# GPU Implementations of HOG-based Object Detection using Deformable Part Models

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Visione-based object detection using camera sensors is an essential piece of perception for autonomous vehicles. Various combinations of features and models can be applied to increase the quality and speed of object detection. A well-known approach uses histograms of oriented gradients (HOG) with deformable models to detect a car in an image. A major challenge of this approach can be found in computational cost introducing a real-time constraint problem in the real world. In this paper, we present implementation techniques using graphics processing units (GPUs) to accelerate computations of similarity scores of the input image and the pre-defined models. Our implementation considers not only the algorithm part but also the entire program structure. We experimentally show that our implementation using commodity GPUs can achieve speedups of 1.5x to 3x in frame-rate over sequential and multithreaded implementations using traditional CPUs.

***Index Terms*—GPGPU; Computer Vision; Object Detection**

## I. Introduction

Grand challenges of cyber-physical systems (CPS) include a high computational cost of understanding the physical world. Image-based object detection is one of compute-intensive tasks for CPS. For example, an autonomous vehicle needs to detect and track other vehicles by itself. Current autonomous driving technologies [6], [11], [16] tend to rely on active sensors such as GPS, RADAR, and LIDAR [9], [14] together with very accurate pre-configured maps, but the use of passive camera sensors is becoming more practical due to recent advances in computer vision [2]–[4]: vision-based object detection can be applied for various ranges and orientations. In particular, histograms of oriented gradients (HOG) [2] features provide reliable high-level representations of an image underlying many state-of-the-art object detection algorithms [3], [5], [13], [15], [17]. However, a major concern of HOG-based object detection remains in computational cost.

Previous work on the implementation of HOG-based object detection are limited to either hardware implementations [7], [8], [10] or specific parts of the HOG algorithm [1], [12].

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