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An Adaptive Approach for Validation in Visual Object Tracking

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Abstract

One of the major goals in the field of computer vision is to enable computers to replicate the basic functions of human vision such as motion perception and scene understanding. To achieve the goal of intelligent motion perception, much effort has been spent on visual object tracking. Research interest in visual object tracking comes from the fact that it has a wide range of real-world applications. The uncertainty of validating unpredictable features in object tracking is a challenging task in visual object tracking with occlusion and large appearance variation. To address this uncertainty, we propose an adaptive approach which uses updating model based on the occlusion and distortion parameters. In case of occlusion or large appearance variation, the proposed method uses backward model validation where it updates the invalid appearance and then validates the target feature model. If the target feature did not undergo any kind of clutter or distortions, it simply validates and then updates the appearance model using forward feature validation. The experimental results obtained from this adaptive approach demonstrate effectiveness in terms of OR (Overlap Rate) and Center Location Error, compared with other relevant existing algorithms.

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Keywords: Visual Object Tracking; Adaptive model; Object Occlusion; Backward Model Validation; Forward Model Validation

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1. Introduction

Despite the importance of object tracking, in the field of computer vision, developing a robust tracking algorithm is still a challenging problem. In the past decades significant progress has been made and produced a variety of interesting results. However due to numerous factors such as partial occlusion, illumination variation, pose change, fast movement and background clutter, developing a robust tracking algorithm is still a challenging problem. Visual object tracking finds many practical applications in motion analysis, video surveillance, human-computer interaction, vehicle navigation and so on. The results produced from tracking is essential for some high level tasks such as suspicious target identification and object behaviour understanding in smart systems. Therefore it is indispensible to develop a robust tracking system that does validation and updating efficiently. Image analysis in tracking can be done by extracting some of the functional details from the captured images. Therefore, if there is a requirement for identifying an object, and notable robust characteristics of an object (color, pattern, edges, intensity, and structure). In this work, a generative and hybrid tracking method based on a novel robust and linear regression algorithm is proposed. In contrast to existing methods, the Least Soft-threshold squares algorithm [1] models the error term with the Gaussian distribution, can be solved efficiently. We derive Least Soft-threshold Squares (LSS), based on maximum joint likelihood of parameters to measure the difference between an observation sample and the dictionary. Compared with the distance derived from ordinary least squares methods, the proposed metric is more effective in dealing with outliers. Several tracking algorithms iVT [2], Struck [3], TLD [4] were developed in the past to efficiently handle the controversies. The target feature identification can be done using particle filter framework where the particles are assigned with weights and re-sampled contiguously from the model pool. When large appearance change (caused by appearance variation or occlusion) is detected, the appearance data is not immediately labelled invalid, but the appearance model is duplicated into the model pool where the duplicated model stays steady and the original one keeps updating with the incoming data.

However in order to handle error accumulation, Mathews et.al. [5] proposes an algorithm for updating, based on training the appearance model. The appearance model is applied to distinguish the appropriate target features. This method is named as forward feature validation in updating the appearance model, as the feature data are updated and then validated. In case of unpredictable target appearance variation forward feature based validation algorithm loses track of target object. Therefore in each step, the target appearance information in the incoming frame backward-check all the appearance models in the model pool. The chosen model which adaptively uses forward as well as backward validation approach is detected as most valid and accurate to estimate the target states and is updated with the estimated target appearance. The experimental results obtained shows that the proposed algorithm which combines both BVT [10] and FVT, in case of occlusion, appearance variation, fast movement, can obtain accurate and consistent tracking results, compared with existing relevant algorithms of visual object tracking.

The rest of the paper is organized as follows: Section II discusses about the related works, Section III explains the proposed work, Section IV represents the Experimental Analysis and Section V describes the Conclusion.

Nomenclature

A	BVT - Backward Validation Tracking
B	IVT - Incremental Visual Tracking
C	IPCA - Incremental Principal Component Analysis

2. Related Works

Incremental learning for robust visual tracking [2]: In this paper, initialized a dictionary using local low-rank features to represent the appearance subspace for the object. In this way, each candidate can be modeled by the sparse linear representation of the learnt dictionary. Then by incrementally updating the local dictionary and learning sparse representation for the candidate, we build a robust online object tracking system. Furthermore, in contrast to the traditional holistic dictionary, the local low-rank features based dictionary contains abundant partial information and spatial information. Experimental results on challenging image sequences show that our method consistently outperforms several state-of-the-art methods.