

prof. Andriy Kovalenko, Department of Electronic Computers,
Kharkiv National University of Radio Electronics,
Nauky Ave. 14, Kharkiv, 61166, Ukraine

1 The relevance of the chosen thesis topic

This habilitation thesis addresses two main areas of research in the field of reliability analysis: the use of the structure function and logic differential calculus in reliability analysis, and the use of logic differential calculus for survival signature. The structure function is one of the more traditional forms of mathematical description of a system's behaviour; however, it can be examined using various relatively new approaches, such as logic and differential calculus. The use of the structure function may also be of interest in relatively new practical fields that require reliability analysis, such as the reliability of drones, AI systems, or various complex systems. In the field of reliability analysis, the topic of survival signature is relatively new, and there are several directions that are pushing this description of the system forward. Whether it is the direction of multi-state systems, Monte Carlo simulations, or uncertain data, the survival signature represents an opportunity for scientific development in the field of reliability analysis. One possible area is the application of logic differential calculus to the survival signature and the possibility of calculating relevant metrics using logic differential calculus. Therefore, it can be concluded that the topic of this habilitation thesis is relevant.

2 Evaluation of the habilitation thesis

The author has decided to present a version of the habilitation thesis that includes a collection of published scientific papers. This collection is supplemented by relevant commentary from the author, who is seeking the academic and pedagogical title of associate professor. The thesis consists of the following sections: Introduction, Chapters 1–7, which deal with specific articles, Conclusion, Resume, and Bibliography. In total, the thesis, from the introduction to the conclusion, is 113 pages long, and the resume in Slovak is 17 pages long. The bibliography is listed at the end of the thesis and contains a total of 19 sources.

The introduction of this thesis is focused on presenting the thesis and its logical division into two parts: the application of the structure function and logic differential calculus in reliability analysis, and the application of logic differential calculus to the survival signature in reliability analysis. Three articles are selected for the first part and four articles for the second part. The introduction also includes the theoretical background necessary for understanding the subsequent chapters. The author describes here concepts such as the structure function, logic differential calculus, survival signature, and importance measures.

In the first chapter, the author provides a commentary on an article that introduces a new algorithm for calculating the system state frequency for a system described by a structure function represented by a binary decision diagram. The algorithm is the main contribution here, and the commentary is just slightly more than one page long.

In the second chapter, the author comments on an article that focuses on the use of the structure function in the analysis of a drone fleet. The main contribution is to demonstrate the potential for using the structure function in the reliability analysis of a drone fleet; the commentary is one and a half pages long.

In the third chapter, the author comments on an article that presents a time-dependent analysis of a disk array. This analysis uses logic differential calculus to compute the time-dependent Birnbaum's importance and, subsequently, the criticality importance. This is the main contribution, and the commentary has two pages.

In the fourth chapter, the author begins to address the second part, selecting an article containing definitions of new directional logic derivatives for the survival signature. In total, three new directional logic derivatives are introduced, which is the main contribution here. The commentary is approximately two and a quarter pages long.

Chapter five contains a commentary on an article that presents algorithms for calculating newly defined directional logic derivatives on a computer. The commentary is four and a half pages long, with the main contribution being the algorithms themselves.

The sixth chapter features a commentary on an article describing three new structural importance measures, along with an algorithm for their calculation. The contribution lies in the definition of the new structure importance and the

corresponding algorithms, with the commentary here being a little over two and a half pages long.

Chapter seven, which is the final chapter containing a commentary on an article, discusses the use of survival signature, new directional logic derivatives, and structure importances in the reliability analysis of a disk array. The author points out the connection to the article discussed in Chapter 3, with the main contribution being the demonstration of the use of new directional logic derivatives and structure importances in a specific topological analysis. Here, the commentary is a little over one page long.

In the conclusion, the author provides a summary of the individual parts of the thesis and suggests possible areas for further research for each part.

The paper is generally written well, although it is evident that the author experienced some time constraints while writing it (examples include “research process” → “research progress” in the introduction, the swap of the second paper and third paper in the introduction, and “basic properties” → “basic measures” in the second chapter). The selection of papers for the second part is fitting, but the selection of papers in the first part does not make a very good impression. This mainly concerns the papers in the first and second chapters, where, although the author provides an acceptable rationale for their selection, it might be more appropriate to link the papers from the first part more closely, following the example of the second part. One possibility would be to select articles dealing with logic differential calculus for structure function.

Despite all the shortcomings mentioned above, it can be concluded that the author has produced a comprehensive work that demonstrates his contribution to the field of reliability analysis.

3 Evaluation of other scientific outputs

In the field of education, the author teaches courses focused on operating systems, C programming, and database systems. He has also supervised several theses covering a wide range of topics.

In terms of scientific output, the author lists 42 publications registered in the university library, 23 of which are indexed in the WoS database. Regarding citations, the author lists 105 citations in the Scopus database (h-index 6), excluding self-citations and 55 citations in the WoS database (h-index 5). The author has also been involved in 11 scientific projects of various types.

Questions:

- Since the thesis mentions binary decision diagrams and survival signatures as approaches for more efficient work with structural functions, how would the author compare them?
- Did the author consider proposing an algorithm for calculating the second directional logic derivative that would use the already calculated first directional logic derivative?

Overall evaluation

As a result of the evaluation, I recommend the submitted habilitation thesis of Ing. Patrik Rusnák, PhD., for defence, and I propose the conferral of the title of associate professor.

Official opponent

Doctor of Technical Sciences, Professor
Head of the Department of Electronic Computers
Kharkiv National University of Radio Electronics

Andriy KOVALENKO

I CERTIFY THE SIGNATURE

Vice-Rector for Scientific Work
Kharkiv National University of Radio Electronics
Doctor of Technical Sciences, Professor

Yuri ROMANENKOV

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