

Ph.D. Thesis Review

Fast Learnable Methods for Object Tracking

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a) Characteristic and significance of the topic.

The thesis deals with visual tracking of an object given current and previous image. The application of this problem is tremendous. The author developed method for fast tracking with limited precision and robustness.

It is interesting that even small child is able to track very fast motion. In the literature, there exist several methods based on minimization the similarity criterion. The idea of object tracking is simple, but the problem is complicated when the picture is presented as a set of pixels with different intensities and colors. There is no global view and only local methods must be applied.

The main contribution of the author is an approach to global view of the image motion.

b) Applied theory and contribution.

The contribution of the thesis is in the regression based tracking methods - creation of learned mapping which author calls predictor.

The goal of the thesis is in the following:

1. Optimal concacensation of the predictors -
it means the use a sequence of simple predictors operating on a fixed set of pixel intensities.
2. Explicit minimization of the computational complexity -
it means learning based optimal sequence of linear predictors.
3. Anytime learning -
it minimizes the computational time delivering predictor with definite precision and robustness.

4. Tracking of objects with variable appearance -
The proposed methods are extended to objects with nontrivial appearances changes. The tracking system is formed from the tracker (linear predictor) and appearance encoder. Simultaneous learning of both predictors is the problem.
5. Adaptive real time optimization of range and accuracy -
The performance of learned sequential predictors is characterized by range - region of predictable motion, accuracy and the speed. Both are dynamically adjusted to obtain most accurate tracking.
6. Large set of tracking data with ground truth -
to verify the tracker, the author used publicly available sequences of frames.

These goals are ambitious and in the thesis are solved. The author designed several regression based tracking methods.

Learned Linear Predictor (LLiP) - optimal linear mapping between intensities and motion. Because of limited range and accuracy of the predictor the author developed more complex structure as

Sequential Learned Linear Predictor (SLLiP) - previous predictor is extended to sequence of predictors. The superiority of the proposed method is demonstrated with respect to published methods.

Parameter Sensitive LLiP is suitable for object parameters changes. Comparison with previous predictor shows the superiority of the approach.

c) Comments and suggestions.

- Mathematical conveniences are not always correct.
- Pseudoinverse of matrix G in equation 2.5 is correct only if the matrix has full column rank.
- If the matrix I is slim - number of pixels is greater then the number of training pairs d - the right pseudoinverse doesn't exist (section 2.3.).
- In fig.2.2 perturbation of motion $\varphi(\cdot)$ is not correct.
- Explanation in fig. 4.1 is not clear
- Solution L_1 and L_∞ problem as linear problem is standard. Quasieuclidean norm explained in appendix A is interesting. It minimization again can be solved as a linear program.
- Plural in definition 9 is a mistake.
- The author uses strange notation φ , $\hat{\varphi}$, φ^* , φ^+ , φ_i for predictor, regressor etc.

- I suppose that the original picture must be carefully analyzed to be able to choose significant features of the object to be followed - it is the approach to tracking objects with known geometrical model.

d) Formal arrangement of the thesis and quality of language

The formal arrangement of the thesis is very good and as to my knowledge of the language I consider the thesis excellent.

e) Publication activity of the author


There are 4 publications related to the thesis and 4 other publications which concern the picture processing. All are prestigious publications on international conferences and in journals. So it can be stated that the results of the dissertation come through international review process.

f) Conclusion

The above comments do not cast any doubt upon the original contribution of the presented work.

The thesis by Ing. Karel Zimmermann has fulfilled the criteria of the §47 of the University Education Act No, 111/98 of the Czech Republic and I recommend the thesis to Ph.D. defence.

In Prague August 15, 2008


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