

Review of the Ph.D. thesis of Mr. Luděk Bryan (Crha)

Mr. Luděk Bryan (Crha) in his Ph.D. thesis focused on research of methods of objects detection implemented in programmable hardware. The performed work is a good example of multi-disciplinary approach as it consists of hardware design and image processing research. The work has been obviously very demanding from the point of view of the extent of knowledge needed to perform the work, from the point of view of the amount of experimental work to be performed, and also from the point of view of the tools and means to perform the work. The topic of the Ph.D. thesis is also important for contemporary research in both image processing and programmable hardware.

The text of the Ph.D. thesis itself is written in English and it is very nicely done. The structure of the text is well prepared, and the graphical layout is of a good quality. One objection, however, can be made towards rather too high count of relatively short chapters that contain implementation details, case studies, and discussion of results.

As for the technical content, the thesis describes implementation of a method of object detection through template matching in images. The methods belonging to the same class as the proposed method are already known in image processing and they are traditionally not considered too efficient. However, in programmable hardware implementation, the method, as demonstrated, can be implemented in very efficient manner and may be considered comparable to the state of the art methods from the point of view of complexity versus e.g. number of pixels processes per second.

Anyhow, while the method of the actual classification (detection of objects of a given class) is well described and the estimated noise sensitivity, robustness, and other features are discussed (pages 45-51), the “training” process description is not detailed enough. Clearly, the “training” or “design” of the detection method templates is not the core of the thesis but still it needs to be explained. Specifically, the description of the “Fill the bank” operation mentioned in Section 5.5 (page 52) does not mention what templates are filled into the filter banks, how the “better half” of the templates is defined, what templates replace the “other half” of the templates, etc. Additionally, it is not mentioned how the co-ordinates of the templates in the image (object) are decided. Is this done “manually” or through some automatic method?

Moreover, the method used in the thesis (or rather its instances used in the case studies) are not evaluated from the point of view of their robustness under scale, illumination, or projection changes (or e.g. under affine transformation and illumination changes as it is usual in image processing field). Therefore, the method cannot be directly compared to some other state of the art methods from the point of their general usability. This fact does not necessarily lower the value of the thesis as in e.g. in the applications used in case studies shown in the Ph.D. thesis, the illumination, size, and projection do not change. Still, the above mentioned evaluation would be nice to perform.

As mentioned above, the submitted Ph.D. thesis of Mr. Luděk Bryan (Crha) is nicely done; however, some questions should be answered in order to clarify it further:

- 1) The features of the detection method mentioned in the thesis (pages 45-51) are evaluated under the assumption that the original image contains the template which is then modified with noise and other sources of distortion. Has also an evaluation take place with a set of images belonging to a certain class based on which the design of the detector been done?
- 2) What are the details of the training procedure described in Section 5.5 (page 52)? Namely, what templates are filled into the bank, how they are evaluated and after the evaluation what is filled into the lower half of the bank? Also of interest would be a range of the number of filters in the filter bank.
- 3) Does any automatic procedure for selection of the templates exist? E.g. in Section 5.3.3 (pages 42-43), three templates are being used for object detection. What is the procedure of their identification and geometrical placement?
- 4) In the case studies in Chapter 8 and Chapter 9, how the (geometrical) placement of the template in the images was determined?
- 5) In Chapter 10, how the classes of “suitable” and “unsuitable” objects have been determined? Why the object detection through binary classification has not been included in the evaluation of the proposed method – the object detection through classification is considered one of the state of the art methods?
- 6) Has the “generality” of the proposed method been evaluated and some automated “training” procedure proposed? If so, what are the results? If not, why this has not been done?

Finally, to my opinion the submitted thesis presents novel and valuable work and it definitely should be recommended for defending.

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