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Report on the PhD thesis of Michal Hradiš

"Sharing Local Information for Faster Scanning-Window Object Detection"

The thesis of Michal Hradiš is on fast detection of objects in images which is an open problem whose importance is clear from the large number of computer vision applications that require detection. The thesis focusses on a particular class of methods for object detection, the WaldBoost sequential classifiers based on the Viola-Jones AdaBoost scanning window approach.

The Abstract as well as the Summary of Contribution highlights two algorithms – the Neighbourhood suppression (NS) and Early Non-maximum Suppression (EnMS) – as the main contributions of the thesis. The contributions are important and their significance is sufficient to become a core of a thesis. However, the two algorithms, including evaluation, are covered on less than 15 pages each. This is sufficient to expose the idea, but not to completely cover the related state-of-the-art, to consider alternatives in realisation of the algorithms or for providing a thorough evaluation that would make the practical merit of the two methods clear.

The structure of the thesis in not balanced. Besides the problem of the shallow treatment of the two main contributions, in Chapter 3 the thesis does not fully cover alternative approaches to fast object detection. I do not doubt that improving WaldBoost is well-motivated, but a thesis must make it clear that there are no approaches dominating the chosen one and that it represents, at least in certain settings, the state-of-the-art. The third problem in the structure is the lack of connection between Chapter 4 "Features and object detection" with Chapters 6 and 7, presenting the main contributions. Yet connection could have been easily established, e.g. by assessing the features from the point of view of their ability to contribute to NS and EnMS algorithms.

Technical issues and questions:

1. (page 15) "The detector of Viola and Jones is effective only for classes that are visually compact". But what does "visually compact" mean? Detectable by Viola-Jones, going circular?
2. (page 21) The explanation of formula (3.1) is wrong. Formula (3.1) expresses the fact that if observations are independent given a hypothesis, the joint probability can be factorized. Formula (3.1) is not an identity. The definition of the test is on the left side.
3. Formula (3.2) is just a different notation of the left-hand side of (3.1) and it is unclear why it is introduced. The text above (3.2) "Consequently, the

decision equation 3.1 reduces to (3.2)" make no sense. Equation (3.1) is not a "decision equation", (3.2) is not a "reduction" of (3.1).

4. (page 23) "SPRT. A. Wald … believed … did not prove …". This sentence suggests that A. Wald had an imprecise view of his results. This is wrong. T A. Wald just states that the SPRT is so close to optimality and so simple that the gap to optimality, which he understood well, is not worth closing (say by complex numerical methods).
5. (page 29) "The purpose of features is to extract useful information". Is this a definition? How is "useful information" defined than?
6. (page 31) "... are completely invariant". A quantity is either invariant or not. It makes no sense to speak about "complete invariance".
7. (page 34) "The HOG descriptor is invariant to translation". It is not.
8. (page 70) "In theory, it is possible to make the early termination decisions only when it is absolutely certain they are correct". Please explain. The trade-off here could be e.g. between speed and location precision.
9. (page 70) Formula (7.1) assumes independence. Is this justifiable?
10. (page 90) "Such tight integration should be further explored as it could lead to significant speed-up". Yes, it should be explored. In the thesis.

In conclusion: Michal Hradiš has published extensively on wide range of topics, demonstrating his ability to carry out scientific research. Most of his publications are in proceedings of international conferences. However, most of those are local events, none of the papers are at major, top-quality conference.

The thesis includes original scientific contributions to an open, well-established, important problem. It is presented according to the standards recognized in its scientific field.

I recommend the thesis for oral defence.

J. Matas