Tesis para optar al grado de Doctor en Ingeniería Eléctrica

Object Detection Using Nested Cascades of Boosted Classifiers

A learning framework and its extension to the multi-class case

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Abstract

Building robust and fast object detection systems is an important goal of computer vision. An approach that has proven to be effective is the use of cascade classifiers, approach introduced by Viola and Jones that allows to obtain fast detection results. Taking this work as starting point, methods for building one-class and multi-class object detectors are proposed. The contributions of this thesis work are three fold. First, an efficient learning framework of nested cascades of boosted classifiers for one-class object detection problems, with special emphasis on the training procedures, is proposed. Secondly, the proposed methods are extended to the multi-class case. Finally a nested tree of cascades, so called *TCAS*, is introduced, classifier that allows to better deal with multiclass object detection problems.

Most existing learning frameworks have a high computational complexity and require to predefine the structure of the classifier. The proposed learning framework for the one-class object detection problem is designed to build robust and fast object detectors in an efficient way without the need to predefine the structure of the classifier. This framework allows to build detection systems that have high accuracy, robustness, processing speed, and training speed. Using this framework state of the art face detection, eyes detection, and gender classification systems, as well as car, hand and robot detections systems are built.

When building systems that require the detection of multiple objects, the processing time becomes an important issue, as it increases linearly if several classifiers are used in parallel. Seeking to find a solution to this problem, we extend the concept of nested boosted cascade classifiers to the multiclass case. For this, a method to build multiclass nested cascades of boosted classifier is proposed, the use of coupled components in multiclass weak classifiers is introduced and compared to two existing alternatives, and the use of coarse-to-fine multiclass cascades in the object target space is proposed.

To better deal with the multiclass detection problem, a new classifier structure that consists of a nested tree of coarse-to-fine multiclass boosted cascades, so called *TCAS*, is proposed. The *TCAS* classifier is evaluated by building a multiclass detector of hand fists and faces, and a in-plane rotation invariant multiview face detector for which state of the art results on the CMU rotated database are obtained. Results showing that the proposed system is faster and more accurate than parallel cascades, and that it scales well with the number of classes, during training and running time, are presented. The results show the robustness of the proposed methods for building multiclass and multiview object detectors.