Review of the PhD dissertation

"Novel Probabilistic Methods for Visual Surveillance Applications"

submitted by Akos Utasi

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THE dissertation addresses several fundamental problems related to visual surveillance. The author proposes various probabilistic models to solve multiplexing of unsynchronized video streams; foreground/background separation with particular attention to the foreground aperture problem; as well as a complex video event analysis system which is capable to recognize unusual events. Two key challanges in video surveillance applications are real-time processing speed and robustness in the presence of noise. The proposed methods address both issues at the modeling level.

I. Presentation

The introduction (Chapter 1) gives a good overview of available surveillance technology (both hardware and software systems), followed by a detailed description of the theoretical foundations in Chapter 2. The remaining chapters discuss the scientific contributions, while the appendix contains illustrations, technical details and calculations. In general, the manuscript is well organized and clearly written. Unfortunately, the conclusion fails to discuss further research directions.

II. Scientific Content

The author's contributions are summarized in *three* thesis groups: irregular camera event detection; foreground/backgroun separation; and unusual event detection in urban environments. All these contributions contain new findings as well as have important applications in surveillance systems.

Thesis 1: The main contributions are a HMM and HSMM models applied to detect irregular camera events in time-multiplexed videos.

Comments and Questions

1) There are ad-hoc parameters (*e.g.* the size of the smoothing kernel in Section 3.2.1) which needs some explanation: why these values are good (at least some intuitive motivation is needed), how to find appropriate parameter values.
2) It is hard to figure out the whole algorithm as the description is too brief. Give at least a summary of the main steps (including the necessary technical details, equations) of the video stream segmentation algorithm. The same applies to training.

Thesis 2: The main contribution is a probabilistic background model for (dynamic) foreground (static) background separation. In particular, a standard GMM background model is modified to reduce the effect of the foreground aperture problem.

Comments and Questions

1) Again: Ad-hoc parameter settings need explanation/motivation (*e.g.* α in Eq. (4.3) or w_{init} in Eq. (4.8).
2) The author considers the color channels to be uncorrelated (Section 4.3). The validity of this assumption largely depends on the color space - which is not specified here. You need to justify this hypothesis either theoretically (*e.g.* by choosing an uncorrelated color space), or experimentally.

Thesis 3: This is the most complex thesis group with various contributions to detect unusual events, the most prominents being pixel-level optical flow direction modeling and a HMM-based unusual event detector with hierarchical representation of regional motion models.

Comments and Questions

1) Notations in Eqs. (5.7)-(5.8) are not always clear. For example, the role and choice of ρ needs to be exlained somewhere, pehaps in the previous chapter. The magic constant $\rho = 0.15$ also needs some intuitive motivation and supporting data.

III. Conclusion

In summary, the scientific content, presentation and supporting publications are up to the standards required by a PhD degree. Therefore **I recommend to proceed with the oral defense of the thesis**.

Zoltan Kato