A Method of Adaptive Learning Rate Tracking for Embedded Device Based Correlation Surface Evaluation

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Introduction

Object tracking has important applications in many fields such as automatic driving and video surveillance. These application not only require high real-time performance for tracking, but also low power consumption and small volume platform. Correlation tracking algorithm has been widely concerned by scholars due to its fast computing speed and high accuracy and many excellent algorithms have proposed, such as KCF, DSST, Staple and ECO. These algorithms all use high dimension features, although this makes them obtain excellent tracking accuracy, but there are also problems of low real-time. At the same time, the huge computation of extracting high dimension features also limits the application of the algorithm on embedded platform. In the correlation tracking, in addition to the selection of features, the update of the model has a great influence on the tracking accuracy. The common fixed learning rate model updating strategy is difficult to adapt to the changing object, which limits the improvement of tracking accuracy. Therefore, we can estimate the change speed of the object, so as to adjust the learning rate adaptively, and improve the tracking accuracy while maintaining the real-time and computational advantages of the low-dimensional feature tracker.

Design and Implementation

The Peak Sidelobe Ratio is defined as the maximum value minus the local mean of the correlation surface maximum and then divided by the local standard deviation. If the quality of the correlation surface is better, the steeper the main peak of the correlation surface is, the larger the difference between the maximum value of the correlation surface and the local mean is, and the larger the local standard deviation is. However, their quotient, ie, the Peak Sidelobe Ratio is not necessarily large. We simulate the correlation surface with two-dimensional Gaussian distributions of different σ and calculate the Peak Sidelobe Ratio (PSR) of these correlation surface. It is found that the Peak Sidelobe Ratio (PSR) value does not decrease strictly with the increase of σ. Based on the above problems, this paper proposes new correlation surface evaluations, the step of Peak to Half Ratio (PHR) and the Area of Half peak Ratio (AHR). According to these two evaluations, we can prediction obejct change speed by the quality of correlation surface, so that the learning rate is adaptively adjusted. At the same time, we consider the case where the object is occluded, propose a Histogram of centroid (HoC) feature, and judge whether the obejct is occluded by calculating L1 distance of HoC features extracted by adjacent frame.The algorithm proposed in this paper finally determines the tracking learning rate based on the speed of the object change and whether it is occluded adaptively. The above process of adaptively determining the learning rate includes the following steps:

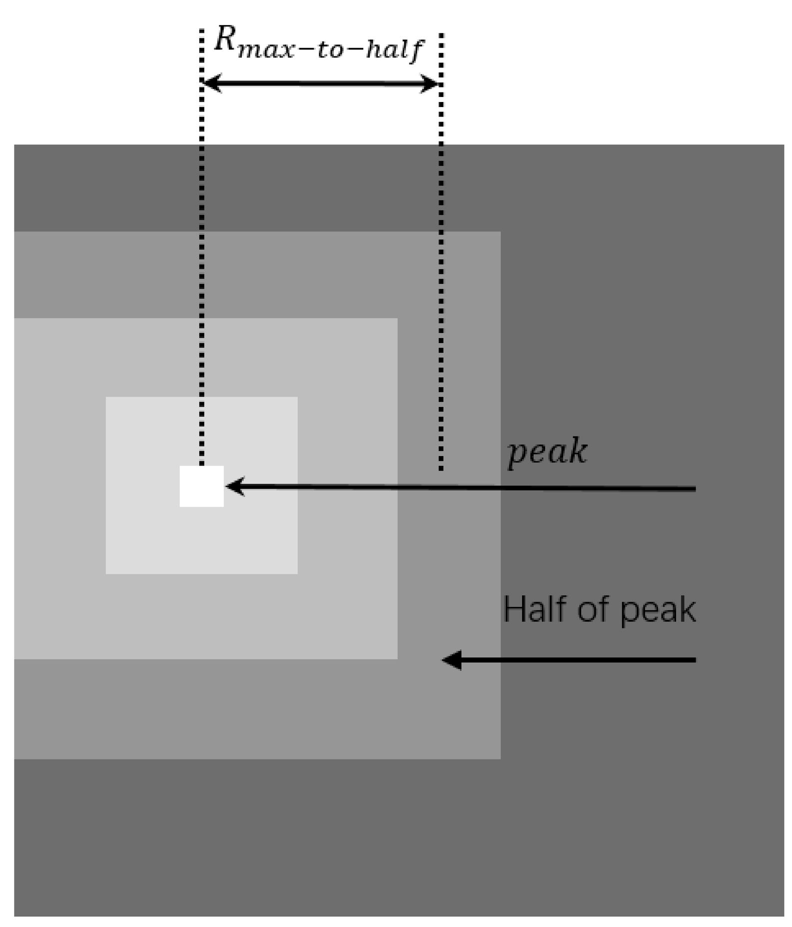

Fig. 1.Rmax-ti-half

According to the size of the tracking object assigned in the first frame, a two-dimensional Gaussian distribution with a standard deviation of σ is generated as label of the linear regression in the tracking, we donate it as g.

Solve the training parameter w and correlate it with the input image to get the correlation surface donated y, and the position corresponding to the maximum of y donated as T,

The step of Peak to Half Ratio (PHR) characterizes the steepness of the main peak of the correlation surface. The calculation process of PHR is in below, the set of points satisfied the checkerboard distance to T on correlation surface is donated by C(r), and the mean of the correlation value in C(r) is denoted by M(r). From 1 onwards, M(r) is calculated until M(r) is less than or equal to 1/2 of max(y), and r at this time is referred to peak to half step of y and donated it by y_r. Similarly, we can calculate the peak to half step of g, and donate it by g_r. The PHR is y_r/(g_r).,

The Area of Half peak Ratio (AHR) characterizes the intensity of the local peaks of the correlation surfaces. The calculation process of AHR is in below, the set of points satisfied the correlation value in y is greater than or equal to max(y) is donate by A(y), and the number of points in A(y) is called the half-peak area and it is donate by y_s . Similarly, we can calculate the half-peak area of g, and donate it by g_s. The AHR is y_s/(g_s).,

The peak to half step ratio (PHR) characterizes the steepness of the main peak of the correlation surface. The smaller the PHR, the steeper the main peak of the correlation surface, and the higher the quality of the correlation surface. The half-peak area (AHR) ratio characterizes the intensity of the local peak of the correlation surface. The weaker the local peak of the small correlation surface, the higher the quality of the correlation surface. We use the square root of the product of the PHR and AHR to comprehensively characterize the quality of the correlation surface donated by MPA, MAP = MAP=√(PHR*AHR).

The Histogram of centroid mean (HoC) feature comprehensively characterizes the structure and gray distribution of an image block. When the obejct is occluded, difference of HoC feature extracted by adjacent frames. The calculation process of HoC is in below, selecting a window of size N*N, and slide it with the Step in the tracking area, we calculate the centroid of the window. We donate the direction of the center of the window to the centroid as the direction of the window. The mean value of pixel in the calculated window is donated by m. The value range of θ is divided into B bins, and the m values corresponding to θ in each bin are accumulated to form a HoC feature vector, and L1 norm of the HoC feature difference of the adjacent frame tracking region is calculated. If it is greater than the threshold thresh, it is determined that the obejct is occluded,

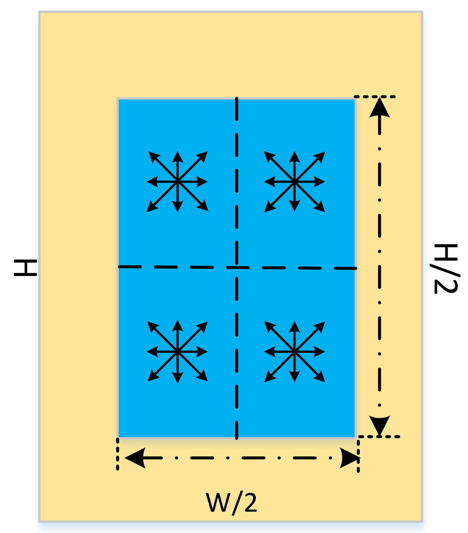

Fig. 2. Distance of L1 norm of HoC

The learning rate is determined adaptively according to the MPA of correlation surface and whether obejct are occluded. Let the basic learning rate α be a small value. If the target does not have occlusion, the learning rate γ=α*MPA, otherwise the learning rate γ=α.,

Results and Conclusions

Experiments based on the OTB50 dataset show that the single-channel gray-scale feature correlation tracker uses the learning rate adaptive strategy proposed in this paper, and the overall tracking accuracy of the whole dataset is improved by about 3%.does not have occlusion, the learning rate γ=α*MPA, otherwise the learning rate γ=α.,

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