FAST ANOMALY DETECTION IN TRAFFIC SURVEILLANCE VIDEO BASED ON ROBUST SPARSE OPTICAL FLOW

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ABSTRACT

Fast abnormal events detection in video is important for intelligent analysis of video. This paper proposes a fast anomaly detection algorithm based on sparse optical flow. We improve the efficiency of optical flow computation with foreground mask and spacial sampling and increase the robustness of optical flow with good feature (TK) points selecting and forward-backward filtering. A foreground channel is also added to the feature vector to help detect static or low speed objects. The algorithm is validated on real-life traffic surveillance to prove its effectiveness. It is also evaluated on a benchmark dataset and achieve detection results comparable to state-of-art methods and outperforms them at pixel-level when the false alarm rate is low. The strength of our algorithm is that it runs real-time on the benchmark dataset which is hundreds of times faster than comparative methods.

Index Terms— Anomaly detection, abnormal event, traffic surveillance, optical flow

1. INTRODUCTION

Automatically locating abnormal events in traffic surveillance video is of vital importance to traffic administration as well as public safety. As is well known, it is hard to handle all scenes with one method, so we select traffic surveillance as the target type of scene to design and test our algorithm.

1.1. Definition of Anomaly

There are many definitions of anomaly to many people. We take events with low possibility as anomaly since it converts the ambiguous concept to an operational one. The word *event* is still not operational. This word contains different meanings in different scenes. In traffic surveillance, we take event as motion. Therefore, anomaly detection in this paper is to detect motion with low possibility in traffic surveillance video. This definition ignores anomaly that is not involved with motion, e.g. appearance anomaly. However, this is acceptable considering our application background being traffic surveillance. The definition is consistent with human cognition in our application and it introduces what features to extract in Section 2.

1.2. Related Work

A group of anomaly detection algorithms[2, 3, 4, 1, 5, 6, 7, 8] performs (subsets of) the following five steps:

a) Feature computation on pixel level;
b) Feature aggregation in space or/and time;
c) Transformation of the aggregated features to certain domains;
d) Build a model/classifier with the final features from training video;
e) Comparison of the final features from test video with the model.

Pixel level features include foreground location[4, 7, 8], HOG (Histogram of Oriented Gradients)[1], HOF (Histogram of Optical Flow)[2] and MDT (Mixtures of Dynamic Textures)[3]. The most common aggregation is to sum up features in a spacial and temporal 3-D block, which helps make the feature more robust to noise. Other aggregation includes building custom models such as locality model used in [8]. Transformation used recently includes sparse representation[1, 9]. Models and classifiers include sparse reconstruction cost[1, 6], maximum norm[7] and one-class SVM[5]. For detection step, researchers usually have to set thresholds or tune parameters based on what model or classifier they adopts and compare features they extract from training and test videos.

Another type of method is based on tracking[10]. This type of method is good at handling uncrowded scenes. However, tracking is unreliable on crowded scenes[3]. And it is hard to obtain reliable detection results with unreliable trajectories. The algorithm proposed by this paper belongs to the first type and can achieve remarkable detection results on real-life traffic surveillance in real-time.

1.3. Our Contributions

The contribution of this paper to anomaly detection lies in several aspects: First, it proposes a procedure comput-