

2005

A Flow-Based Approach to Vehicle Detection and Background Mosaicking in Airborne Video

Hulya Yalcin
Carnegie Mellon University

Martial Hebert
Carnegie Mellon University

Robert Collins
Pennsylvania State University - Main Campus

Michael J. Black
Brown University

Follow this and additional works at: <http://repository.cmu.edu/robotics>

 Part of the [Robotics Commons](#)

Published In

Video Proceedings in conjunction with CVPR'05.

This Conference Proceeding is brought to you for free and open access by the School of Computer Science at Research Showcase @ CMU. It has been accepted for inclusion in Robotics Institute by an authorized administrator of Research Showcase @ CMU. For more information, please contact research-showcase@andrew.cmu.edu.

A Flow-Based Approach to Vehicle Detection and Background Mosaicking in Airborne Video

Hulya Yalcin & Martial Hebert
Robotics Institute
Carnegie Mellon University
Pittsburgh, PA 15213
{hulya,hebert}@cs.cmu.edu

Robert Collins
CSE Department
Penn State University
University Park, PA 16802
rcollins@cse.psu.edu

Michael J. Black
Computer Science
Brown University
Providence, RI 02912
black@cs.brown.edu

DESCRIPTION

In this work, we address the detection of vehicles in a video stream obtained from a moving airborne platform. We propose a Bayesian framework for estimating dense optical flow over time that explicitly estimates a persistent model of background appearance. The approach assumes that the scene can be described by background and occlusion layers, estimated within an Expectation-Maximization framework. The mathematical formulation of the paper is an extension of the work in [9] where motion and appearance models for foreground and background layers are estimated simultaneously in a Bayesian framework.

Layered models of optical flow have been one of the key paradigms for simultaneously segmenting the scene and estimating its motion [3], [5], [8]. Tao et.al. [7] develop a practical, layer-based algorithm within a rigorous Bayesian framework that specifies data terms and priors for object appearance, motion and shape cues. In particular, mixture model frameworks make a soft assignment of pixels to layers. Unfortunately, these methods are typically limited to parametric motion models.

Here, we extend [9] to detect moving vehicles by segmenting dense optic flow fields into background and occlusion layers. Unlike the related work in [2], [4], [6], where thresholding and connected component analysis follow up the background stabilization, our approach is based on a robust optical flow algorithm applied on stabilized frames. Stabilization of the frames compensates for gross affine background motion prior to running robust optical flow to compute dense residual flow. Based on the flow and the previous background appearance model, the new frame is separated into background and foreground occlusion layers using an EM-based motion segmentation. The preliminary results presented here show that ground vehicles can be detected and segmented from airborne video sequences while building a mosaic of the background layer. Further details of the approach and videos can be found in [1] and [10] respectively.

ACKNOWLEDGEMENTS

This work was sponsored by DARPA Grant NBCH1030013. The content does not necessarily reflect the position or the

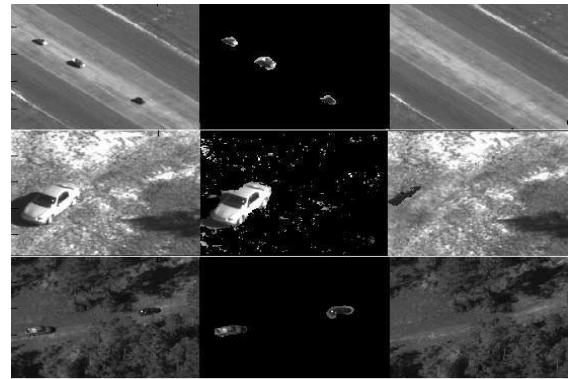


Fig. 1

DETECTING VEHICLES: INPUT FRAMES (COLUMN 1), DETECTED VEHICLES (COLUMN2), BACKGROUND APPEARANCE (COLUMN3).

policy of the Government, and no official endorsement should be inferred.

REFERENCES

- [1] <http://www.cs.cmu.edu/~hulya/research.html>.
- [2] P. Arambel, J. Silver, J. Krant, M. Antone, and T. Strat. Multiple-hypothesis tracking of multiple ground targets from aerial video with dynamic sensor control. In *Proc. of SPIE 5429, (Signal Processing, Sensor Fusion, and Target Recognition XIII)*, pages 23–32, Aug. 2004.
- [3] S. Ayer and H. Sawhney. Layered representation of motion video using robust maximum likelihood estimation of mixture models and mdl encoding. In *ICCV95*, pages 777–784, 1995.
- [4] W. Bell, P. Felzenszwalb, and D. Huttenlocher. Detection and long term tracking of moving objects in aerial video. Technical report, Computer Science, Cornell, March 1999.
- [5] A. Jepson and M. Black. Mixture models for optical flow computation. In *CVPR93*, pages 760–761, 1993.
- [6] G. Medioni, I. Cohen, F. Bremond, S. Hongeng, and R. Nevatia. Event detection and analysis from video streams. *PAMI*, 23(8):873–889, August 2001.
- [7] H. Tao, H. Sawhney, and R. Kumar. Object tracking with bayesian estimation of dynamic layer representations. *PAMI*, 24(1):75–89, 2002.
- [8] Y. Weiss. Smoothness in layers: Motion segmentation using nonparametric mixture estimation. In *CVPR97*, pages 520–526, 1997.
- [9] H. Yalcin, M. Black, and R. Fablet. The dense estimation of motion and appearance in layers. *Second IEEE Workshop on Image and Video Registration (IVR'04)*, 2004.
- [10] H. Yalcin, R. Collins, M. Black, and M. Hebert. A flow-based approach to vehicle detection and background mosaicking in airborne video. *Technical Report CMU-RI-TR-05-11*, March, 2005.