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A variable patch approach with polling mechanism for intelligent human tracking ☆

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Abstract

Human tracking is one of the challenging and significant components of intelligent tracking systems. Even though the correlation filter-based trackers accomplished the competitive outcomes in terms of accuracy and robustness, there is a need to improve tracking performance. In this paper, the vote mapping of patched confidence methodology is used to enhance a tracking system's performance by continuously increasing the number of patches. The system aims to provide robustness to occlusion and global scene changes by utilizing numerous patches from an image's bounding box. The proposed variable patch approach with a polling mechanism provides robustness to the occlusion in real-life tracking scenarios. The extensive quantitative and qualitative evaluation of a few challenging sequences is carried out using various patches. The tracking performance of proposed technique is better than existing techniques in terms of precision and success rate.

Introduction

In intelligent computing-based computer vision applications, one of the famous research areas is human tracking. The tracking process is improved to a great extent with target position estimation of frame sequences and real-time depth cameras. With an increase in security issues, it is necessary to observe and comprehend society's suspicious activities. Tracking the human is difficult as there

are many challenging attributes like out-of-view, out-of-plane rotation, in-plane rotation, motion blur, fast motion, illumination variation, and occlusion. There is a requirement for developing an improved technique to address these issues in human tracking. Human tracking framework is highly required in applications such as telepresence, security, human-computer interaction, military [1]. Human monitoring at public places like railway stations, bus stops, hospitals, and airports is complicated, and it requires significant attention in susceptible areas [2]. In the medical image analysis, J. Shotton and A.Criminisi (2013) represented an efficient and unified decision forest model for automatic diagnosis from radiological scans [3]. The above model is also useful in object recognition in the images and scene recognition from photographs.

Ramanan & Forsyth (2003) use people tracking by matching models with clustering appearance across the segments [4]. The recovery of human poses and motion has been carried out, and they were observed as a regression problem [5]. J. Cui and Y. Liu (2013) developed various e-health management methods by integrating low and high dimensional approaches [6]. This technique focuses on various structural optimization problems, also performance verification of human metaheuristic algorithms.

In the Fourier domain, and the convolution of two patches gives element-wise product equivalency. For various image shifts or translations, the linear classifier's desired output can be specified by the filters. There are numerous correlation filter-based trackers used for tracking. D. S. Bolme et al. (2009) developed a concept of the correlation filter, referred to as a minimum output sum of squared error (MOSSE) filter [7]. MOSSE is an adaptive training algorithm for developing a stable correlation filter initialized using a single frame. An improved kernelized correlation filter based on the histogram of oriented gradient (HOG) features has been presented for improving the tracking performance [8]. The above methods are limited to eliminating only target translation, which affects the performance in sequences. Few algorithms with correlation filter-based tracker (CFT) are utilized to increase the efficiency and robustness [10], [11]. The context-aware correlation filter-based tracker has been developed using the correlation filters (CF) trackers with a global context. The work by Danelljan et al. (2015) is modified by improving the efficiency of the algorithm with a series of optimization methods [12]. Goa et al. (2018) introduced the ridge regression formula with a spatially regularized matrix using a kernelized correlation filter (KCF). It also demonstrates the new regression formula that utilizes the property of the circulant matrix [13]. However, these trackers perform poorly while recovering the targets from drifting and handling Occlusion.

Ning et al. (2009) introduced scale and orientation adaptive mean shift algorithm to handle the issues related to scaling and orientation changes [14]. Unfortunately, the method is vulnerable to occlusion. The choice of an informative part that holds most of the information about an object class's presence is well discussed in the literature [15], [16]. Moreover, the effect of using patch-based tracking is well represented in [17], which effectively used the fragment-based tracking mechanism. But all these algorithms are not robust for the effect of occlusion.

The KCF algorithm uses the base sample's cyclic shift, which leads to an improper representation of

an image along with the training samples [18]. The difficulties further resulted in the reduction of the learned model's discriminative power. The spatially regularized matrix is used in our proposed system to solve the problem by expanding the sample size for enclosing additional negative samples. Harmonious polling of patch-based tracking mechanism provides improved human tracking [9]. The accuracy of the tracker is in comparison to state-of-the-art algorithms [19], [20], [21]. The mechanism utilizes different patches from the bounding box estimated in the past frame, and all patches are tracked independently using the spatially regularized kernelized correlation filter (SRKCF). SRKCF evaluates poll from every patch in the form of correlation scores. The polls from the patches are combined to form correlation maps for the target to be tracked.The mechanism shows cooperative behavior by repeating the same steps for every frame to locate the target and to encounter the effects of occlusion.

The polling mechanism is the prime focus of this work, where all the correlation scores are combined robustly to draw a correlation map. The highest value in the correlation map gives the target position. The process of applying the SRKCF to every patch shows cooperative behavior, and the exact target position is determined by associating the correlation scores. The system mainly improves the accuracy of the tracking process. From the quantitative and qualitative analysis of their framework, it has been demonstrated that the success rate and precision value are improved while comparing with the existing systems at the cost of run time.

The significant modification in our proposed framework is polling, which improves the precision and success rate. A patch-based appearance model has been developed in the literature for target representation [19]. The dynamic model adaptively selects the hue, saturation, and value features and provides better performance than the previous works. Unfortunately, the algorithm suffers from an increase in computational load because of the Basin Hopping Monte Carlo.

The proposed framework proposes two significant contributions to the improvement of human tracking. The first contribution of this work is an enhanced patch-based tracking method. Here the number of patches are extracted from the bounding box is increased to address the occlusion effect in the tracking process. The second contribution is the correlation filter-based tracking system using a spatially regularized matrix. A spatially normalized matrix resolves the KCF algorithm's issues by expanding the sample size so that more negative samples can be enclosed. The paper is organized into five sections. Introduction and related works are discussed in Section 1. In Section 2, the proposed technique is explained with the help of necessary equations and block diagrams. Section 3 describes the experimental setup and evaluation methods. Section 4 presents performance evaluation results. Section 5 concludes the work.

Section snippets

An improved harmonic polling of patched correlation tracker

The patch-based tracking with the polling mechanism is used in the proposed framework that differs from existing works in many aspects. Many current works are not robust and cannot handle Occlusion effectively in human tracking. The significant achievement in the proposed framework is its robustness for occlusion. In this paper, the proposed system depends on the patch-based tracking approach, where the bounding box patches are sampled continuously and treated individually throughout the…

Test sequences

The proposed algorithm is tested using the OOTB-100 database, available from [22], a National Laboratory of Pattern Recognition NLPR_MCT [25]. Few real-time data are also utilized for testing the performance of the proposed work. The proposed algorithm is compared with kernelized correlation filter (KCF) [9], Spatio-temporal context (STC) [24], Color naming (CN) [19], Multistore tracker (MUSTER) [10], Tracking Learning Detection (TLD) [23]. The proposed tracker is used for every sequence as…

Performance evaluation & result analysis

The proposed system is compared with the most popular CFT algorithms considering almost 300 sequences. The sequences are challenging as the target is facing continuous occlusion, illumination change, out-plane, and in-plane rotation. For comparison, the results of a few existing trackers are also reported, KCF [9], MUSTER [10], CN [19], TLD [23], STC [24]. To obtain better performance, the number of patches considered in the proposed work is 80. The experiment is conducted on different patches…

Conclusion

A novel polling methodology gives the exact target position and achieves the maximum score from the confidence map. Special attention is given to remove the occlusion effect, as the system is mainly intended to use in public places. It has been proved from the experiments that the proposed HPPC tracker performs well in various challenging situations such as plane rotation, in-plane rotation, fast motion, background clutters, scale variation, illumination variation, and occlusion. Though it is…

Declaration of Competing Interest

None.…

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Kavita Wagh is pursuing a Ph.D. in Electronics Department from Babasaheb Ambedkar Marathwada University. Her research interest is in Image and Video processing. She has published in many national and international journals. She has 11 years of experience in teaching as an assistant professor. She is a member of various professional bodies like IET, ISTE....

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