Ph.D. Thesis Reviewer's Report

Thesis title:	ON PARALLEL PROCESSING IN FORMAL MODELS: JUMPING AUTOMATA AND NORMAL FORMS
Candidate:	Ing. RADIM KOCMAN DEPARTMENT OF INFORMATION SYSTEMS FACULTY OF INFORMATION TECHNOLOGY, BRNO UNIVERSITY OF TECHNOLOGY
Reviewer:	doc. Ing. Jan Janoušek, Ph.D. Department of Theoretical Computer Science, Faculty of Information Technology, Czech Technical University in Prague

Description of the thesis

The thesis in question describes new original results in the theory of formal languages, automata and grammars. It is a very well and carefully written thesis, with only a few minor inaccuracies in the text of the thesis. The thesis is focused on new research areas aimed on parallel processing in formal models. The major value of this work is its endeavour to incorporate modern approaches from computer science, such as parallel processing and discontinuous information processing, to traditional formal models so that they can more adequately capture the behaviour of modern computation methods. The thesis deals with finite automata whose transition functions define non–standard jumping transitions. The ideas, definitions of new kinds of jumping automata and their properties are presented clearly and comprehensively.

Moreover, new proof techniques are developed in this work, such as the debt lemma, and they can be also used more generally to reason about the accepting powers of finite automata that process their inputs semi–continuously.

The whole thesis indicates me that the candidate has a deep knowledge of the field of jumping automata. Definitions and basic properties of the automata and of the languages the automata accept are presented, with all the theorems thoroughly and correctly proved.

Structure of the thesis

The thesis consists of three main parts and eight chapters.

Introduction provides a sufficient description of the thesis aim and sets it in a comprehensive context. The reader gains a good understanding of the goals and purpose of the research undertaking.

The terminology, notation, and basic facts are presented in Chapter 2.

The definition of a new parallel jumping finite automaton, with multiple reading heads that work synchronously, and their properties are provided in Chapter 3.

Chapter 4 deals with double–jumping finite automata, which represents another extension of basic jumping automata.

Chapter 5 presents the jumping extension of Watson-Crick automaton. The corresponding properties are again thoroughly presented.

Chapter 6 introduces new normal forms of grammars focused on parallel processing properties.

Some application perspectives are discussed in Chapter 7.

Chapter 8 presents conclusions. It summarises the thesis well, and draws reasonable conclusions from the results.

Drawbacks of the thesis

The currently presented results are interesting, however, they are mainly beneficial only for the follow-up research studies:

- The thesis is focused on the underlying mathematical theory in many details, but possible real-life application perspectives are only briefly hinted in Chapter 7.
- The thesis does not discuss how to implement the presented models of jumping automata in efficient ways on sequential (RAM) and/or parallel (PRAM) models of RAM computations or by commonly used programming languages.
- There is a lack of discussion on deterministic or other properties of the presented automata, which could have impacts for time efficient sequential and parallel runs of the automata.

Points to be discussed at the defense

- Are there any detailed ideas for which application areas the automata presented in the thesis could serve as a suitable model of computation?
- Are there any ideas how effective implementations of the automata presented in the thesis could be created?
- The thesis deals with automata and grammars. Are there any ideas how equivalent expressions could be defined?

Conclusion and Overall Recommendation

The contributions of the thesis are of the required originality, quality, and quantity for a Ph.D. research. Therefore, I recommend for the thesis to be successfully defended.

In Prague, on the 23rd April 2021