Doctoral Thesis Review

Author: **Amr Mohamed Abdelhameed Nagy Abdo**
Title: **Recognition of Objects and Their Defects**
Reviewer: **Balázs Nagy, PhD**
Submission: **Oct. 30. 2022**

Scope

The candidate proposed new methods in the field of visual inspection focusing on recognition of objects and surface defects. In particular, the candidate has investigated and demonstrates original and new results for a set of selected problems in object recognition and pose estimation, detection of traffic sign defects, and zero and fast few-shot learning of steel surface defects. These topics convey great research interest (for the scientific community & industry) as they are key enabling technologies for visual inspection and explainable AI.

Scientific evaluation

The candidate proposed three new scientific contributions:

1. Object Recognition Techniques using Deep Neural Networks and HMMs
   The candidate showed that Hidden Markov Models can be efficiently combined with deep neural networks and the fusioned model can be used for object recognition and pose estimation.
2. Detection of traffic sign defects
   A Siamese-style neural network architecture was proposed to recognize the defects of traffic signs. The combination of Siamese confidence value with SVMs was also introduced and the superiority of the method was proved compared to ensemble methods.
3. Classification, Zero and Fast Few-Shot Learning of Steel Surface Defects
   The candidate proposed a new architecture by combining EfficientNet with randomized networks. Few and zero shot learning was proposed to detect steel surface defects.

In my opinion, the presented thesis offers original and new insights in three core research aspects. The new scientific results are also confirmed by a significant publication activity containing 2 international journal papers and 5 international conference papers. The quality of the publication record satisfies the expected level to obtain a PhD degree. The topical distribution of the papers and that of the thesis matches well, well supporting the claimed novelties and their weighting, as presented

in the thesis. The scientific level of the thesis is high, and the underlying scientific assumptions are sound. The novelty aspect is also given.

The candidate has answered all the criticized aspects which have been pointed out during the preliminary evaluation. The candidate has accomplished high quality additions:

- More accurate definition of the core problems, and comparison between the algorithmic/representational concepts.
- Standardized equations and figures.
- The candidate has provided convincing answers to most of my question.

For all three research targets, experimental validation reaches high scientific standards. In some cases, the number of experiments is limited, but sufficient and convincing for proving the proposed claims.

Overall Summary

In my opinion, the submitted thesis demonstrates the scientific qualities of the candidate. The candidate has generated a solid set of publication outcome and the practical relevance of the proposed methods is also proved. Based on the proposed results the candidate has established a high-quality scientific expertise in this specific domain. Considering the presented thesis work, I recommend awarding the PhD degree.

Toyama, Japan, Oct. 30. 2022

Balázs Nagy, PhD