Tracking-Based Semi-Supervised Learning using Stationary Video

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Abstract

This paper deal addresses the semi-supervised problem of tracking and recognizing objects in videos taken with stationary cameras. Building on work on Stanford's autonomous vehicle using laser range finders to solve the same problem, we aim to develop accurate methods for classifying objects without the additional benefit of 3D laser scans. We set out with three main goals, each building on the previous ones. The first is to perform background subtraction to remove all background objects (those objects that are stationary in the frame of the camera). The second is to track the foreground objects through every frame of the video. Finally, the third goal is to use semi-supervised methods to classify tracked foreground objects. A successful semi-supervised approach will greatly reduce the amount of training data needed for many classification problems.

1. Introduction

The objective of this paper has three subgoals:
(1) Remove background objects.
(2) Track foreground objects.
(3) Classify foreground objects using semi-supervised learning.

1.1. Removal of Background Objects

We plan to initially use OpenCV's implementation of Mixture of Gaussians for background subtraction [2]. If this method proves inadequate we will explore the possibility of using Sheikh and Shah's Bayesian Modelling Method to reduce the error in the subtraction [3]. Sheikh and Shah's method is purported to handle cases with non-stationary backgrounds, so we hope that no further methods will be necessary. The background subtraction methods will first be evaluated qualitatively, and then against supervised data if the performances of the different methods are too similar to compare. Performance (speed) of the algorithms may also be considered.

1.2. Foreground Object Tracking

Foreground object tracking will initially be done using a K-Shortest paths method developed by Berclaz *et al*. [1]. If this method is not sufficient then we will investigate further methods.

1.3. Semi-Supervised Classification

Classification will be done in a semi-supervised way using methods already developed in a previous paper by Teichman and Thrun [4].

References

[1] J. Berclaz, F. Fleuret, E. Turetken, and P. Fua. Multiple object tracking using k-shortest paths optimization. *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, PP(99):1, 2011.

[2] G. Bradski. The OpenCV Library. *Dr. Dobb's Journal of Software Tools*, 2000.

[3] Y. Sheikh and M. Shah. Bayesian modeling of dynamic scenes for object detection. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 27:1778–1792, 2005.

[4] A. Teichman and S. Thrun. Tracking-based semi-supervised learning. In *Robotics: Science and Systems*, Los Angeles, CA, USA, 2011.

2. Appendix

The work in this project builds Alex Teichman's work (advised by Sebastian Thrun) that performs the the same object tracking and semi-supervised classification, but while using a laser range finder. This project aims to perform both steps with only video input.

1. The computer vision components of this project include:
   (a) Background removal
   (b) Clustering and tracking of foreground objects
   (c) Semi-supervised Classification
2. I personally plan to contribute:

(a) Ideas and implementation (or use of a library like OpenCV) for background removal

(b) Implementation and testing of object tracking algorithms

(c) Design and analysis of quantitative experiments

3. Andrew Chou is enrolled in CS231A, and is the sole author of this writeup.