapid development of computer technology provides more convenience for people's life. For example, the important method of quantitative calculation of fault tree is to use computer for auxiliary calculation. Unfortunately, the current fault tree qualitative analysis and quantitative calculation algorithm is not widely used, but only limited to the fault tree of monotonic correlation system. Only by continuously testing various failure causes, can we further determine all possible combinations and their probability of occurrence.

2.Research and application status at home and abroad

The application research of fault tree is mainly reflected in the following aspects: the integration of fault analysis methods, computer-aided fault tree analysis, fuzzy fault tree analysis method. Compared with foreign countries, China started late. During the period of reform and opening up, China introduced FTA technology for the first time. In foreign countries, this technology has been developed for decades, coupled with the external blockade, China's FTA technology in the same period is relatively backward. It was not until 1989 that there was a new research result, that is, a method of using matrix to study fault tree. After decades of development, we have a relatively perfect situation today. The research progress of FTA has driven the development of more fields. It has gradually expanded from cutting-edge fields to various fields. Thanks to the efforts and popularization of generations of researchers, it has made drastic changes in terms of cost and operation difficulty, So that more fields can apply it to such individual objects as computers, of course, this also opens up a new research direction for FTA.

3.Overview of reliability engineering

Reliability is a measure of the ability of a product to work without failure. Generally speaking, reliability refers to the ability of the product to complete the specified functions under the specified working conditions and within the specified time. The four quality characteristics of products are: product performance, reliability, safety and economy. As one of them, reliability is undoubtedly important, so the research on product reliability has important theoretical significance and practical value. The reliability discipline has experienced decades of development and improvement since it was proposed. The fundamental reason for the formation of this discipline is that the traditional quality analysis

methods can not solve and deal with the failure problems in practice.[1]

In view of the failure or unreliability of some products, many researchers aim to solve the failure probability of products from human factors, product itself, design defects and the impact of the environment, which is the ultimate idea to reach the lowest. These are the narrow sense of reliability engineering, reliability engineering is not only from the program and software to deal with the failure rate of products. According to the failure rate of products, after a series of system analysis, as the main sub module of fault tree plays an indispensable role, can save a lot of manpower and material resources, also improve the efficiency of reliability engineering.

In order to analyze its reliability, we must first determine the reliability model of the system, and then analyze and determine the reliability characteristic quantity of the system according to the topological structure of the system and the reliability quality and status of the constituent units in the system. Secondly, system reliability prediction, reliability index allocation and reliability optimization are all based on system reliability analysis, so it is the core and foundation of system reliability research.[2] Reliability engineering directly determines the satisfaction of the product, is an indispensable part of the test, so it is also very important.

4.Fault tree analysis

Its function is to complete a logical reasoning with preconditions. To put it simply, FTA is to conduct an internal system analysis of various external and internal factors (covering four factors of hardware, software, environment and human factors) that are easy to cause system failure or failure, from the overall analysis to the idea of dividing each part into parts, The processing method is named after the dendriform structure of the photo, which adopts the progressive way. In summary, the logic block diagram formed by the above is called fault tree.

After the completion of the above analysis, after the investigation, to determine the various combinations and occurrence probability of the causes of system failure (failure), the analysts need to control the system according to the obtained data, or the system should still take corresponding measures according to the results, so that theoretically there will be no failure and no failure. In fact, it is an analysis method to reduce the failure probability.

The characteristic of fault tree analysis is that it has great flexibility and will not be too rigid. The analysis and algorithm of fault tree can deal with the problem of product failure. It is a promising research direction that this method can be applied to more fields, It is worthy of the relevant scientific researchers to spend a lot of time to practice the theoretical knowledge and promote it, so as to provide more convenience for more fields. Later, this paper represents the feasibility of this idea through the quantitative calculation algorithm module of fault tree, which is not limited to the general analysis of system reliability, but also can analyze various fault states of the system; It can not only analyze the impact of some parts failure on the system, but also analyze the special causes of these parts failure: the process of FTA analysis is the process of in-depth understanding of the system. It requires analysts to grasp the internal relationship of the system, be able to clearly know the way and degree of the impact of various potential factors on product satisfaction (failure), and require analysts to have the ability of self judgment for the collation and analysis of data, so as to find and solve problems in time in the later analysis process, So as to greatly improve the reliability and credibility of the system, so as to enhance the customer experience of the product.

5.Calculation module design

In fault tree analysis, the key to build a fault tree is to clearly understand the logical relationship of the analyzed system function and fault mode, impact and criticality. The perfection of the fault tree directly affects the correctness of the qualitative analysis and quantitative calculation results. The fault should be the correct abstraction of the logical relationship of the actual system fault combination and transmission. The whole building process is the analysis and thinking process of engineering and technical personnel to the system.

The function of the quantitative calculation module is to complete the quantitative calculation of the reliability characteristics of the fault tree. For the basic fault tree, the structure function can be used for certain calculation, and certain qualitative analysis results can be obtained through the mathematical expression.

The calculation of the unreliability and importance of the associated system is also a very important calculation process. Only after these processes are calculated can the parameters of the fault tree be better judged. In addition, the calculation of the parameters of the repairable system can calculate the unavailability, and then there is the system fault tree analysis method with statistical dependent events. There will be many complex parameters in the calculation steps, We must pay attention to the correlation of these parameters.

Finally, the management of calculation results mainly includes two aspects, one is the management of intermediate calculation results, the other is the output of final results.

This paper introduces the following categories:

(1) Main functions of event class cbeventdata:

long GetIndex （）；

double GetUnreliability（）；

CBeventData*GetNextEvent （）；

void Setlndex(long Eventlndex)；

void SetUnreliability(double EventUnreliabiity)；

void SetNextEvent(CBeventData*pEvent)；

Main data:

double BeventUnreliability；

long BeventIndex；

CBeventData*NextEvent；

(2) The main functions of ccaldatallaader are as follows:

CBeventData*GetMCSEvent()；

CCalDataHeader*GetNextMCS （）；

void SetMCSEvent(CBeventData*pEvent)；

void SetNextMCS(cCalD8taHeader*pMCS)；

Main data:

CBeventData*MCSEvent；

CCalDataHeader*NextMCS；

(3) Cut set class: ccalculationdata main functions:

CCalDataHeader*GetHeader（）；

CCalDataHeader*CreateHeader （）；

Main data:

CCalDataHeader Header；

int IACSNumber；

(4) Main functions of Ccalculation class:

double Unrellability(CCalculationData*CalData)；

double ProbImportance(int BeventIndex，CCalculationData*calData)；

double Strulmportance(int geventlndex，CCalculationData*CalData)；

double CruxImportance(int BeventIndex，CCalculationData*CalData)；

double Ws(CCalculationData*CalData)；

double Vs(CCalculatLonl)ata*alData)；

double MTBF(CCalculationData*CalData)；

(5) According to the ccalculationresult class, the main functions are as follows:

void SetBeventProb(int BeventIndex，double Prob)；

void SetBeventStru(int Beventlndex，double Prob)；

void SetBeventCrux(int BeventIndex．double Prob)；

void SetRUnreliability(double Unreliability)；
void SetRWs(double RWs)；
void SetRVs(double RVs)；
void SetlwTBF(double MTBF)；
double GetBeventProb(int BeventIndex)；
Itoubl e GetBeventStru(int BeventIndex)；
double GetBeventCrux(int geventIndex)；
touble GetRUnreliability（）；
d(mbl．e GetRWs()；
double GetRVs()；
double GetRMTBF（）；

Cbeventdata class is mainly responsible for storing and providing the basic data of the bottom event, which can be called by Ccalculation. Ccaldata header class organizes the bottom event objects in the form of disjoint cut sets, and each ccaldata header object corresponds to a disjoint cut set. Ccalleulationdata class is mainly responsible for the organization of ccaldata header object, which is the total connection F 1 of data. The ccmulation class obtains data from ccalculationdata object for calculation, and the calculation result is handed over to ccalculationresult class for processing. Ccalculationresult class is the external output interface of the module.

6.Implementation theory and analysis of quantitative calculation module

The quantitative calculation module adopts the software development technology based on COM and encapsulates the calculation function in the form of DLL file, which increases the universality of the module. The quantitative calculation function is realized by the member function of Ccalculation. On the one hand, whether the quantitative calculation result of fault tree is accurate or not depends on whether the drawn fault tree can fully and accurately reflect the causes of system faults and the relationship between them, which requires the operators who draw fault tree to have a deep understanding of the system. The more we understand the system, the more the fault tree can reflect the nature of the system fault; On the other hand, because the quantitative calculation of fault tree is complicated, it usually needs computer-aided calculation.[3] The quality and accuracy of computer-aided algorithm also affect the accuracy of calculation results to a certain extent.

7. Conclusions

For the calculation of fault tree, it is a very complex project, which requires a certain engineering precision index. In each case of large error, we must check all possible factors in time. Due to the short space of this paper, only a few of them are listed, such as the error between the calculation formula used in the module and the accurate calculation formula, When the computer stores data, it uses binary system, which can’t accurately represent all decimal system, resulting in storage truncation error. Under the interference of some unrelated factors, computer-aided still needs to be very careful. Moreover, there are still many problems to be solved in the fault tree analysis, which can only be studied continuously, In order to provide some help for the related research.

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