Hybrid Face Detector Based on Boosted Classifiers

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The task of object detection is one of the most widespread research domains in computer vision. Despite of the fact that humans have the extraordinary capacity to detect several types of objects or object categories, the general problem of object detection has not been solved yet. Nowadays, a high-performance system supposes a high rate of detection, and at the same time, a low rate of false detections.

This paper presents a robust face detection system that combines holistic and component-based methods. At first, a very fast appearance-based method detects the face as a whole using the well-known AdaBoost algorithm [1, 2]. This method does an exhaustive search over the image in different scales and positions using the image pyramid. Millions of image parts have to be analysed, out of which only a few are faces and all the others are backgrounds. A rate of $5 \cdot 10^{-6}$ false detections is not sufficient to eliminate all of the backgrounds [3]. Visually, the falsely detected images are not similar at all to the face. This is the reason why in the second phase, we propose a detection system whose role is to examine the image in detail. This process is slow, but it needs to be done only rarely.

The second part of the system is built with a well-known deformable object model [4] based on our proposed local descriptor. The deformable model solution can be implemented through a dynamic programming technique [5] which applies a new proposed algorithm for general distance transform [6]. The most important factor that determines the system's performance is the local image descriptor. Our idea comes from the working principle of the visual receptive field of mammalians. Hence, the proposed descriptor is based on Gabor filters. As you may know, the bi-dimensional Gabor filter [7] is defined in a high dimensional space of 9 parameters. One of the difficult tasks is to limit the domain of parameters. The first step is a thorough study that defines their theoretical limits. The fine-tuning process of the parameters for one kind of patch is done experimentally, with the goal to retrieve the most characteristic set of filters for the target object. The selection of the filters is done by the GentleBoost algorithm [8]. We implemented a supervised learning process that needs a huge amount of image patches of the object. This translates to a high computational complexity of the proposed descriptor. Nevertheless, it can be implemented in almost all detection systems.

The case study has been made for face detection, and the detailed search has used the above-mentioned descriptor for eye detection. We demonstrate the viability of the proposed system experimentally. We try to find the optimum between local and global aspect-based methods and between computational speed and detection performances.

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