

Report for the thesis of RNDr. Matej Lebl “New Methods for Recognizing Blurred Images”

Overview: The main topics of the thesis are blur invariants and blur invariant measures. The thesis consists of six papers published in a range of venues (e.g., journals and conference proceedings). These papers expand our knowledge and understanding of blur invariants and describe new approaches for image classification that are based on blur invariants.

Which of the contained results can be referred to as a new scientific result?

- Although blur invariants were previously studied, the thesis develops a unified theoretical framework for blur invariants, with all previously considered blur invariants as special cases. Not only were new blur invariants proposed, but also new theory for constructing blur invariants with no prior knowledge of the blur type was developed.
- A new blur-invariant distance using projections was proposed and studied.
- An integrated neural network approach that combines standard CNNs with an image invariant branch was developed and tested. These contributions are two-fold: (1) they provide new approaches that connect machine learning algorithms with the theory of blurred images and (2) the algorithms outperform existing CNN approaches.

What is the importance of it for the area?

Blurry images are ubiquitous in the field of computer vision. This thesis contains both theoretical contributions to the understanding and analysis of blur invariants and new methods that can be used in practice. Extensions to integrate machine learning and AI techniques with mathematically sound approaches have the potential for high impact in the field of image processing.

What are the possible applications to other areas?

- Blurred images arise in a wide variety of scientific applications (e.g., geoscience, atmospheric, biomedical imaging, and surveillance), so the potential broader impact of the research developments from this thesis is high. More specific to imaging processing tasks, there are potential applications to image recognition, robust template matching, and object classification.
- Moreover, blur invariants were introduced in the 90s, where the motivation was that recognition of objects in blurred images was more important than the reconstruction of the image itself. There is a similar idea underlying goal-oriented inverse problems, where some quantity of interest that is a function of the deblurred or reconstructed image is desired. These approaches have gained recent interest, and there is potential for future contributions that exploit or leverage work in this thesis on blur invariants or blur invariant measures.

Comments to the submitted thesis.

There were some grammatical errors and typos in the thesis. I encourage the author to do another round of careful editing (especially in Section 1.6 and Chapter 3).

Conclusion:

In summary, the thesis demonstrates the author's ability for creative and impactful scientific work.