EVALUATION REPORT

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Regarding: the PhD thesis of Mr. **Mikhail Levchenko** on the topic: "*Analysis and compression of dynamic speckle*" to obtain an educational and scientific degree "doctor" in Professional field. 4.1 Physical Sciences, Doctoral program: "Physics of wave processes"

1. General comments

In his PhD thesis, Mikhail Levchenko presents a system of investigations in the field of dynamic speckle. The study of this phenomenon constitutes a multidisciplinary area and requires a sound background, which Levchenko obviously has. The PhD thesis subject is contemporary due to the challenges related to the non-uniform laser illumination of the tested object, low image contrast, the impact of environmental noise, and computational complexity, such as time and memory consumption.

The objective of the thesis (introduced on p. 7) is to contribute to solving some critical issues in dynamic speckle imaging (DSI). The tasks of the study are well-defined. The thesis contains scientific and scientifically applied results representing an original contribution to optical metrology with applications in non-destructive testing. The thesis's general contribution is proposing new solutions for advanced data processing and storage obtained in dynamic speckle analysis. A significant contribution is expanding the application field of this method by using it in out-of-laboratory conditions which is the strength of this PhD thesis.

The presented PhD thesis is well-written and comprehensive, including a thorough literature review In my opinion, the outcome of the whole effort is positive, and it demonstrates that the PhD candidate has reached a good scientific level and maturity in his PhD program.

2. Detailed Comments

The PhD thesis contains 142 pages, 4 chapters, 134 figures, and 1 table. Specific comments are provided for each chapter·

Chapter 1 (pages 8 - 31)

The theoretical backgrounds of the speckle and the dynamic speckle method are provided. The main DSI algorithms are described. The wide range of dynamic speckle applications is briefly described. Thus, all introductory material needed for this PhD thesis, with the associated references, is provided.

Chapter 2 (pages 32 - 69)

This chapter is divided into four main sections. Each author's paper from A1 to A5 reveals the fundamental ideas in these sections. The first section investigates existing and newly proposed algorithms for processing dynamic speckle images. The feasibility of the algorithms is proved both by simulation and experiment. Overall, the efficiency and accuracy of the implemented

algorithms are demonstrated. The second section describes a temporal resolution improvement in dynamic speckle analysis. Again, a set of simulations and physical experiments to study the influence of the temporal resolution on the quality of activity maps are conducted. The third section studies the efficiency of the dynamic speckle method for analyzing variable-rate dynamic events. The proposed algorithm is applied to simulated and experimental data. Finally, the fourth section analyzes the efficiency of the dynamic speckle method in the presence of environmental noise.

Chapter 3 (pages 70 - 101)

This chapter studies the compression of speckle images. Three methods for image compression in dynamic speckle analysis are proposed. JPEG/JPEG2000, SVD, and PCA compression. New algorithms for speckle data compression are developed. Their efficiency is confirmed by simulation and experiment. Their influence on the quality of calculated activity maps is studied. The results presented in this chapter are novel and noteworthy

Chapter 4 (pages 102 - 130)

The PhD thesis demonstrated that the dynamic speckle method can be successfully applied in different areas. The applications of the method in non-destructive testing are shown in Chapter 4. Three experiments have been conducted. the creation of a novel miniature portable device, based on a low-cost laser attached to a smartphone; the implementation of dynamic speckle imaging with a high-speed camera in dynamic test; and the use of dynamic speckle for hidden defect detection in static test. The outcomes successfully showed that by dynamic speckle imaging some solutions related to non-destructive testing can be found.

3. Overall Evaluation

Summarizing all the above, the following remarks are stated.

- The PhD thesis is well-written and clearly structured. The objective, the planning, the methodology, and the results are all described in a detailed and comprehensive manner All tasks of the thesis have been fulfilled successfully I have no critical remarks about the materials presented.
- The DSI algorithms are well implemented and have original advancements, while the thesis results are novel and interesting, with scientific impact and practical relevance.
- The author's contribution is evident throughout the PhD thesis. Some sections of this thesis, with Mikhail Levchenko as the first author, have been published in refereed journals and presented at international conferences. Three of the publications have five citations.
- The synopsis has been prepared according to the requirements. Its content corresponds to the content of the thesis, adequately reflecting the main results obtained. Single typos are observed, which generally do not impede the understanding of the material.

4. Conclusion with a clear opinion on whether or not to confer the academic degree. Grading of the dissertation according to the requirements of the TU Berlin.

Considering the above comments, per the requirements of the TU Berlin for this procedure, I give the PhD thesis a "very good" grade. In conclusion, I fully support and strongly recommend that the Scientific Jury confer to Mikhail Levchenko the educational and scientific degree “Doctor” in Professional field: 4.1. Physical sciences, Doctoral program “Physics of wave processes.”

25/02/2025 Prepared the Evaluation Report:

Sofia /D. Pashkouleva/