Real-Time Tracking with On-line Feature Selection

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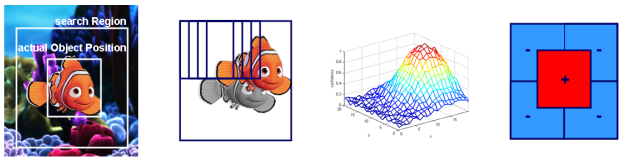
DESCRIPTION

The main idea is to formulate the tracking problem as a binary classification task and to achieve robustness by continuously updating the current classifier of the target object with respect to the current surrounding background. For this purpose we use an on-line AdaBoost feature selection algorithm [1] for tracking. The distinct advantage of the method is its capability of updating a model (classifier) during tracking. This allows on the one hand that a classifier can adapt to any object and on the other hand to handle appearance changes (e.g. out of plane rotations, illumination changes) quite naturally. Moreover, depending on the background the algorithm selects the most discriminating features for tracking resulting in stable tracking results. By using fast computable features (e.g. Haar wavelets, integral orientation histograms, local binary patterns) the algorithm runs in real-time (more than 20 fps using a standard 1.6 GHz PC with 512 MB RAM).

The main innovation of the proposed tracking approach is an on-line AdaBoost algorithm [1] which allows efficient updating of a classifier and makes an on-line selection of tracking features feasible. The principle of the tracking approach with a classifier is depicted in Figure 1. Since we are



(a) (b) (c) (d)

Fig. 1

GIVEN A INITIAL POSITION OF THE OBJECT (A) IN TIME t, THE CLASSIFIER IS EVALUATED AT MANY POSSIBLE POSITIONS IN A SURROUNDING SEARCH REGION IN FRAME $t+1$. THE ACHIEVED CONFIDENCE MAP (C) IS ANALYZED IN ORDER TO ESTIMATE THE MOST PROBABLE POSITION AND FINALLY THE TRACKER (CLASSIFIER) IS UPDATED (D).

interested in tracking, we assume that the target object has already been detected. This image region is assumed to be a positive image sample for the tracker. At the same time negative examples are extracted by taking regions of the same size as the target window from the surrounding background. These samples are used to make several iterations of the on-line boosting algorithm in order to adapt to the specific target object. The tracking step is based on the classical approach of template tracking. We evaluate the current classifier at a region of interest and obtain for each sub patch a confidence value. We analyze the confidence map and shift the target window to the new location of the maximum. Once the object has been tracked the classifier has to be updated in order to adjust to possible changes in appearance of the target object and its background. The current target region is used as a positive update of the classifier while again the surrounding regions represent the negative samples. As new frames arrive, the whole procedure is repeated and the classifier is therefore able to adapt to possible appearance changes and in addition becomes robust against background clutter. Note that the classifier focuses on the current target object while at the same time tries to distinguish the target from its surrounding. Apart from this, tracking of multiple objects is feasible by initializing a separate classifier for each target object.

We use three different types of features, namely Haar-like features, orientation histograms and local binary patterns (LBP). Note, that the computation of all feature types can be done very efficiently using integral images [2] and integral histograms [3] as data structures.

To summarize, the sequences in the video present a robust and generic real-time tracking technique, which considers the tracking problem as binary classification problem between object and background. The basis is an on-line AdaBoost algorithm which allows both - adjusting to the variations in appearance during tracking and selecting suitable features which can learn any object and can discriminate it from the surrounding background. The efficient computation of the features allows to use this tracker within real-time applications.

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